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Bee Culture

April Features . . .

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This photo was taken in the almond orchards of California several years ago. It was taken by Kodua Galieti, another friend recently lost to cancer.

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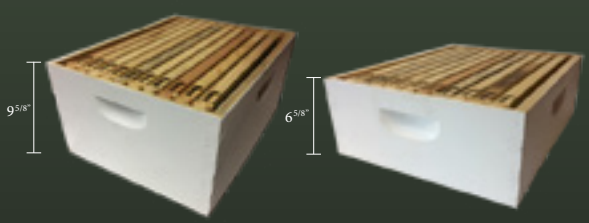

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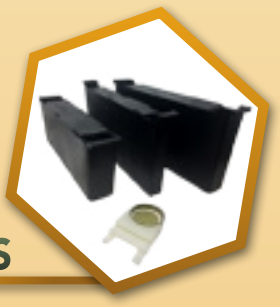

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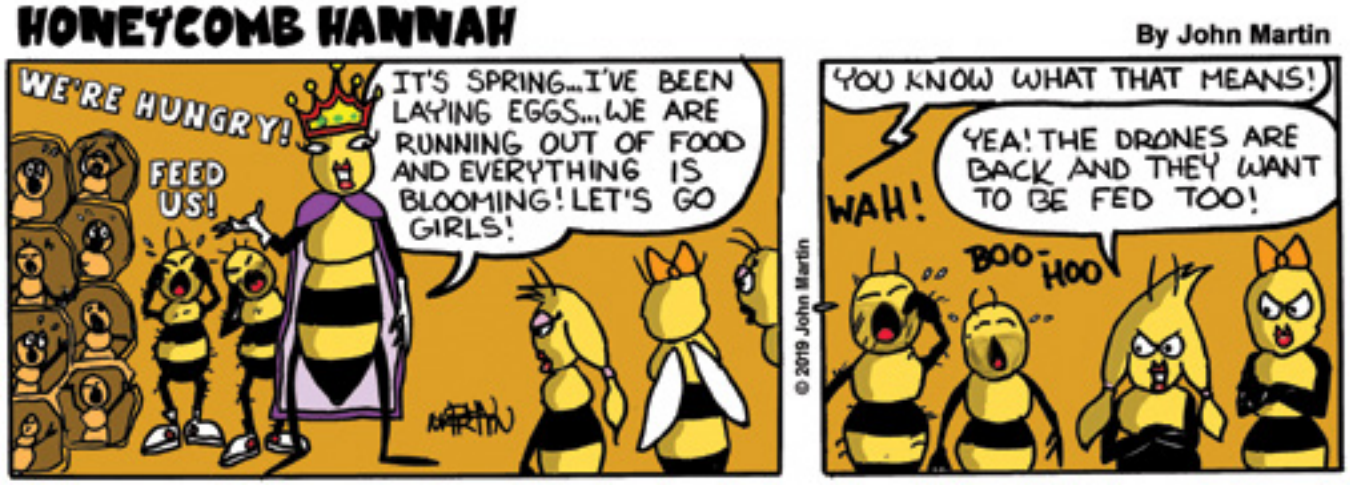

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Magnetoreception

The Significance of magnetoreception on the flight behavior of honey bee workers and drones (DCA'S): a brief discussion of the literature and possible research approaches.

Evidence has been accumulating in the bee research literature since about 1960 that both applied and natural magnetic fields can be sensed and responded to by honey bees (*Apis mellifera*) – both in the hive and while free-flying.

As I surveyed the literature, I found that there is a wealth of data documenting the magnetic responses of honey bee workers to various experimental and natural magnetic fields, I did not find any that specifically reported any effect on honey bee drones. Except a mention of drones and DCAs related to electric power lines (Loper, Wolf and Taylor Jr. in J.Kansas Ent. Soc. 1992). Using a very sensitive magnetometer, I surveyed several natural and unnatural magnetic anomalies related to honey bee drone activity and found values in the range of 250 t0 2,500 nano Teslas (nT). The earth's normal magnetic field in the areas was about 50,000 nT.

Several of the published studies describing the magnetic "sensors" in the worker honey bees have found the magnetite location in the bees and found their sensitivity to magnetic fields to be even lower than the 250 nano Teslas I had found (as low as 22 nT).

Even though there are least two published reports in the literature documenting the location of iron in the trophocytes of honey bee drones, none of the studies examined the magnetite that, until now is just assumed to be in honey bee drones.

As is well known, honey bee drones, during the mating season, leave their nests In the afternoons, and day after day (even year after year) fly to the same local and specific mating locations called Drone Congregation Areas (DCAs). In their flight to these locations, drones form flyways often using visual terrain features, and along the way form these DCAs. The specific locations are not predictable, and the "reasons" for the locations are unknown, although many have tried to predict them without much success.

I am proposing that at least some DCAs are formed as the drones interact with the magnetic field as they encounter magnetic anomalies. These anomalies can easily be found using a magnetometer or produced experimentally to test this idea.

A more complete study could be conducted which include the best of current radar tracking capabilities to locate and define some DCAs and then use magnetometers (with GPS) combined with techniques to experimentally create and or negate magnetic anomalies within the drone flyways to definitively determine the influence of magnetoreception in honey bees – especially drones.

If anyone is interested in this, please contact me:

Gerald M. Loper
4434 E. Blacklidge Dr.
Tucson, AZ. 85712
ggloper@cox.net

Apitourism

Bees for Development has a long history of sharing its experiences in other countries with some lucky UK beekeepers. In fact, next year will see the 20th anniversary of our ever-popular 'Safari' to the Islands of Trinidad and Tobago, where our host and Trustee Gladstone Solomon introduces holidaymakers to tropical beekeeping with both European and Africanized bees.

In 2018 we decided to organise a beekeepers' safari to Ethiopia. We have been working in the Amhara region for many years and we have established **Bees for Development Ethiopia**, an NGO with a proven track record in training young people to become beekeepers, with the objective of alleviating poverty while also preserving and encouraging biodiversity. It is important to understand that peer-to-peer training, delivered in the Amharic language, is one of the keys to the scheme's success. Bees for Development's approach is always to build on local skills, everywhere utilising local bees and making equipment with locally-

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available materials.

When you gather a group of beekeepers, with the common objectives of having a great holiday and a stunning new experience, you have a winning formula. Our group of 18 UK *Apitourists* was soon sharing both a cultural rollercoaster and a common love of bees. And honey. We had the opportunity to sample honey straight from the comb, and it had a wonderful flavor.

Visiting some of the region's world-renowned sites like the rock-hewn churches of Lalibela and examining our 'ancestor' Lucy in the National Museum of Ethiopia in Addis Ababa formed part of the fascinating holiday. Along the way we met real farmers, and real beekeepers – some of the people who have been trained by BfDE in beehive construction, apiary management and honey harvesting methods. These lovely people were proud to tell us how they had benefited from the carefully delivered skill modules. Some are changing from using local-style hives to the more sophisticated, but more complicated to construct, top-bar hives which give them better yields. We heard how beekeeping activities are in harmony with the local flora and how sustainability is a key concept in Ethiopia. Some local beekeepers explained to our group how they are using the money they have earned from selling honey and beeswax to improve their lives and those of their children. We at **Bees for Development** know that it is important that our UK beekeepers should witness the impact of our continuing work.

There is a well-established tradition of eating honey in Ethiopia; it is usually crushed comb pushed into any available container. **Bees for Development** encourages beekeepers to form cooperatives to process and pack their honey better (eg in clean, standard jars) or in bulk, and this way they can achieve greater income from better marketing, both locally and further afield, as well as selling to tourists.

Apitourism is a new way of combining bees and beekeeping with travel, witnessing the creation of new employment prospects and economic growth – while exploring some aspects of a country that other, more traditionally-led travellers may well miss altogether. *Apitourism* offers the host country an opportunity to increase or strengthen local beekeeping – thanks to added support and targeted fundraising.

So, what do lucky beekeepers do during the Winter months? They go on a **Bees for Development Beekeepers' Safari**! We look forward to welcoming more of you soon.

Please see our website **www.beesfordevelopment.org** or call us now for details of this year's Safaris: 01600 714848

March 2018 Update

At a family acreage when a river had become unsafe because of a late Spring storm and an unusual weather pattern, my days would be known. In a field where there are bales of hay, some rows of beans were recently produced. This past season the beans weren't productive. A man claimed that when, during youthful days, he bucked hay, he maintained that a days of activity, both types of work involved much labor. Last season, when doing walks with a pack, it rained considerable, and I hadn't expected it.

They began at the Wallula area where at days past I attended a sheep auction. The first week of February, a ladder didn't maintain its position when being used. After I fell, there'd be several weeks that I couldn't walk.

A letter was printed in the March 2018 issue and it discusses a hive that a man built. The observation hive could be different than any other hive located anywhere (shown below). Someone who could want the hive, may obtain it free of charge. They'd need to haul it and it weighs considerably.

The letter mentions a homestead. My dad's family would spend a number of days located at Harney County, Oregon.

Willie Rogers
1104 E. 6th Ave
Kennewick, WA 99336

Smart Snowman

We have the smartest snowmen on the planet. Also, my wife, Shelby, and I are giving another Beekeeping Apprenticeship Course for The Olympia Beekeepers Association through the Washington Master Beekeepers Association. It is a one night per week, six consecutive weeks course. She is an Apprentice and I am a Master Beekeeper. We have set the course max at 35 but we have 51 signed up. How do you say no, right? Out of the goodness of your heart, Shelby and I would LOVE to be able to start our "Newbees" new found hobby out with the best literature on beekeeping right off the bat. In the past, our candidates went wild and loved it. We used real time, current articles from *Bee Culture* in our curriculum during the courses.

Thanx in advance. Shelby and I, OBA, and our candidates all very much appreciate it.

Tim and Shelby Weible
Olympia, WA

Editor's Note: Bee Culture *is always happy to send magazines for your beekeeping classes. We need at least four weeks notice by email to be able to process your request. We get a lot of them. Please email Amanda all of the information on how many and where to send and she will get them to you. Her email is* **Amanda@BeeCulture.com**.

Learning About Bees

I'd like to learn as much as I can to start keeping bees. Can you advise me? I'd love an introduction to beekeepers in the area. Also, I would like to subscribe to your magazine.

Eleanor Mascheroni
New York, NY

Editor's Note: *You probably have a county beekeeping association. Google that and find it, or one close by. Join the group, take the beginner's class they will have this spring. Send me an address and we'll send a sample magazine. Find out from your class/association where to get equipment locally, where to get bees locally and*

then find a mentor in the group if you can. Offer to work for free to get experience. Join another group if you can, check out the state group, and anybody close to you that can help. Get a copy of The Backyard Beekeeper *and read it. I wrote it for you. Then get three or four other beginner books and read them. Be prepared to spend $300 - $400 for all this.*

New Prof At Purdue

Starting January 1st Dr. Brock Harpur started as assistant professor at Purdue University's Department of Entomology, replacing Dr. Greg Hunt. Congratulations Brock!

Brock Harpur is currently a National Science and Engineering Research Council Postdoctoral Fellow at the Donnelley Centre, University of Toronto. His work brings together large data sets to explore the evolution and genetics of honey bees. Brock completed his Ph.D. on population genomics of honey bees at York University (Canada). He has established beekeeping programs in Northern Canada, worked with the City of Toronto to establish goals for pollinator health, and given public talks to dozens of local organizations. Brock has been awarded the Eickwort Award from the International Union for the study of Social Insects, the prestigious Julie Payette Research Scholarship from the National Science and Engineering Research Council, an Ontario Graduate Scholarship, the Entomological Society of Canada's President's Prize, and was an Elia Research Scholar during his time at York University.

Greg Hunt

Apology to BDA

In the December 2018 issue of *Bee Culture*, the logo of the Biodynamic Association (BDA) was erroneously printed with the article "An Apology to Oxalic Acid" by Frank Mortimer. The BDA is not connected in any way with this article and does not support its content. As an association with over 1500 members from across North America, the BDA recognizes that there are many perspectives

about biodynamics. However, several of the statements made in Mr. Mortimer's article do not reflect the BDA's understanding of core biodynamic principles. Biodynamics is a holistic, ecological, and ethical approach to farming, gardening, and land stewardship, and biodynamic beekeeping offers insights into the nature of honey bees as well as practices to nurture their health and wellbeing. The BDA offers many educational resources at **www.biodynamics.com**, and welcomes inquiries from readers who wish to learn more about biodynamic beekeeping at **info@biodynamics.com** or 262-649-9212 x2.

Thea Maria Carlson
Executive Director, BDA

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transport drones from a select hive to another apiary. This may help to prevent inbreeding and spread selected characteristics. Made in USA. Available at **www.beetlejail.com**

The Honey Bus. A Memoir of a Girl Saved by Bees. Meredith May. ISBN-9780778307785 6" x 9", 270 pages. Published by Park Row Books. $24.99.

I've known Meredith May since the Fall of 1991, when she sent in a story about helping her grandfather extract honey in an old bus he used as his honey house. It was a good story, well told, and she shared lessons in life she learned from her grandfather, and from the bees that were a part of every extraction event. Most every beekeeper I know can share similar stories about working with children in similar circumstances.

It was, I found out nearly 30 years later, the first article that she wrote that was published, and in a magazine she had known from childhood. Her grandfather read *Gleanings In Bee Culture* back then.

That we published her story, she told me, helped lead her to a life of journalism, working for west coast newspapers, teaching, and writing other books. She spent sixteen years at the *San Francisco Chronicle* and has won many writing awards, including being shortlisted for the Pulitzer Prize. There's a quiet pride in having some small role in shaping a gifted life.

She also taught journalism and podcasting at Mills College in Oakland and keeps bees in a community garden to this day. You can see her bees, her grandfather and the honey bus itself on her videos at **www.TheHoneyBus.com**.

Her book, *The Honey Bus* is the rest of that first story, and it too is a very good story, well told. Her parents divorced when she was five, and she, her younger brother and her mother went to live with her mother's parents near Big Sur, California, moving there from Rhode Island. The story is her life all the way to college. And it was a difficult life. Her mother didn't recover from the divorce, so her grandparents did most of the parenting. Where she was living was very small, and though she had time with her father, those times were short, and far away. Her grandmother was a school teacher, so had that discipline with children. But her grandfather was a plumber, and a beekeeper, and kept his bees near the ocean. And his honey bus in the backyard.

She very early on traveled with him on trips to his beeyards, and it was these times that were special when he shared his life's wisdom and his experience with her mother (his step daughter), and his wife. And when they got to where they were going, there were more lessons, these taught by the bees. Bees were family, bees took care of each other, bees were loyal. Bees were special.

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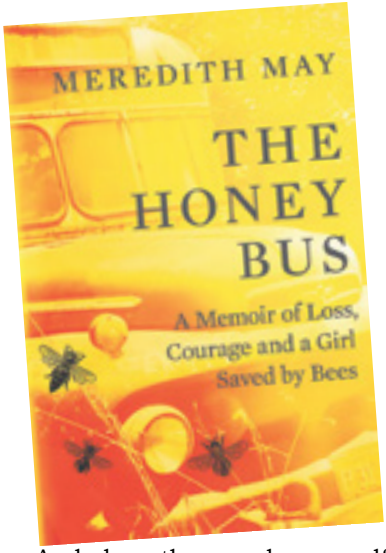
The band is made of leather. The top is black leather with yellow stitching while the bottom is made of yellow leather.

The Watch which retails for $150, will be available beginning mid-April and can be found here – **https://projectswatches.com/?post_type=product&p=67582&preview=true**



And along the way, her grandfather taught her a lot about the bees. About wax glands, about stings, about hexagon cells, about queens and swarms and drones and waggle dances and flowers and honey and take care of the bees and they will take care of you.

So it's a bee book, kind of. It's a family story. It's a memoir. It's what shaped a little girl. You will learn some things about bees when you read this, but you will learn more about yourself, and your life with bees. *Kim Flottum*

INNER COVER

Take a look at that article on thermal efficiency on page 61. Read it, then read it again. I found it amazing how much honey it takes to make honey. When you look at that hollow tree and its very thick walls, then compare to the walls of the hives we use, I wonder why bees bother to stay with us. The homes we give them are remarkably inefficient. Not quite paper thin, but almost so, the heat exchange between inside and outside, cold in Winter, hot in Summer, quite simply wears out our bees. They die faster than they ought to, they work harder than they ought to, they use more honey making honey than they ought to, they spend more time not collecting nectar than they ought to, and they make less honey for us than they ought to. We are, quite simply, wasting a lot of their time, energy and resources.

Thicker walls seem to be one answer. Look at the thickness of hollow trees in the wild. Inches thick, providing lots and lots of insulation. Easier to keep warm in the Winter, easier to keep cool in the Summer.

Adding insulation to a beehive in the Winter certainly makes sense. Making the temperature difference greater between the outside of the wall and the inside of the wall makes keeping the cluster temperature easier, requiring less energy – food – than if the empty space inside a hive surrounding the cluster is the same as the outside temperature. And, for the most part, that's a pretty close picture to what's going on. The only real warm place in one of our hives is the cluster, and a bit of the space directly above the cluster. The rest is about as cold as it is outside.

And the same for warm summer days. Did you ever feel the inside of a hive on the south or west side on a hot Summer day? It is warmer than the north side, certainly. And that heat has to be removed, this hive has to be cooled, so bees have to be fanning. Of course warm air helps dehydrate the nectar coming in, if nectar is coming in, but the air has to be dry so it can absorb the moisture being released by the nectar, and to get dry air in and humid air out fanning takes place. That takes energy. Honey energy.

Thicker walls. But thicker walls mean heavier walls. I use eight frame equipment because of the weight of 10-frame equipment. If those boxes had walls that were 10 inches thick, I'm thinking I couldn't even lift a box, forget about frames and honey inside. But that's what trees in the wild have. That's what lots of house walls have.

What bees want is a cavity about the volume of a deep super, protected from the elements, and an easy to defend entrance, preferably on the bottom of the cavity. The thicker the walls the better, but seldom do they take that measurement. It's just that trees in the wild mostly, but not always, have thick walls.

So this year I'm looking into those Styrofoam/polystyrene/polypropolene boxes that are available. And yes, I know, they've been around for decades, claiming to keep bees warmer in the winter, and cooler in the summer. Sometimes you have to hit me a couple of times before things start to sink in. I'll let you know how they turn out a year from now. Or ask one of the sellers. They already know.

•

We recently did a podcast with Peter Nelson, producer of a new documentary on the commercial pollination business in the US. He's also a beekeeper so he knew what he was doing. One of the people he interviewed was Johnathon Lundgren, from Blue Dasher Farm, who is a strong advocate of sustainable agriculture, especially working with the soil. To change big ag, he summarized, wouldn't happen from the top down, but from the bottom up – change customer demand from destructive practices to better farming, and it will happen.

In early March a couple of similar events happened. A group representing tomato workers in Florida have convinced several big chain fast food companies that they should be using fruit from farms that have turned around their labor practices, ending physical abuse, even slavery of their workers, and paying them local minimum wage. Fast food customers have caught on and are, for instance, banning some from campuses and even towns if they are using fruit from non-complying companies.

Suppose we could do that with honey on grocery store shelves?

•

Yes, we really are going to have A.I. Root, L.L. Langstroth, Jim Tew, Wyatt Mangum, Tammy Horn-Potter, Gerry Hayes, Gabe Dadant and Jim Thompson here in October to talk about the history of American beekeeping. If you've always wanted to meet any of these people up close and personal, this will be your chance. You can ask A.I. about his windmill driven printing press, or L.L. about that fancy front porch on his new hives, or Wyatt about all those different kinds of boxes, or Jim about the hive tool collection he has, or Gerry about the ABF, the AHPA, The American Honey Institute, or Gabe about the history of the Dadant business, or Jim Tew about the thousand authors who have written books about bees, or Tammy about all the creations American women have had on bees and beekeeping. But you can't if you don't register, and you can do that on our web page.

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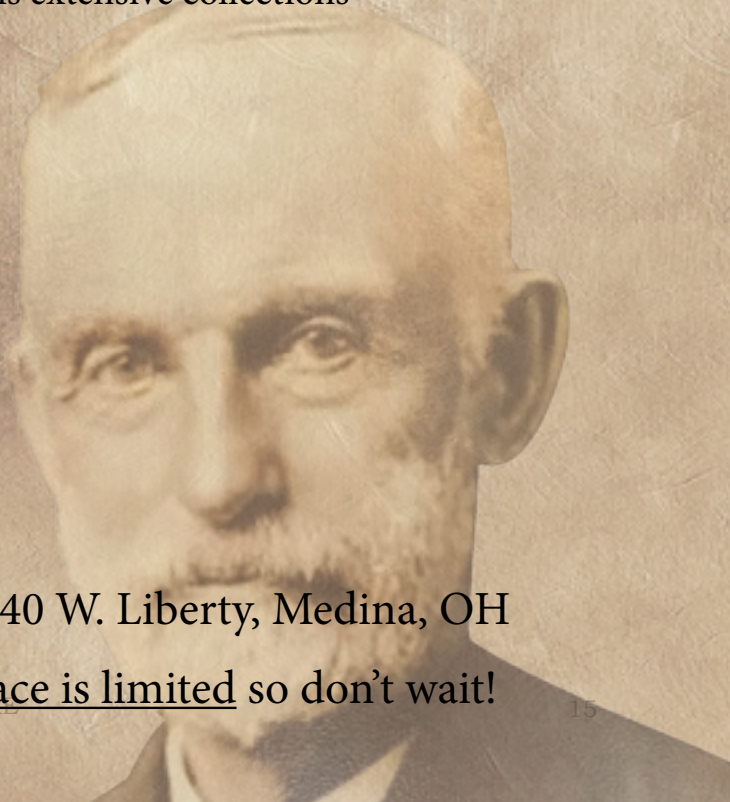

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It's Summers Time –

Meetings, Friends, October and Chickens

Spring is trying to be in the air, but without much success. It was 22°F this morning when we got up. But the true first sign of Spring coming to Northeast Ohio is the Tri-County Beekeepers Conference held in Wooster at OARDC. It's always the first Saturday in March and even if the weather is against us close to 1,000 beekeepers still show up.

This year's conference wasn't hindered by snow, just cold so we all showed up and it was an incredible day. We had almost all of our *Bee Culture* team there and Kim was the keynote speaker this year. This is the first big meeting of the year and it gets us all in the mood to be outside and in the bees. All of the big vendors and lots of local folks are there selling their wares. It's a day of seeing fellow beekeepers, helping beginners get ready and just talking about bees all day.

At the end of March we'll be going to Cincinnati for the Southeast Ohio Beekeeping School. It's a much smaller meeting, but still a good day of teaching beginners, selling books, talking to old friends. I get the added treat of being in the car for three hours with Kim and Jim Tew – usually Jim's wife, Vallie is also with us, but this year she's abandoned me.

We found out recently that we've lost another good friend. This job and beekeeping in general have connected Kim and I to so many people that we would never have met if not for the bees. And Peter was one of those people.

Peter Smith was very British. He lived in a small town near London. In 2003 he wrote and sent to Kim an article about swarming. We published it in the February issue of 2003. Then we were invited to the National Honey Show which at that time took place in downtown London. It's always toward the end of October. So we made plans to go and in chatting back and forth with Peter found out he was also going to be a speaker. That's when we got to meet him in person.

We quickly bonded with him. He was delightful. On that first trip to England, after the Honey Show he picked us up and drove us all around London and then to his home where we spent a few days with him and his wife. Then he took us to Stonehenge, to Wales, Bath, we saw Buckingham Palace. And became very good friends.

With Peter Smith, October 2017.

In 2005 when I was president of EAS held here in Ohio at Kent State University, we invited Peter over to be part of the meeting. He did a workshop on English hives and spent a few days before and after the meeting just visiting. He saw his first fire flies on that trip.

Between 2005 and 2017 we've made several trips to England and I think each time we were always able to connect with Peter and spend at least a day with him. Not only was he entertaining, but very smart. He was an engineer and in his younger days had travelled all over the world overseeing the digging of boreholes. Until I met Peter I had no idea what a borehole was.

Our last visit with Peter was in October of 2017 and the timing worked out that we spent his 87th birthday with him and had a wonderful visit – not knowing it would be our last in person. We miss you Peter. Thank you for being in our lives.

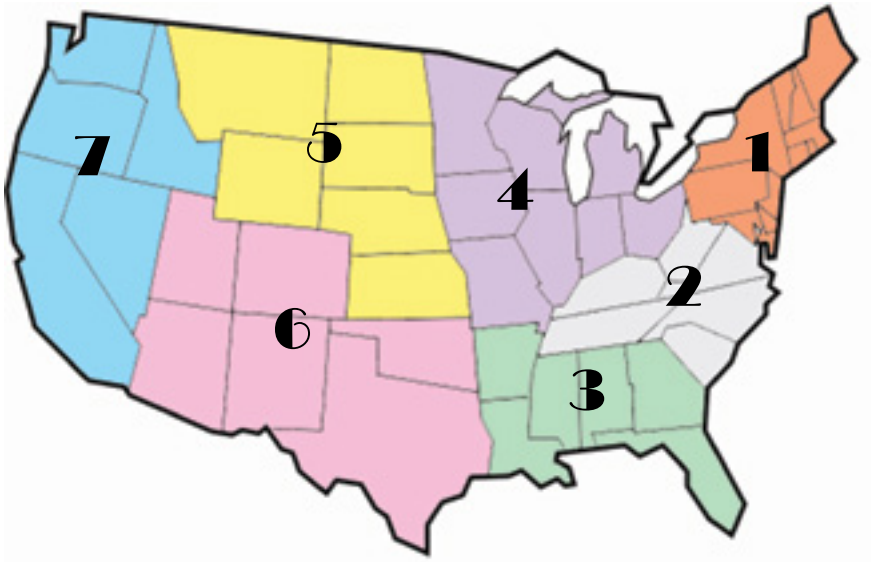
It's time for you to start thinking about attending our October event. Please take a look at Page 15. Registration starts May 1. We're celebrating the 150th anniversary of the A.I. Root Company and the History of American Beekeeping. We hope you can be here with us. A.I. and L.L. and C.P. will all be here.

The local feed stores have gotten their chicks and ducklings in. It seems a bit early and a bit too cold. So we'll wait awhile before getting ours. I like it to be a little warmer before we bring those babies home. We're at 16 hens right now. The one Rhode Island Red we had died about a month ago. She was from the original group so approaching seven years old this Spring. She had not acted sick or different but one day Kim went out to check on them and there she was, as if she had just fallen right off the perch.

Happy Spring, hopefully soon!

The younger Bee Culture *team members – Amanda, Kelsey and Jake.*

APRIL – REGIONAL HONEY PRICE REPORT



We asked our reporters what they did last Summer/Fall to get their bees ready for what has turned to be a long, cold, wet Winter in most places. Here's a summary of their management actions and some results so far.

27% did not feed their bees anything last Fall. 33% fed both protein and carbs, 6% protein only and 34% fed carbs only.

What about mite control (we didn't ask about measuring mites, just control substance application). 20% did not apply anything for mite control, while 78% applied some form of mite control.

And what about moving them only a short distance to a better/safer/easier to get to location? 83% didn't move them at all, but 14% actually did more them somewhere better.

And moving them further, to a warmer climate? 6% did move them, to places like Georgia, California or to lower elevations in several places.

Buildings are becoming important to some for wintering, 93% or our reporters haven't explored that option yet however, but 5% are moving in that direction, using underground bunkers, storage sheds and the like.

Winter protection of any kind? 69% don't use any, but 30% do use some. What kind? Pre-made wraps from bee suppliers, regular tar paper, black plastic, heavy duty foam insulation of several types, bee cozies are popular, roofing felt paper, and plastic cardboard wraps.

As of the first week in March, a quarter of our reporters hadn't been able to inspect their bees yet, but based on previous experience, or actual inspections, 24% thought they were doing better than they expected, 39% were right where they thought they should be, 33% however were doing worse than expected, with some arguing it was the worst Winter in 25 years.

	REPORTING REGIONS							SUMMARY			History	
	1	2	3	4	5	6	7	Range	Avg.	$/lb	Last Month	Last Year
EXTRACTED HONEY PRICES SOLD BULK TO PACKERS OR PROCESSORS												
55 Gal. Drum, Light	2.18	2.22	2.15	2.19	2.39	2.15	3.00	1.28-3.00	2.22	2.22	2.28	2.29
55 Gal. Drum, Ambr	2.11	2.15	1.95	2.18	2.11	1.98	3.00	1.28-3.00	2.09	2.09	2.19	2.19
60# Light (retail)	213.37	187.50	197.50	210.19	157.50	195.55	213.37	137.74-300.00	207.88	3.46	201.36	202.88
60# Amber (retail)	206.84	187.25	191.25	207.69	206.84	187.62	223.33	125.74-285.00	208.31	3.47	201.96	202.10
WHOLESALE PRICES SOLD TO STORES OR DISTRIBUTORS IN CASE LOTS												
1/2# 24/case	105.02	76.83	87.40	67.00	61.20	84.00	105.02	54.60-194.40	85.54	7.13	90.32	85.19
1# 24/case	159.05	110.53	125.39	119.35	120.00	124.88	168.00	72.00-300.00	132.11	5.50	133.17	124.55
2# 12/case	141.93	99.00	119.88	120.77	111.84	104.40	141.93	79.20-246.00	121.26	5.05	114.76	110.42
12.oz. Plas. 24/cs	109.01	95.04	96.00	87.93	83.76	104.00	96.00	66.00-172.80	98.61	5.48	98.78	98.57
5# 6/case	143.51	112.63	118.93	120.25	113.16	115.50	143.51	71.50-240.00	131.27	4.38	128.84	126.05
Quarts 12/case	179.07	142.50	128.84	157.04	123.54	137.27	144.00	108.00-300.00	154.14	4.28	157.36	141.78
Pints 12/case	99.67	81.64	76.60	98.71	99.67	84.08	84.00	60.00-160.00	89.35	4.96	94.66	91.65
RETAIL SHELF PRICES												
1/2#	5.31	4.69	4.22	4.79	4.24	4.76	5.31	2.28-9.00	4.97	9.94	5.21	4.86
12 oz. Plastic	6.58	6.06	5.09	5.95	4.60	6.46	4.80	3.50-11.00	5.91	7.88	6.07	5.78
1# Glass/Plastic	9.33	7.76	7.36	7.50	7.27	7.92	9.50	4.50-17.00	7.90	7.90	7.91	7.40
2# Glass/Plastic	15.04	12.92	13.18	12.90	13.14	13.80	13.50	6.99-26.00	13.58	6.79	13.76	12.47
Pint	14.22	10.31	8.32	15.13	10.67	10.38	9.80	6.00-29.00	10.94	7.29	10.86	10.08
Quart	20.52	18.10	15.25	17.96	17.14	17.68	20.38	9.25-36.00	18.41	6.14	17.99	17.10
5# Glass/Plastic	29.51	27.10	31.70	30.60	25.91	24.74	45.00	15.00-45.00	29.02	5.80	29.91	26.74
1# Cream	12.03	8.58	8.00	9.40	10.47	8.50	10.50	6.00-22.00	10.06	10.06	10.52	9.07
1# Cut Comb	13.15	9.63	9.49	10.13	10.00	10.50	13.15	6.00-24.00	11.29	11.29	11.93	11.48
Ross Round	9.66	6.93	9.66	9.66	9.66	10.75	12.49	6.00-13.00	9.83	13.10	9.17	8.27
Wholesale Wax (Lt)	7.62	4.88	4.89	5.95	5.50	5.63	8.80	2.45-15.00	6.52	-	6.80	6.41
Wholesale Wax (Dk)	6.95	4.68	3.94	5.31	6.95	3.17	15.00	2.00-15.00	5.39	-	5.92	5.64
Pollination Fee/Col.	109.74	67.00	83.75	83.75	109.74	141.00	105.00	50.00-200.00	94.48	-	86.00	89.58

NEXT MONTH

Welcome to NEXT MONTH, where our Honey Reporters share a line or two about what they will be doing NEXT month with their bees. Advice is given for each region so you can see what others are doing where you are, and, of course in all the rest of the regions. Check these out. These reporters are successful in business.

Region One
- Make splits
- Move bees to production yards
- Feed
- Medicate
- Clean up
- Check mites
- Check for brood & queen
- Feed sugar, pollen
- Reverse and scrap old comb
- Start monitoring for varroa mites
- Swarm prevention
- Ensure bees have room to expand
- Check for swarm cells
- Keep feeding until honey flow in June
- Add honey supers as needed
- Insert varroa control
- Check stores, bear fences repair
- Replace a third of the comb
- Balance brood in all hives
- Apply pollen substitute

Region Two
- Insect prevention/ mite prevention
- Ground/ location improvements
- Provide space in the brood boxes
- Perform mite counts
- Add honey supers to hives
- Monitor mite levels in every colony
- Check on honey flow
- Check on any diseases
- Check queens
- Check for swarming
- Inspections to make sure hives are queen right
- Keep adding honey supers to stay ahead of the bees making honey
- Check for feed, mite counts
- Try to control the small hive beetle
- Replace old equipment

Region Three
- Queen right
- Food stores
- Mite treatment
- Check mites
- Split for swarm control
- Apply microbial
- Add supers
- Pull honey, watch for more
- Provide more room
- Clean bottom boards
- Check for parasites
- Treat for *Varroa*
- Re-queen weak colonies
- Inspect for Queen cells
- Produce Queen cells for splits
- Remove any remaining patties
- Put in beetle traps

Region Four
- Mite & small hive beetle control
- Feed
- Feed both carbs and protein
- Split/ re-queen as needed
- Add honey supers when needed
- Monitor for swarming
- Check stores
- Control pests
- Do swarm control without making splits. Tip the top hive body up and check for Queen Cell activity every seven days.
- Make sure you have supers on your strong hives for the black locust flow

Region Five
- Make sure they have feed
- Move them to summer yards
- Check for mites
- Feed syrup and pollen patties
- Re-queen
- Treat for mites

Region Six
- Medicate for mites/disease
- Feed syrup and pollen
- Order bee packages to replace winter losses
- Re-queen
- Reverse hive bodies
- Swarm control
- Move to a flow
- Don't let them get spray (pesticide) exposure
- Make sure they are close to water

Region Seven
- Move to a location with early abundant food source
- May need to feed due to location
- Try to control mites
- Queens
- Feed as required
- Make splits
- Swarm control

Honey Reporters Wanted

We are expanding our Honey Reporter population and need new reporters in EVERY region. We ask that you fill in most of the wholesale or retail or both sections, most months, and our short survey on the back. We give you a FREE subscription for your service. So if you are interested send an email to **Amanda@BeeCulture.com** and put REPORTER in the subject line. Include name, email, phone number and mailing address and we'll get you the next Honey Report form. Sign up today and be a part of the BEST Monthly Honey Price and Beekeeping Management Report in the industry.

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BEE TALK

Welcome to BEETALK, Where Bee Culture Answers YOUR questions. Got a question for our regular writers? Send it to me, KIM@BeeCulture.com, and I'll send it to all of our regulars. So we'll provide an answer that will come from this or that part of the country, or from a beekeeper, a bee researcher, or a bee business person. You'll get all kinds of Perspectives to the question. All kinds of experiences, all kinds of locations, all kinds of answers. It is, quite simply Beekeepers having a BEETALK. What could be better, and who better to answer your questions! Send in your questions to me, at KIM@BeeCulture.com, and put BEETALK in the subject line. That's all it takes to be part of the grandest BEETALK you can imagine.

Question 1

What's the best way to replace a queen in a strong, active colony this month?

Split the hive and remove the old queen. Let both splits go queenless for 24 hours. Place new caged queens in both splits, with the cage candy plug exposed. Don't touch either split for 10 days. You can make this more complicated, but I don't recommend it. *Ed Cobey, CO*

So much as possible, I leave my productive, larger colonies to themselves therefore, I probably would not be replacing or requeening such a colony. If I were making splits, I would separate the broodnest with queen excluders, wait three-four days and look for the broodnest section that had eggs. Find the queen, make the splits, install new queens and then decide what to do with old queen. I suspect that I would let her go another year. For different reasons and on different occasions, I might search for the queen in such a powerful colony in an effort to employ swarm prevention procedures. *Jim Tew, OH*

I assume you have a good reason to replace the queen of a strong, active colony. I would establish a nucleus colony above the current one, separating them with a double screen. The new queen would be introduced into the nuc. After this new queen is well established and laying well remove the original queen and double screen then combine using a sheet of newspaper. *Ann Harman, VA*

The best way in terms of successfully getting the hive to accept a mated queen the fastest, is to remove the old queen and after 24-48 hours spray all the frames, bees, brood, etc., with a light coating of lemongrass and spearmint essential oils emulsified in sugar syrup at a ratio equivalent to four teaspoons of concentrated essential oils per quart of sugar syrup. Then introduce the queen directly into the colony by uncorking her cage and letting her walk out onto the frames of comb. These essential oils are sold under brand names such as "Pro Health" and "Honey-B-Healthy". To try and replace a queen with the best quality queen however, I would let the colony raise their own queen from eggs since queens successfully raised by the bees are almost always good, while queens raised by beekeepers are sometimes good, and sometimes not. *Ross Conrad, VT*

Welcome to April. To get to April with live bees means you were on your varroa management game last August. Good going. Because of *Varroa* and all of the variety of *Varroa* products, agents and schemes Queens simply don't last as long as they did pre-*Varroa*. Having a Queen replacement plan ahead of the loss of her is a smart idea.

Having access to a Queen(s) that you in turn have some level of confidence in the Queen producer whether yourself or beekeeper friend or a commercial supplier is paramount. Raising good Queens is hard. Anybody can raise poor queens. And then we all tend to forget that the other 50% of this equation is the sperm contribution from selected 'good' Drones. Virgin queens mate in Drone Congregation Areas (DCA) with 15-20 different Drones from miles around. Those Drones are the fathers of those worker you will see shortly. Have you looked in your colony(ies) and seen some darker colored workers, or very yellow or almost orangish workers? Each one of those colors indicates a different Drone Dad for those workers. You can have a Queen that has the traits you want or are advertised but if Dad doesn't have those too then you have a very good mongrel for your all your $$$$.

So, before you buy ask some questions. Then when you have reached a comfort level purchase what you need based on your assessment of colonies to re-queen and get a delivery date to plan around.

There are a variety of ways to requeen and they all have positives. The goal is to have your replacement Queens in hand in a safe secure warm place fed and ready be introduced to their new first family to start their new egg laying job.

It takes about 8 hours for a colony to fully recognize that they are queen less. Once you have removed the 'old' Queen let the colony be queen less for that period of 8 hours or overnight. I don't suggest direct release but rather a slower release with the attendants still in the queen cage. This is kind of like uniting two colonies only one is big and one is small. Place the cage of whatever design in a position that the bees in the colony can access the Queen pheromones from the cage and share food with the worker attendants. They need to get to know each other as friends not foes. To be sure everybody is happy on both sides of the cage I always spray a little bit of sugar syrup that has vanilla or lemon extract in it on the colony workers and on the cage. This way everybody smells the same and tastes the same.

If the Queen cage has a cork or door that has a sugar fondant plug in it remove it and expose it to the

colony to eat it slowly and release the Queen and the attendants.

If the cage does not have this feature wait a few hours for the odors, smells and taste to become shared in the colony and then you can do a direct release.

Is this perfect – nothing in Beekeeping is but if you take your time you will be successful more than not. *Gerry Hayes, MO*

Question 2

Replacing old combs – how many and how?

Most everything we do in managed beekeeping is designed for us not the bees. Back before us, honey bees would live in a hollow tree for a few years and swarm or abscond and wax moths would move in and destroy the old comb as they ate it and removed this reservoir of toxins and disease. Remember that beeswax is a 'fatty acid' which is a chemical sponge and absorbs and hangs on to all the toxins brought in from the environment or we as beekeepers have put in. Plus in brood comb there is this dark layer of larval skins that can harbor bacterial and viral diseases.

As part of a honey bee health management practice removing some portion of this toxic and disease reservoir from your colony is a good idea since we beekeepers don't want wax moths anymore to clean things up. The simplest thing to do before brood rearing takes off in full force is remove three old frames/comb every year replacing with new foundation. Over a period and about 3+ years this effort will remove most of the old comb and keep it relatively 'clean' and a more healthy environment to raise new bees. Then keep this new comb removal rotation habit going and you will have help reduce a variety of stresses in the colony. They have enough.

The old comb can be discarded or if you have pounds of it, it can be melted and reprocessed by your beekeeping supply dealer. *Gerry Hayes, MO*

Question 2 is a bit awkward to answer – some people have eight-frame, others have 10-frame. So – I can't say "remove frames one and 10 or one, two and 9, 10 – and if I say move to the outer sides some brainless beekeeper would think I meant "outside the hive itself" and then there are the ones with a top bar hive. Where you are sort of doing back and front. However, Establish a practice of moving older comb to the outer sides inside brood boxes. These may be empty of stores in Spring, depending on food supplies. Frames with new comb from honey extraction or with new foundation can be put in place. Try to exchange up to one-third of old comb each year. *Ann Harman, VA*

Presently, I do not have a lot of colonies; therefore, I do not have a large amount of extra, old combs. Generally, when the colony dies and I clear the mess for reuse, I replace combs then. After honey extraction, any combs with issues go away. A functional, solid comb would need to be seriously old or have other issues before I would just toss it. But oddly, I do not disagree that it is a good thing to regularly cull combs. My life's time and energy are limited. *Jim Tew, OH*

We have, after decades, finally weeded out frames branded by a certain departed researcher, and now just do it by gut based on how small and dark the cells are. It is likely that this means an average lifespan of eight to 10 years (but we ARE a disease lab). *Jay Evans, DC*

I try to rotate two frames of brood comb per hive each spring. I never rotate medium honey super frames. Sobering fact: bees hate foundation and sometimes refuse to draw it out into comb. Plus building comb takes a lot of hive energy. If you want to harvest a honey surplus, I wouldn't get too carried away with frame rotation. *Ed Cobey, CO*

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FOUND IN TRANSLATION

Delayed Mortification

Jay **Evans**, USDA Beltsville Bee Lab

Thousands of studies have shown the impacts of disease, chemical stress, and poor nutrition on honey bee queen, worker, and drone longevity. Acute insults from any of these routes can kill bees in days. What has been harder to measure is how challenges affect bee behavior and productivity across entire lifespans and in the context of the colony as a whole. Several recent studies provide insights into colony-level impacts of disease and stress, providing new avenues for measuring these factors in a way that is important for bees and beekeepers.

The first challenge has been to translate 'sublethal' events into traits that individual bees use to provision, protect, and maintain their colonies. Honey bees are notoriously smart for insects, so an appropriate target for such studies is to measure how individual bees learn tasks. In repeated studies, honey bee workers learn relevant tasks (such as the ability to associate a smell with a food reward) at a lower rate after exposure to disease agents and certain chemical stresses. Zhiguo Li and colleagues describe possible mechanisms behind these learning deficits in their paper "Brain transcriptome of honey bees (*Apis mellifera*) exhibiting impaired olfactory learning induced by a sublethal dose of imidacloprid" (*Pesticide Biochemistry and Physiology*, 2019, **https://doi.org/10.1016/j.pestbp.2019.02.001**). After low-level pesticide exposure, worker honey bees showed no increased mortality but did poorly on a test of their abilities to associate a smell (lemon) with a food reward. The brains of treated bees were then analyzed for gene activity. Bees under chemical stress showed reduced levels for genes arguably involved with sensory perception and learning, among others. The behavioral results in this study are similar to those found in worker honey bees following infection with Deformed wing virus (Javaid Iqbal and Uli Mueller, "Virus infection causes specific learning deficits in honeybee foragers", 2007, **https://royalsocietypublishing.org/doi/10.1098/rspb.2007.0022**). In both studies, exposed or infected worker bees did not show obvious symptoms and lived to a typical age, in some cases even longer than expected. The presumed impact was on their legacy of providing for the colony as a whole.

As we tackle longterm effects on bees, there is a need to resolve how good and bad events alike interact to affect bee health and productivity. A striking recent example of such interactions involves the simultaneous exposure of honey bees to two agrochemicals. In a careful pairwise study, Andrea Wade and colleagues found a 2000-fold increase in adverse impacts when a particular fungicide and insecticide were presented together ("Combined toxicity of insecticides and fungicides applied to California almond orchards to honey bee larvae and adults", *Insects* 2019, **https://doi.org/10.3390/insects10010020**). This information was immediately used by a sympathetic orchard industry to alert growers. Nature being nature, these synergistic interactions seem rare. This is good news for regulators and industries who wish to reduce impacts, but challenging in that the reasons behind these synergisms are still mysterious. In the meantime, identifying the myriad of co-occurring insults picked up by honey bees is a big challenge, yet that is exactly what is needed to direct future research into possible synergists.

Interactions often must be measured across long time periods and at the level of colonies. On the plus side, honey bee colonies provide a buffer of sorts against disease and abiotic stress. Whether because of an ability of colonies to shift behaviors or resources, genetic diversity that allows at least a fraction of the colony to escape threats, or simply a huge 'body' that is harder to perturb, honey bee colonies can endure stresses that are consistently lethal for solitary pollinators or those with smaller colonies. This 'superorganism' benefit likely prevents honey bee losses from being even higher than those observed (read a review by Lars Straub and colleagues, "Superorganism resilience: eusociality and susceptibility of ecosystem service providing insects to stressors", **https://doi.org/10.1016/j.cois.2015.10.010**). On the down side, honey bee colonies are a target of numerous parasites and pathogens. Once they get established, these agents can be additive over the season or lifetime of colonies, increasing risks to both bees and entire colonies months later.

Richard Odemer and colleagues in Germany describe the most recent attempt to measure the combined and individual impacts of chemicals and disease on bees in the field. Their work, "Sublethal effects of clothianidin and Nosema spp. on the longevity and foraging activity of free flying honey bees" (*Ecotoxicology*, 2019, **https://doi.org/10.1007/s10646-018-1925-5**) reflects an ambitious study to expose field colonies to field-relevant levels of a common neonicitinoid pesticide, measure residues in bee stores and bees themselves, and then see how these exposures impact bees

in the presence or absence of an induced nosema infection. Exposure to *Nosema apis* led to higher bee mortality rates but low-level exposure to clothianidin did not. Surprisingly, combined exposure to both threats showed no synergism, in contrast to several laboratory studies, perhaps reflecting thre resilience of the superorganism. Also in *Ecotoxicology*, Reinhold Seide and colleagues describe a similar project aimed at identifying the impacts of clothianidin on disease levels (**https://doi.org/10.1007/s10646-018-1937-1**). In a study of 24 colonies that spanned nearly one full year, colonies given an initial dose of 200 ppb clothianidin died within ca. 50 days, while those receiving lower doses survived at the same rate of controls and maintained similar worker numbers. They observed trends toward higher mite levels in colonies exposed to low levels of clothianidin (10 and 50 ppb in nectar at the start of the experiment) but no significant differences for levels of mites, nosema, or viruses. Both *Ecotoxicology* studies were strengthened by the careful measurement of pesticide levels in exposed and control hives, giving insights into the fates of field-collected nectar contaminated by pesticides. One caveat to the work with low-level exposure to pesticides was that the observed residues in bees were even lower, in part because spiked nectar was further diluted by outside sources. As with most field studies, the results were also weakened by small sample sizes. Quantifying subtle differences in disease loads and survivorship requires screening on the order of 50 or more colonies, given the many unknown factors and chance events that cause bee colonies to differ in important traits.

As challenging as it might be to expose worker bees to multiple stresses, it is even harder to design experiments that measure how challenges on one life stage or caste (queen, worker, or drone) affect later ones. Christina Mogren and colleagues faced this challenge by meassuring the impacts of larval nutrition on the abilities of worker bees to survive adult challenges ("Larval pollen stress increases adult susceptibility to clothianidin in honey bees,",*Insects* 2019, **https://doi.org/10.3390/insects10010021**. To do this, they deployed pollen traps to rob pollen from ten nucleus colonies and then fed a fraction of this pollen to 10 additional nucleus colonies in the form of patties. After four sessions of pollen distribution, frames were removed from both colony types and worker bees were allowed to finish development and emerge in incubators. Newly emerged bees were reared in cups on a diet of sucrose syrup spiked with the insecticide clothianidin at concentrations of 10, 40, 200 and 400 parts-per-billion. Bees from pollen-starved colonies did especially badly when they subsisted on syrup with 40 and 200 ppb of the insecticide. While pollen-starved bees also fared more poorly than pollen-supplemented bees when maintained on non-contaminated sugar water, the experiments did suggest that both physiological changes and mortality in bees exposed to chemicals were affected by larval nutrition.

A large fraction of honey bee research is now focused on the challenges of determining the key impacts of disease and stress on the colony level. Hopefully, this work will lead to additional insights and recommendations for maintaining colony health in the face of these challenges. Honey bees thrive in the face of a range of environmental challenges, in part because they maintain a sisterhood of thousands of workers, but even honey bees will need more help to persist in the face of these challenges. Complex field research projects, and over-arching analyses across many such studies, are helping to identify the main factors that bug honey bees, the first step in managing these threats. BC

A Closer LOOK

MATING BIOLOGY AND QUEEN OVIPOSITION

Clarence **Collison**

If you raise queens this is what you need to know.

In the face of high proportions of yearly colony losses, queen health and fecundity has been a major focus in several research programs. Much of the reproductive quality of the queen is a function of her mating success and quality of the drones (males) she mates with. Many environmental factors can negatively impact drone semen quality, but little is known about factors that impact the drone's ability to successfully mate and deliver that semen, or how widely drones vary. Metz and Tarpy (2019) observed the daily variation in honey bee drone reproductive quality over time, along with a number of morphological traits. Drones were reared in cages in bank colonies, and 20 individuals were dissected and measured daily. The number of viable spermatozoa in the seminal vesicles was zero at emergence and reached an average maximum of 7.39 ± 0.19 million around 20 days of life. Decline in spermatozoa count occurred after day 30, though viability was constant throughout life, when controlling for count. Older drones had smaller wet weights, head widths and wing lengths. They predict that this is likely due to sampling bias due to a differential lifespan among larger, more reproductively developed drones. Drones have a significant variation in reproductive physiology, as a function of age.

Duay et al. (2002) developed a bioassay to measure the flying power of drones, in order to determine which drones could reach a drone congregation area. A wind tunnel was used to test unparasitized drones and drones slightly parasitized by one or two *Varroa* mites during pupal development, and counts were made of the number of spermatozoa that they produced. Drones parasitized with one mite flew as long as control drones, however, those that had been infested by two mites flew significantly less. There was a significant positive correlation between flight duration and the number of spermatozoa per drone in control group and in both the one mite and two mite groups. Drones infested during development with one or two mites produced 24 and 45% fewer sperm, respectively.

Honey bee colonies invest a substantial amount of colony resources in the production of drones during the reproductive season to enable mating with virgin queens from nearby colonies. Studies have recently shown significant differences in the production of sperm cells that are viable (i.e., sperm viability) that can fertilize an ovule among sexually mature drones that are exposed to different environmental conditions during development or as adults. In particular, sperm viability may be negatively affected during drone development from exposure to pesticides in contaminated beeswax. To assess whether sperm viability is negatively affected during drone development from exposure to beeswax contaminated with in-hive pesticides, Fisher and Rangel (2018) compared the viability of sperm collected from drones reared in pesticide-free beeswax with that of drones reared in beeswax contaminated with field-relevant concentrations of the pesticides most commonly found in wax from commercial beekeeping operations in the United States. These pesticides include the miticides fluvalinate, coumaphos, and amitraz, and the agro-chemicals chlorothalonil and chlorpyrifos. Sperm from drones collected at 10 and 18 days post emergence were classified as viable or non-viable to calculate sperm viability. For all pesticide treatment groups, drones that were reared in pesticide-laden beeswax had lower sperm viability compared to those reared in pesticide-free beeswax. This difference was especially pronounced among drones reared in miticide-laden wax. Their results reinforce the notion that pesticide contamination of beeswax negatively affects the reproductive quality of drones, which can affect the queens they mate with, ultimately compromising colony health.

The number of female progeny that a queen produces in her lifetime is directly dependent on the amount of semen she collects upon mating (i.e., insemination volume) and the number of viable sperm cells contained within the semen (i.e., sperm viability). Queen insemination volume has been shown to alter queen mandibular pheromone profiles, as well as worker behavior and physiology at the individual level. In order to determine if queen insemination volume has any colony-level effects,

Payne and Rangel (2018) compared the growth of newly established colonies headed by queens instrumentally inseminated with either a low volume (1.5 µL) or a high volume (9.0 µL) of pooled semen from May to October in 2013 and 2015. They did not find a significant effect of queen insemination volume on the production of worker comb, drone comb, stored food, worker population, or seasonal queen or colony survivorship. Therefore, they concluded that queen insemination volume does not seem to directly affect growth at the colony level, at least during a colony's first year.

Roughly a week after emerging, virgin queens undertake one to a few nuptial flights over several days (Winston 1987). Honey bee queens are polyandrous and they mate with multiple drones, which reach sexual maturity about two weeks after emergence (Rhodes et al. 2011). During a nuptial flight, the queen flies up to three km (1.86 miles) away from her hive to rendezvous with thousands of drones at a drone congregation area (DCA), located 5-40 m above ground (Koeniger et al. 2014). Older reports have determined that queens mate with an average of 12 drones (Kraus et al. 2005), but recent work found that queens can mate up to 34-77 drones (Withrow and Tarpy 2018). During copulation, the drone irreversibly everts its endophallus into the female, transfers his semen into the oviduct and drops to the ground to die (Koeniger et al. 2014). Roughly 10% of each male's ejaculate is transferred into the queen's oviduct (Schlüns et al. 2005). Once a queen has terminated her final nuptial flight and returns to the hive, to store sperm in her spermatheca, a specialized organ to facilitate spermatozoa storage, and commences egg laying (Koeniger et al. 2014). Only about 3% to 5% of ejaculated spermatozoa from each drone is stored in the queen's spermatheca for future egg fertilization.

At the beginning of natural mating, the drone becomes paralyzed. However, the muscles in the abdomen continuously contract shrinking the abdomen till mating has ended and the pair have separated. It is not the queen that ends the nuptial flight. The termination of the nuptial flight is determined by the drone, which fails to remove the mating sign of the previous drone from the sting chamber of the queen. The mating sign originates from two or more drones. The queen also does not determine the age at which she starts oviposition. It is the last drone, which tried to mate, but failed to remove the mating sign of the predecessor that determines the age that the queen starts oviposition (Woyke 2016).

During mating flights, some honey bee queens are lost due to predation or because of mistakes they make when trying to find their way back to their nests. Gabka (2018) investigated the factors affecting the drifting of queen bees. Italian and Carniolan queens spaced in different hives, long hive and mating nucleus layouts, were examined. There were significantly more queens drifting during flights in colonies spaced in rows without landmarks, than in those colonies arranged in rows near trees or bushes. The smallest percent of lost queens was found in colonies in which the hives were irregularly placed facing different directions and near landmarks in the vicinity. Losses of queens from parent colonies with high worker activity at the entrances and very weak nuclei with a low activity of bees did not differ significantly. Parent and nucleus colonies were located in the same long hives with entrances in the same direction. In this study, the effect of colony strength (more than 30,000 or about 1000 bees) on loss of queens during mating flights was not shown. No significant differences were found between the drifting of Italian or Carniolan queen bees. It was found that queens returning from flights can be accepted and start oviposition in foreign colonies; probably, the acceptance happens when the foreign colony had lost its own queen.

Heidinger et al. (2014) used radio-frequency identification (RFID) to record the duration and frequency of nuptial flights of honey bee queens at two mainland mating apiraries. They investigated the effect of a number of factors on flight duration and frequency: mating apiary, number of drone colonies, queen's age and temperature. They found significant differences between the two locations concerning the number of flights on the first three days. They also observed an effect of the ambient temperature, with queens flying less often but longer at high temperatures compared to lower temperatures. Increasing the number of drone colonies from 33 to 80 colonies had no effect on the duration or on the frequency of nuptial flights.

Egg-laying rates of queen honey bees were measured in colonies containing no brood and ca. 3,000 or 12,000 worker bees. Naturally mated queens were heavier and laid more eggs per day than instrumentally inseminated queens. Carbon dioxide narcosis caused weight loss in queens and may account for at least some of the difference. When nitrogen narcosis replaced carbon dioxide during

Honey bee colonies invest a substantial amount of colony resources in the production of drones during the reproductive season to enable mating with virgin queens from nearby colonies.

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instrumental insemination, queen weights increased, but still did not equal those of naturally mated queens that received no narcosis. The correlation between egg-laying rate and queen weight was r =0.73 (Harbo 1986).

The number of days from emergence to the onset of oviposition in seven groups of queens was as follows: naturally mated queens, 10.33 ± 0.68; free-flying queens treated with CO_2, 11.00 ± 0.36; queens instrumentally inseminated by the Mackensen technique, 13.8 ± 1.94; virgin queens treated with CO_2, 14.00 ± 0.77; queens instrumentally inseminated, using the washing technique, 14.58 ± 0.53; queens injected with washing fluid, 15. 82 ± 1.42; queens injected with Kiev solution, 17.77 ± 1.24. The number of spermatozoa in the spermatheca of naturally mated queens, of queens inseminated by the Mackensen technique, and of queens inseminated by the washing technique, was 4.54 ± 0.7, 3.83 ± 0.47, and 3.02 ± 0.52 millions, respectively. Naturally mated queens started laying eggs earlier than the instrumentally inseminated queens (Kaftanoglu and Peng 1982).

The onset of oviposition of 1396 queens reared in two years in the Peace River region of Alberta, Canada, ranged from four to 22 days after emergence, with a mean of 10.6 ± 0.1 days. There was evidence to suggest that some queens may start to lay eggs within 24 hours after mating. No consistent correlation was found between queen weight at emergence and the onset of oviposition. Mean weight of queens was 211.2 ± 0.7 mg (range 160-266 mg) in 1981 and 222.6 ± 0.06 mg (range 173-273 mg) in 1982. There was a close association between maximum daily temperature and time of oviposition. A large number of queens mated at temperatures below 25°C (77°F) (Szabo et al. 1987).

Honey bee queens only mate during a very brief period early in life to acquire and store a lifetime supply of sperm. As sperm cannot be replenished, queens have to be highly economic when using stored sperm to fertilize eggs. Baer et al. (2016) quantified sperm usage in honey bees by counting the number of sperm on freshly laid eggs. They examined sperm use in naturally mated queens of different ages and in queens artificially inseminated with different volumes of semen. They found that queens are remarkably efficient and only use a median of two sperm per egg fertilization, with decreasing sperm use in older queens. The number of sperm in storage was always a significant predictor for the number of sperm used per fertilization, indicating that queens use a constant ratio of spermathecal fluid relative to total spermathecal volume of 2.364×10^{-6} to fertilize eggs. This allowed them to calculate a lifetime fecundity for honey bee queens of around 1,500,000 fertilized eggs. Their data provide the first empirical evidence that honey bee queens do not manipulate sperm use, and fertilization failures in worker-destined eggs are therefore honest signals that workers can use to time queen replacement, which is crucial for colony performance and fitness.

The honey bee mating system is extremely polyandrous, where reproductive females (queens) typically mate with 12 or more males (drones) during their mating flight(s). The ability of queens to gauge and adjust their reproductive success is important for selection to act on queen mating number at both the evolutionary (colony level) and proximate (individual-level) timescales. Simone-Finstrom and Tarpy (2018) observed the mating flight activities of 80 queens in their respective mating nucleus hives each with a modified entrance that restricts flight attempts. They also attached a small weight (0, 16, or 38 mg) onto each queen's thorax as a means of imposing additional flight costs. They then compared queens that were restricted from taking multiple mating flights to those that started oviposition after a single flight for their mating numbers as quantified by microsatellite analyses of their respective worker offspring. They found that neither additional weight nor restricted mating attempts had any significant effect on the effective mating frequencies of the experimental queens during their single mating flight. This observation suggests that queens are not adjusting their nuptial flight activity according to their precise mating number during their flight.

The process of mating initiates numerous behavioral, physiological, and molecular changes that shape the fertility of the queen and her influence on the colony. For example, receipt of drone semen can modulate queen ovary activation, pheromone production, and subsequent worker retinue behavior. In addition, seminal fluid is a major component of semen that is primarily derived from drone accessory glands. It also contains a complex mixture of proteins such as proteases, antioxidants, and antimicrobial proteins (Brutscher et al. 2019).

Seminal fluid is a biochemically complex mixture of glandular secretions that is transferred to the female's sexual tract as part of the ejaculate. Seminal fluid has received increasing scientific interest in the field of reproductive biology, as it seems to be a major determinant of male fertility/infertility and reproductive success. In honey bees, seminal fluid can be collected as part of a drone's ejaculate, and King et al. (2011) performed a series of experiments to investigate the effects of seminal fluid and its components on sperm viability. They showed that honey bee seminal fluid is highly potent in keeping sperm alive and this positive effect is present over a 24 hour time span, comparable to the timing of the sperm storage process in the queen. They also showed that the presence of proteins within the seminal fluid and their structural integrity are crucial for this effect. Finally they activated sperm using fructose and provided evidence that the positive effect of seminal fluid proteins on sperm survival cannot be replicated using generic protein substitutes. BC

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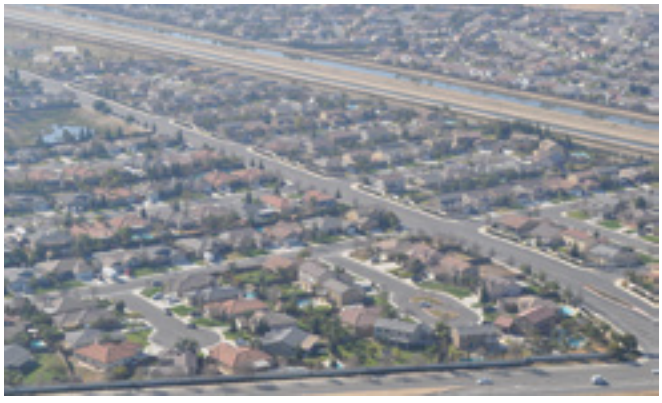
Colony Loss And Poor Nutrition

Sujit **Kamath**

Honey bee populations aren't what they used to be, yet the reason why may be less complicated than we think. We're all familiar with the usual suspects: *Varroa destructor, Nosema,* herbicides, and GMO seed treatments. Even weather has been known to play a part.

But the real culprit behind it all? ***Poor Nutrition.***

Think about it: honey bee diets today (especially in larger apiaries) consist mainly of sugar, soy, and monocultures. Sugar syrups and HFCS (high fructose corn syrup) contain zero micronutrients – fructose is even known to form HMF (hydroxymethylfurfural), a toxic chemical under acidic or hot conditions. Soy protein is often a GMO, and GMOs have a linked lineage with herbicide use. In fact, most soy is genetically modified solely to withstand extended exposure to herbicides such as glyphosate. Glyphosate has been shown to negatively affect honey bee gut health, and poor gut health can lead to infection, disease, and shorter lifespans. Monocultures (i.e. when bees pollinate acres and acres of a single crop) by nature aren't nutritionally diverse. Oftentimes, these monocultures lack key amino acids that bees need in order to synthesize protein properly. These amino acids are in greatest demand during brood rearing and periods of growth early in life (Behmer 2009; Tigreros 2013), a lack of which can impede proper development in the next generation of honey bees.



In summary, we aren't really providing our bees with quality nutrients. We're also hurting their gut health – after all, herbicides not only kill forage, they alter the gut microbiome in detrimental ways. We're even limiting their access to balanced nutrition when we expose them to monocultures during pollination. This "perfect storm" degrades the health of our bees, so much so that when they come across the usual suspects listed above, they aren't equipped to fight them off on their own.

The same rules apply to bees as they do to humans: if we're not healthy due to poor nutrition, small problems like pathogens (which our bodies usually fight off on their own) end up becoming big ones.

Poor nutrition in honey bees has also shown to have a synergistic effect when combined with other honey bee ailments. Pesticides, in particular, cause significantly more honey bee deaths when present in malnourished hives. Researchers at the University of California at San Diego (Proceedings of the Royal Society B, 2017) were surprised to find that **bee deaths increased by up to 50% more than expected compared with the individual effects of pesticides and poor nutrition**.

Another major concern is a growing lack of unadulterated forage. Twenty years ago, bees had access to healthier, more diverse forage. Today, human expansion and overuse of herbicides have left little remaining for our bees. In order to maintain their health, honey bees (just like humans) need daily access to vitamins, minerals, and other micronutrients. By continuing to feed our bees with syrup and soy products, we aren't actually helping them – we're hurting them.

So, what is the solution? As beekeepers, we first need to acknowledge that poor nutrition is a real problem. Next, we must take it upon ourselves to ensure we're filling in the nutritional gaps. We may not be able to change the demands of our industry, but we can take steps to ensure our bees are healthy – and that starts with providing them with balanced nutrition.

It is, after all, the missing link in beekeeping today. BC

Sujit Kamath is the Director of Communications at Healthy Bees, LLC, which manufactures all-natural spirulina patties and powders. For more information, ***www.healthybeesllc.com****.*

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THE STORY OF A.I. ROOT

Humbugs & Swindles In The Bee Business

A.I. **Root**

In 1873, when the April number of the *American Bee Journal* came out, I was glad to find an advertisement of dollar hives. At this time I hoped that more manufacturers of dollar hives would follow in my tracks, but I also hoped that they would not meet with the abuse I had received in breaking the first furrow in that direction.

So far as stirring up trouble is concerned I went on record in the May number of the *American Bee Journal*, 1873, as agreeing to overhaul all articles written with motives of profit by patentees of hives and I agreed to accept the abuse that followed as a matter of course. When patent rights should be dropped and the attention of the patentees turned toward making good hives at a fair price (and this result seemed even then dawning), I agreed to be ready to drop personalities, having accomplished all that I desired.

In the July number of the *American Bee Journal* for 1873 a writer mentioned those whom "Novice has so mercilessly punched." Now my friend was in error for I did not punch any one, or at least did not mean to, but I hoped I punched their claims hard and full of holes too, when they were gross exaggerations. For instance, when some one in order to sell rights led beginners to expect that a hundred pounds of box honey or more might be obtained per hive on an average, I undertook to remonstrate with all my power.

One of the most lamentable wrongs in bee culture was the custom of taking money for a right to make and use a hive, the "inventor" knowing that the buyer could make and use a hive so nearly like it as to answer every purpose without using a single one of the patented features. In starting *Gleanings in Bee Culture* it was one of my special aims to inform the public fully of all such transactions coming under my observation.

Selling Secrets

Several irresponsible persons had advertisements inserted in some of the bee journals; and in one instance considerable sums of money were lost by beekeepers sending to them. When *Gleanings* was first started I positively refused to advertise any recipes or methods of doing desirable things in the apiary, for the first person sending the needed amount could if he chose then publish it to the world. I felt that information of all kinds should be free through the journal. Samples, models to work from, or implements themselves, of course, have a cash value but not secrets as a general rule.

A.T. Wright of Chicago sold a very small 25-cent pamphlet recommending his patent hive. He not only endorsed sugar syrup for wintering, but left me far in the shade in directing that it be fed the bees to produce nice box honey profitably. Nice-looking comb honey can be produced, it is true, as my experiments in feeding gave me ample proof; but in taste it is sugar syrup still, and worse still it costs $1.00 a pound or more.

In 1873 I received a circular telling how to make artificial honey, "Ambrosia honey," in every respect as good as that made by the bees. The recipe was copy-righted and secured according to law, and parties receiving it were cautioned not to sell or make known the recipe to others.

Now, if I hadn't a fondness for "good things" I don't know who had, and I sent a two-dollar bill for the recipe. I proposed to give the whole thing in the next number and take the consequences.

The recipe was as follows: Fifteen pounds of white sugar, four pounds of soft water, one-half teaspoonful tartaric acid, one teaspoonful of salt, four drops of oil of peppermint, one drop of oil of rose, one ounce of gum arabic dissolved in half a pint of water. This was to be boiled and one and a half pints infusion of slippery elm added, then when nearly cold another pound of good honey was to be put in also. The originator claimed to have invented this during the Winter of 1871, with the assistance of an expert (?) New York chemist at a cost of nearly $500. However, the recipe was really nothing more than a copy of an old honey recipe without a single addition or improvement. The whole thing appeared in Dr. Chase's recipe book published in 1867. I gave the recipe in *Gleanings* so the originator had good grounds for seeking legal redress if the law allowed any in such case.

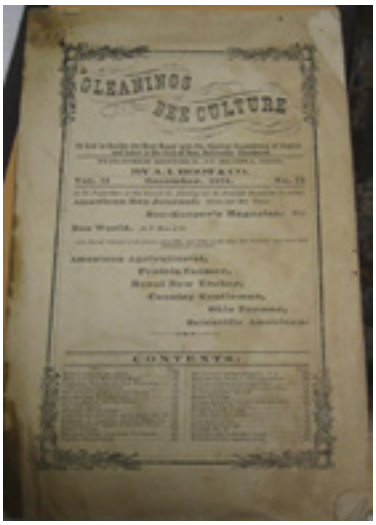
I sent 10 cents to one H. Herman Flick for a bee sting cure, guaranteed to cure without cost and with no more pain or swelling. The principal paragraph in the cure was as follows:

"How cured. In severe cases the person should drink freely of whisky or some strong alcoholic drink until he feels its effect. This will prevent all danger and further swelling." The saloons had just been closed in Medina or I feared there would have been a serious rush to the beehives for the sole purpose of being stung, if such treatment had been recommended.

Fraudulent Bee and Queen Breeders

In the April number of *Gleanings* for 1874 I published a letter from a man who had sent $30 to Gray and Winder of Cincinnati for two imported Italian queens. They acknowledged the receipt of the order but failed to send the queen. They offered to make it right some time if the complainant would be quiet and gentlemanly about it, but in a letter to me at the time, Mr. Winder said if the transaction was published he would never pay it at all. As the $30 was probably lost. I felt that nothing would be gained by keeping quiet, so I went ahead and published the details in the November issue of 1874, for fear he might go ahead and get the hard-earned dollars from some one else.

Letters that I received from such delinquents came to an old story and I became so hardened that I did not mind it a bit when I was told that I was meddling, that my advice and assistance had not been asked. I was sometimes informed that great numbers of similar complaints had been made of me, but dropped out of kindness. Now this was "mistaken kindness" certainly, for if anyone had a complaint I wanted to know about it. I even agreed to print the complaint.


GLEANINGS IN BEE CULTURE

T.H.B. Woody of Manchester, Mo., was complained of early in 1874, and I wrote him asking if he could give me any explanation. He replied at length that he had faithfully filled all orders with the exception of one, the writer of which had failed to give his address, and that he would be pleased to learn where he should send the money or the queen. In closing he called on God to witness the purity of all his motives and his intentions, and I might have thought him upright and honorable; but I wrote the complainant, that Mr. Woody had lost his address. The complainant in question considered this too big a joke altogether and forwarded me a mass of letters of apologies and excuses and attempted to lay the blame on other people. It seems to me it would have been worth full $12, the amount in question, to write all these letters. Woody first blamed some one else for having cheated him out of a larger amount, as if that excused him at all, and finally said he would return the money by post office order if the complainant would take the risk of having it sent back. Afterwards he wanted to know if he would not take pigs, as money was so hard to get. It looked as though it was hard to get in Texas also, where the complainant lived.


AMERICAN BEE JOURNAL

The matter of the business methods of H.A. Burch and Company occupied a large amount of space in *Gleanings* in 1881 and 1882. He was unable to make good his promises; and finally feeling that the matter had gone far enough, I announced that I would make good all losses occasioned by his advertisement in *Gleanings*, and I announced in the August number, 1882, that I could not accept further advertising from him. I paid claims of $115.00, $14.00, $3.50, $35.00, $10.50, $50.00, $6.65, $11.50 and $12.00. The number of kind letters I received, however, gave me renewed faith in humanity.

In 1886 Mr. Thomas Horn, an advertiser of queens, accepted money for orders sent him and then refused to fill the orders or answer letters. A subscriber suggested that he was going to make a sight draft on Mr. Horn and tell him that if he did not pay his draft or send the bees he would report him to the post office authorities. I did not know then that under certain circumstances the United States postal authorities would refuse to deliver mail to parties when engaged in swindling operations, but it did not occur to me until after reading this letter that we could oblige men like Mr. Horn to give some sort of a civil reply to complaints by the plan suggested. I waited patiently for Mr. Horn, published his promises and kept back complaints by suggesting that he would fix everything in time, until I finally received the censure of many good men. Later, after becoming thoroughly convinced of this duplicity, I took a different line of action, and some of my readers thought I was beginning to be terribly severe. However, I wanted every man like Mr. Horn to know that he could not conduct business in this way and get off scott free, and that the way of the transgressor is hard. It seemed to me that it was my duty to help make it hard – so hard in fact that those who were tempted would conclude it would not pay, and give it up even before they started out. BC

GUT MICROBIALS

Vera **Strogolova**

Probiotics offer a way to take our livestock off the antibiotic treadmill.

Jessica Snyder Sachs, Good Germs, Bad Germs, 2007

1. Functional importance of gut microbials

Phoretic behavior (from Greek phorēsis, being carried), colloquially referred to as "a bug *on* a bug", is a difficult enough organization. Gut microbiota of honey bee is literally millions of "bugs *within* a bug, and it's amazing that works at all. After all, many a concert, a meeting, or a scientific study go awry when participants don't know where to go, what to do, and how to work with others. Yet, gut microbiota achieves amazing feats exactly because of its complexity.

As Dr. Collison writes in February 2019 article *Gut Microbials*, different gut bacteria occupy distinct spatial and functional rank in the bee gut, facilitating nutrient conversion and promoting host weight gain. Some bacteria (*Lactobacilli*, *Gilliamella. apicola*) ferment sugars, while others (*Bacilli*, *Bifidobacterium asteroides*), digest more complex carbohydrates, producing short chain fatty acids acetate, propionate, butyrate. Honey bee absorbs butyrate and amino acids produced by bacteria, while facultative bacteria (*Snodgrassella alvi*) use acetate to consume a small amount of oxygen that diffuses in the gut lumen, creating anaerobic environment. Gut bacteria also protect the host, producing chemical signals that promote host tissue development (thicker gut wall), modulating immune system, detoxifying pesticides, and inhibiting pathogens.

2. Scientific approaches

Gut microbial ecology is investigated by sacrificing honey bee to examine its gut contents. There are two ways to examine honey bee gut microbes: culture-dependent and culture-independent. Culture-dependent methods involve growing isolated microorganisms on a solid substrate and observing their growth and its characteristics. Culture-independent methods are based on DNA extraction or microscopy and include PCR, gene sequencing, and fluorescent microscopy. Culture-dependent methods are generally more time and labor consuming than culture-independent methods but are the only way to confirm microorganism viability. Additionally, microbial inhibition assays are only possible with cultured microorganisms. Such pathogen inhibition assay reveals that many *Lactobacillus* isolates from bumblebee gut inhibit foulbrood pathogens *P. larvae* and *M. plutonius* (Praet et al., 2017

Functional importance of gut microbes can be investigated by their exclusion. In this approach, gut bacteria are killed, and gut sterilized with a goal of creating bees that are axenic (from Greek a xénos, without guests). Honey bees have an almost sterile gut at the time of eclosion. Axenic, also called germ-free honey bees could be achieved by keeping honey bees in sterile conditions and/or by repeated antibiotic treatments.

Another approach used to investigate the roles of specific microorganisms is feeding specific bacteria to the honey bees, or probiotic supplementation. This allows to study the effects of the microorganisms in a more natural situation. Both of these scientific approaches are used extensively. New studies reveal declines in endogenous gut microorganisms as a result of antibiotic, pesticide, herbicide use.

3. New findings in the field of gut microbial community

Dysbiosis is a decline in gut microbial community. Dysbiosis encompasses lower numbers and skewed ratios of beneficial microorganisms, which opens up the possibility of unwelcome

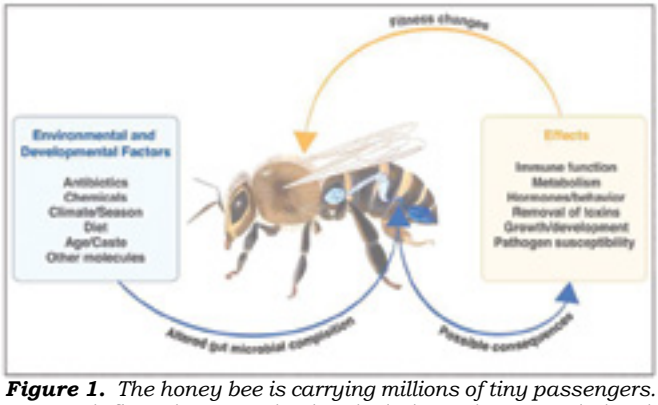


Figure 1. *The honey bee is carrying millions of tiny passengers. Factors influencing gut microbes include environmental chemicals and antibiotics and their functions include removal of toxins and influence bee fitness (source: Raymann and Moran, 2018).*

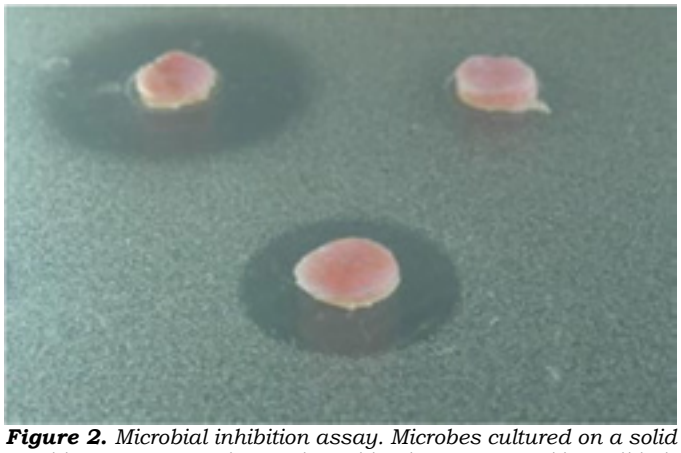


Figure 2. *Microbial inhibition assay. Microbes cultured on a solid nutritive agar (appearing as tiny white dots) are tested in antibiotic inhibition assay. In this assay, two out of three meat samples contain antibiotic residues, which inhibit growth of bacteria (source: Pikkemaat, 2009).*

microorganisms – opportunistic or specific pathogens – to occupy honeybee gut. Dysbiosis has been detected in cases of colony collapse disorder and nosemosis, but thorough investigations lag behind the advances made in other organisms. A recent retrospective study used sequencing method to compare gut microbial community of thriving to non-thriving hives, detected dysbiosis in non-thriving hives (Ribière et al., 2018). The dysbiosis was characterized by *Lactobacilli* depletion, while other bacteria, such as *Gilliamella apicola*, were increased. This study demonstrates a complex balance between different members of microbial community in the gut. The sampled hives were in a rural and pristine area of Ireland and the cause of the dysbiosis is unknown.

More commonly, dysbiosis is caused by antimicrobial substances. Dr. Nancy Moran (University of Texas) has been studying detrimental consequences of antibiotic use for decades using culture-independent methods and comparing normal bees to germ-free, or axenic bees. Moran team found that antibiotic tetracycline causes dysbiosis, increases honey bee mortality and susceptibility to infection infection by opportunistic pathogens (Raymann et al., 2017). Glyphosate, the active ingredient in herbicide RoundUp, is also an antibiotic. Glyphosate inhibits an enzyme found in plants and bacteria. Honey bee gut bacteria are susceptible to glyphosate. The Moran team found that honey bee exposure to glyphosate, similarly to tetracycline, causes dysbiosis, increases mortality and susceptibility to infection (Motta et al., 2018). The study found that exposure to glyphosate most strongly diminished levels of gut bacteria *Snodgrassella alvi.*

Antibiotic-induced dysbiosis may be a missing puzzle piece to variability in severity and survivorship of honey bee colonies exposed to microsporidian parasite Nosema ceranae. An USDA-ARS study reported increased mortality and Nosema spore counts when Nosema-inoculated bees received antibiotic treatment (Li et al., 2017). Ironically, chemical that was until recently used to inhibit Nosema, fumagillin, is an antibiotic, likely to adversely impact gut microbiome. Feeding specific probiotic bacteria, on the other hand, can provide pest control and health support. With many options to choose from, *Lactobacilli*, *Bifidobacteria*, and *Bacilli* are used most commonly, either separately or in combination (Alberoni et al, 2016). Several studies found that probiotic supplementation is effective at preventing and treating Nosema infection (Baffoni et al., 2016, El Khoury et al., 2018). BC

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Technology In Action

HiveTracks Hobbyist Platform

Joseph **Cazier,** James **Wilkes,** Ethan **Walton,** HiveTracks **Superusers**

Introduction

This is the second article in a new series we are calling *Technology in Action.* Many readers may recall that the first dozen or so articles we wrote last year were focused on laying out the case for why technology and data science were essential to bees and beekeepers. We then discussed the path to making that happen with articles on topics such as the Healthy Colony Checklist and BeeXML and finally analyzed some of the obstacles and risks, such as privacy, security, and technology acceptance, sharing some ideas for addressing those areas.

In this mini-series, we plan to spotlight some of the people, products, innovations, and organizations that are putting science and technology into action to help save the bees and make the lives of beekeepers easier.

Last month we started with a profile of the HiveTracks Commercial Beekeepers software system and discussed how it could add value to the business of beekeeping. This month we continue by focusing on the HiveTracks Hobbyist Platform.

In the sections that follow, we discuss the creation of this software platform, including how it has evolved and what problems it is trying to address. Next, we share an overview of its features and discuss how it works. Then, we move to a few use cases by sharing the experiences of some long time users. Finally, we conclude with thoughts of how the system might grow and evolve from here.

Know the Innovator, Understand the Technology
Evolution of HiveTracks

More than 10 years ago, the vision for Hive Tracks was born in the minds of two beekeepers, James Wilkes and Mark Henson, who lived and kept bees in the Blue Ridge mountains of North Carolina, an area rich in beekeeping tradition and well known for the world famous varietal sourwood honey. These two beekeepers dreamed of utilizing cutting edge technology to build easy-to-use tools and services to help beekeepers have healthy and productive honey bee colonies. The hope was that by maintaining information like records of inspections and events in hives and bee yards, every beekeeper would be equipped with the information needed to make wise management decisions for their bees. Their vision encompassed all beekeepers, from those with a couple of hives in the backyard to a couple of hundred in varietal honey production to several thousand colonies for pollination and honey production. Knowing the current state your bees is essential to being a successful beekeeper.

James Wilkes lives in the Creston area of Ashe County in North Carolina with his wife and children and operates Faith Mountain Farm, which includes a sideliner beekeeping operation selling nucs and producing sourwood honey. He is also a computer science professor at Appalachian State University in nearby Boone, NC. When his computer science side collided with his beekeeping side, the result was the innovation of HiveTracks in 2008.

James recounts the moment when the idea first occurred to him: "I was standing at a hive in my bee yard in the summer of 2008. I scratched my heading trying to remember what I observed the last time I was inspecting this hive. In a moment of clarity, I caught a glimpse of what the future could be like: walking up to a hive, a handheld mobile device (smart phones were not so smart back then) recognizes the hive being inspected and shares information with the beekeeper that will help with this inspection, like the health or strength of the hive, the queen status including her age, any unusual observations at the last inspection, medications or feed that should be checked, honey flows in the region, tips on what to look for at this time of year, etc. I saw the future, but did not have the time or resources to make it a reality."

Ideas are relatively easy to dream up, but implementing them is the real challenge. In the case of Hive Tracks, a plan was made to develop the first production version of the software with a launch date of August 1, 2010, coinciding with the 2010 Eastern Apicultural Society Conference, which happened to be held in Boone, NC that year. Over the course of 2009 and early 2010 bee seasons, the first version was created with feedback and encouragement from local beekeepers and friends and folks like Dave Tarpy of NCSU and Shane Gebauer of Brushy Mountain Bee Farm. Following the initial launch, 400+ users signed up by the end of August. By the end of 2010, 800+ people had registered accounts with HiveTracks with no real marketing other than a favorable review in Bee Culture and word-of-mouth through bee club presentations. Growth in user accounts has always been steady with over 6000 users by the beginning of

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James Wilkes, Ph.D is the founder of HiveTracks, Computer Science Professor at Appalachian State University and Sideline Beekeeper at Faith Mountain Farm.

Ethan Walton, Product Development Associate and Customer Support Representative for ***HiveTracks.com***

HiveTracks.com *Superusers - consistent* ***HiveTracks.com*** *customers that have used HiveTracks for multiple seasons and rank in the top 5% in terms of usage quality and consistency.*

2013 and continuing to this day. HiveTracks now serves a user base of over 30,000 registered users in 152 countries managing over 150,000 hives in 38,000+ yards. There is much more to come as the benefits of technology to our collective beekeeping experience are quite profound and exciting to consider and pursue.

Introduction to TAM

Readers of this series may recall an article we wrote in *Bee Culture*, nearly a year ago (June 2018), titled, "Nudging Beekeepers Into the Future With the Technology Acceptance Model." In that article, we shared the concept of the Technology Acceptance Model (TAM), which posits that the main factors that influence the adoption of a new technology are[1]:

- *Usefulness:* The degree to which the software system provides real value to beekeepers
- *Ease of Use:* How easy it is to use the system. Our research shows that this includes both in the software application and in the beeyard.
- *Enjoyment*[2]: Left out of the original model, which focused more on systems for business. However, enjoyment has been shown to be very important for adopting systems that are consumer-focused and optional. Our system includes the fun and satisfaction of watching your bees as well as (for some) enjoying the social aspects of sharing bee health and status information.

Recall that the *Technology Acceptance Model* (see Fig. 1) has proven itself after decades of research with only minor modifications. As we continue this series, we plan to look at most of the technologies in our *Technology in Action* series through this lens to see how they stack up.

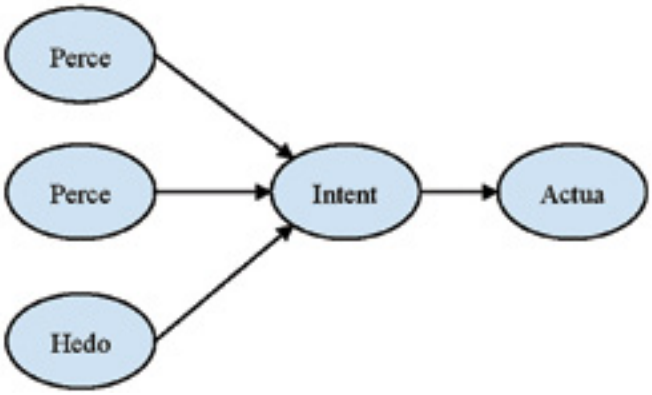

Figure 1. *The Technology Acceptance Model.*

The HiveTracks Hobbyist platform has many elements of each of the features in TAM, as illustrated below. To the best of our knowledge, this is the oldest bee tracking software platform (available to beekeepers since 2010). It has also evolved and continues to evolve over time. If you have not used HiveTracks in a while, you might be surprised by its evolution.

Usefulness

Listed below are a few of the most cited useful features, based on feedback from the HiveTracks user base.

Preservation and Organization of Data

Attend any introductory beekeeping course and odds are favorable that a portion of the time will be devoted to good record keeping practices (if not, you should ask for it!). Observation and assessment are essential elements of good beekeeping and a component of that process is comparing what you see today to what you saw the last time you were in the hive to all previous times, which is why record keeping is a best practice for beekeepers. If you don't know the previous condition of your bees, how can you evaluate today's condition and know where they are going?

Many record keeping methods have been employed historically, such as:

- Using beekeeper memory
- Writing directly on hives
- Keeping paper notebooks
- Managing spreadsheets
- Taking advantage of specialized software like HiveTracks

All of these methods are useful to some degree, but also have their own drawbacks, including preservation of data, recall of data, and organization of data. HiveTracks is designed to mitigate each of these challenges by storing data on a reliable, secure server, making data accessible through a desktop, wireless, or cell phone internet connection, organizing data according to how beekeepers think.

This ability to record information (see Fig. 2) is the core and foundational base for any system for tracking hives, and makes it possible to take advantage of several add-on features to emerge as discussed in the sections below.

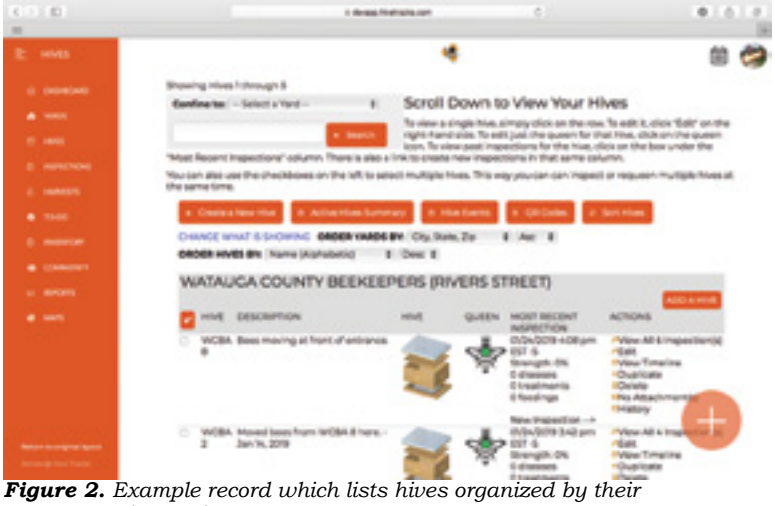

Figure 2. *Example record which lists hives organized by their most recent inspection.*

Maps

The geographic location of a colony of honey bees is the most important factor in the life of the hive because the bees, absent of beekeeper intervention, are totally

[1]Technically TAM is predicting the intention to use a system, which is believed to be predictive of actual usage, but has historically been hard for academics to measure. Our research has actually proven this linkage for beekeepers.

[2]This is sometimes referred to by the Greek word hedonic in the academic literature

dependent on the local ecosystem for food and water and can be affected by exposure to environmental hazards. The map feature provides a view of this critical information to the beekeeper: you can see not only where your bees are and where they have been, but what is around them that influences their behavior and health status. Since bees can forage up to two to three miles away as the bee flies, it is easy to miss everything around them as we usually travel by roads with a limited view of the neighborhood.

For example, Figure 3 reveals that each yard location is surrounded by three concentric radius rings showing the one, two, and three-mile areas around each hive. The true utility of the map is found by switching to the satellite view to see the type of environment your bees encounter and the type of food they forage, whether it's agricultural, wooded areas, or developed land.

Figure 3. *Satellite view of yard location using Maps in HiveTracks.*

Reminders

We all forget things from time to time. Sometimes this is an inconvenience, sometimes it can have a big effect on the bees. Having the ability to set reminders helps us follow through on the things we know we need to do, but may forget. This feature helps you to never miss those important tasks like feeding, inspections, and queen status updates.

Figure 4 shows an example of this feature in HiveTracks.

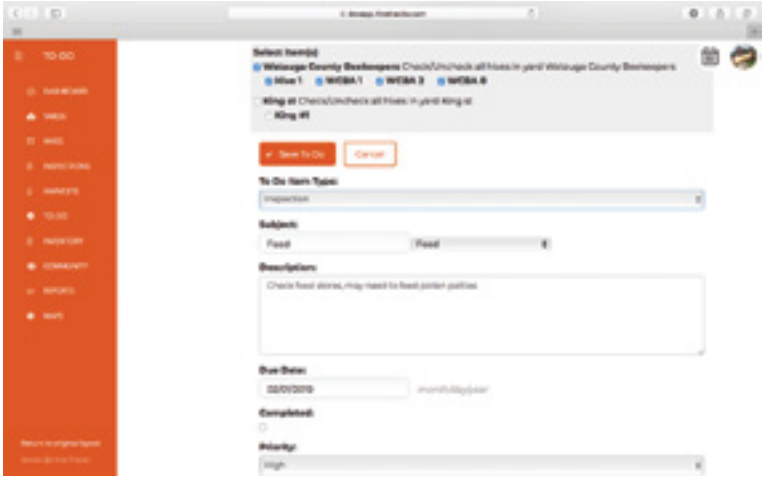

Figure 4. *Setting a To Do reminder in HiveTracks.*

Reports

There are many reports automatically generated in HiveTracks that can help you better understand and manage your bees. You can generate online and PDF reports of key metrics. Here is a sample.

- *Health Trends:* See trends in health and production of your bees throughout the year.
- *Tasks Completed:* Compare and contrast tasks recorded by month, such as treatments applied or feedings, with individual hive strength, to assess which actions might have influenced the production and health of a hive.
- *Inventory Tracking:* Keep track of your hive and tool inventory, age, and status. This is useful for tax, insurance, and financial reports on the business side of an operation.
- *Harvest Report:* Run a harvest report to see the total amount of honey produced per yard or hive by season.
- *Mite and Disease Reports:* View average mite counts per yard and success rates of treatments over different time periods.

These reports make HiveTracks useful to beekeepers. Now let's discuss the second feature.

Easy to Use

Here are a few of the features that make HiveTracks easy to use.

Intuitive

Designed by beekeepers for beekeepers, the order of the inspections in HiveTracks follow a beekeepers natural path during a hive inspection. Big buttons and clear language make navigation simple. You can easily snap photos within the application and attach it to the inspection; a picture is worth a thousand words. Integrated audio functionality enables hand-free dictation by simply speaking to your phone. On and offline functionality allows for data collection in any environment, whether or not there's connectivity. The inspection data simply syncs to the cloud once connectivity is established.

Figure 5 shows a few of these easy-to-use features.

Figure 5. *A few mobile first features making HiveTracks easy to use.*

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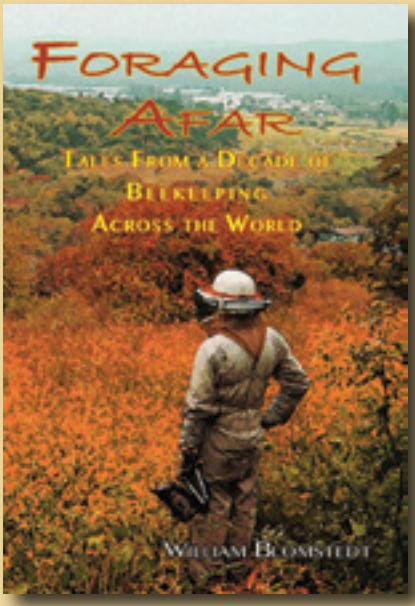

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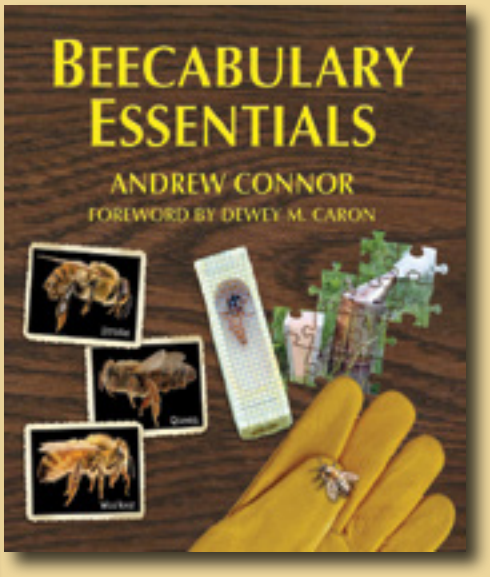

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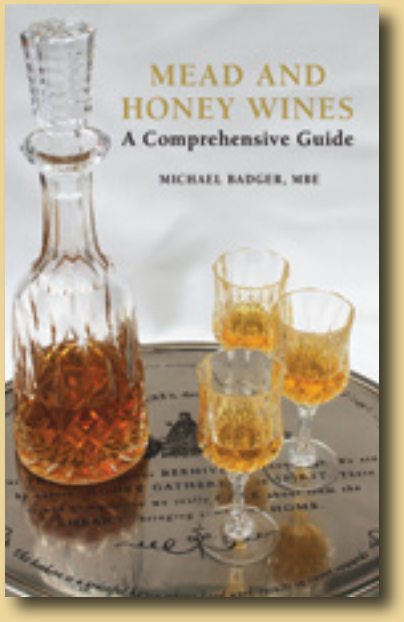

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The Healthy Colony Checklist

The Healthy Colony Checklist is a one-page document, listing the six conditions that need to be satisfied for a honey bee colony to be considered healthy. The form captures the specific details needed to answer the three most important questions when you open a hive: 1) Is the colony healthy?; 2) If so, why?; and 3) What needs to be done to fix the problem? It was developed by Dick Rogers, who has over 45 years of beekeeping experience and is currently the Manager of Bee Healthy and Integrated Apiculture Research. By his definition:

A healthy honey bee colony has below threshold levels of parasites, pathogens, and predators; no deficiency of, or out of balance, beneficial microbes; and sustainable strength and health with a reasonable amount of management by the beekeeper to provide food, shelter, and safety as needed, for any livestock operation.

This definition has been tested and refined over the years into a practical and useful way to inspect colonies using six key concepts to guide the hive inspections. The key concepts are as follows:

- Brood: All stages of brood and instars present in appropriate amounts.
- Adults: Sufficient adult bees and age structure to care for brood and perform all tasks of the colony.
- Queen: A young, productive, laying queen present.
- Nourishment: Sufficient nutritious water, forage, and food stores available.
- Stressors: No apparent stressors present that would lead to reduced colony survival and/or growth potential.
- Space: Suitable space for current & near-term expected colony size that is sanitary, defendable, and room for egg laying

If each of these six areas is satisfactory, the hive is generally considered healthy. If one or more areas are struggling you can start a deeper inspection to assess likely sub-conditions that are causing the problem and record them. In this way, you can do a quick assessment and focus your attention on those hives that need help.

We have built the Healthy Colony Checklist into the **HiveTracks** hobbyist platform and made it available for use with our system to include with all of your other bee data. It is an easy-to-use digital implementation that can be done on the website or a mobile device within our app.

During a hive inspection, you can look at the six key factors in the framework and simply mark if they are satisfactory, not satisfactory, or you are unsure. You can also take and upload a picture for future reference and comparison. In this way, the information is recorded automatically and seamlessly with all of your other data.

Figure 6 shows the form on the **HiveTracks** webpage.

Mobile First Design

HiveTracks' simple, easy-to-use, mobile first user interface design requires the fewest number of clicks to get the most valuable data, allowing you to efficiently collect data at the source in real-time.

HiveTracks is a cloud-based web application, meaning you just sign into the application using any web browser and it's available instantly allowing for safe, effective, and flexible access to your data anywhere, at anytime. The responsive web application and mobile apps for offline work give you the ease and convenience of managing your honey bees on your mobile device.

In the field

It is important to note that the mobile first platform is not just about making it easier to enter data into the system, it is about making it easier to do that in the field where the bees are. This offline access and easy-to-use interface is designed for this tough environment.

Enjoyment

There are many features, and more evolvolving, which make HiveTracks fun and enjoyable. Here are a few of them.

Community Groups

The collaborative and club features built into HiveTracks allow beekeepers to share their joy and love of bees (and their sorrows) with their chosen community. These community features in HiveTracks (see Fig. 7) allow users to connect with others in their bee clubs and classes, beekeeping friends, and mentors and mentees by sharing hive information and insights with one another. Customize your community with your group's icon, post updates for upcoming events, share important announcements, beekeeping news and articles, and view a map of the community's hives.

Figure 6. *The Healthy Colony Checklist at* ***HiveTracks.com****.*

Figure 7. *Community Group Features in HiveTracks.*

Sharing the beekeeping experience with friends can double the joy and divide our pain, as noted below by the poet Joseph Addison.

Friendship improves happiness, and abates misery, by doubling our joy, and dividing our grief.
~ Joseph Addison

Remote Access

With HiveTracks, beekeepers can stay connected with their bees from the comfort of their home; view photos from yard visits throughout the year; enter in more detailed records or notes from previous inspections; view a calendar of all hive events and actions performed; observe other beekeepers in the area using the global map; and evaluate various apiary metrics, such the number of honey bee miles logged each week and pollination events each day.

Figure 8 shows how remote access works.

Since most hobbyist beekeepers keep bees out of a spirit of love and service for them, this feature multiplies their enjoyment.

Figure 8. *Remotely Monitoring Bee Statistics.*

Giving Back

While it can also be fun to use tools like the Hive Editor (see Fig. 8), one of the most satisfying features of using HIveTracks is not really even a feature, but a product. It is knowing that some portion of the data, which you can choose to donate and share, can be used to better understand bees everywhere. One of nature's largest and most important natural experiments, your data, if willingly shared, can help us all better understand bees and the factors that influence them. This information can lead to many improvements for beekeepers too, such as the eventual development of the Genius Hive as outlined in our April 2018 article "The Path to a Genius Hive" in *Bee Culture*.

Figure 9. *Editing a Langstroth hive using the hive editor.*

Voice of the Customer

Finally, here is the experience of using HiveTracks as told by some of our superusers: those who have been using HiveTracks for multiple seasons and rank in the top 5% of users in terms of frequency and consistency of usage controlled for seasonality and the number of hives.

Mark Smith, Durham, North Carolina USA

"HiveTracks is a digital 'database' of all my happenings with my apiary since the day I started using the software. As a new beekeeper, the importance of keeping detailed notes was taught to me from experienced beekeepers during my local club's bee school. Now that I am starting my fourth year, I continue to use HiveTracks to record all of my hive management practices, observations, harvests, and equipment inventory. I can easily search when my last sugar roll was completed, view a map showing proximity of other beekeepers in the US and the world, and check when a hive re-queened itself. Having this information at my fingertips in a searchable format has been a great benefit to me and my bees."

Karen Peteros, SFBeeCause, San Francisco, California USA

"San Francisco Bee-Cause runs a free, two-year beekeeping apprenticeship program to train new beekeepers through book, internet, discussion, testing and hands-on learning. First year apprentices participate in honey bee colony inspections under the guidance of second-year apprentice mentors. In their second year, they serve as mentors for the new first-year apprentices, and are responsible for managing a colony with another mentor. Mentors enter inspection reports in HiveTracks. The software enables the co-mentors and others to be timely informed of their colony's development and needs, and helps them to understand the changes to their colony as a 'superorganism' through the seasons.[3]"

Diana Taekema, Oosterbeek, Gelderland Netherlands

"Hive Tracks helped me as a beginning beekeeper to take care of the administrative side of beekeeping. It helped focus on the important items to check during an inspection. I really like the fact that there is an app now that I can use on my Phone, so I can use on site."

Conclusion

HiveTracks can be a very useful, easy-to-use, and enjoyable tool that can help beekeepers better manage and understand their bees. It can also help all beekeepers by laying the digital platform of data needed to build tools such as the Genius Hive, making the lives of all beekeepers easier.

Special thanks to *Project Apis m.* for supporting a portion of this work with a *Healthy Hives 2020* grant, to leaders at HiveTracks for sharing their thoughts on this topic, and to the editors of *Bee Culture* for publishing this work. These efforts would not have been possible without visionary groups like these providing support and resources. BC

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The Bee Informed Partnership's April Survey

Geoff **Williams**[1], Selina **Bruckner**[1], Karen **Rennich**[2], Nathalie **Steinhauer**[2]

The month of April is known for many things – rain showers, Easter bunnies, practical jokes, and heck, even one of the author's birthday! For beekeepers, April also signifies the time of year when most across the country have had more than a little peak inside their hives to see what's going on after Winter. This is why for over a decade, April is when the Bee Informed Partnership opens up its National Colony Loss and Management Survey to beekeepers across the country. Given that this month traditionally starts out with a few tricks, we thought we'd counter this culture with some TRUTHS about the Bee Informed Partnership's Surveys!

This is the survey's 13th year (well kind of)

The precursor to the Bee Informed Partnership's first ever survey was conducted collaboratively with the Apiary Inspectors of America way back in the spring of 2007. This was when the iPod Touch was the most common Christmas present of the year! Basically, an iPhone without the phone part! Anyways . . . the Survey was primarily a response to Colony Collapse Disorder that was first reported the previous Fall in a number of operations across the country. At this point, there had not been a nation-wide survey of winter colony mortality, so information on 'normal' levels of mortality, or important factors correlated to mortality, was few and far between. The first few surveys were conducted over the telephone. It was not until the spring of 2010 that an online version of the loss survey went out to beekeepers. The Bee Informed Partnership was formed in the spring of 2011 after being awarded a USDA grant. Thereafter, it began to formally conduct an annual loss survey to obtain baseline information of colony mortality during this critical period of the beekeeping calendar. Although the Survey is no longer federally funded, the Bee Informed Partnership continues with it because its data are so important to our industry!

Winter colony mortality questions have been the bread and butter of the Bee Informed Partnership's Survey ever since its inception. But today, the Survey is so much more. For example, we all know that colonies don't just die in the Winter. Therefore since 2010/11 we now calculate Summer and annual losses, in addition to Winter loss. We also know that population health information, like number of dying colonies, is very important to understanding the beekeeping industry, but it's only the start. That's why questions examining beekeeping management, demographics, and socio-economic situation were introduced to the survey starting in 2010/11. That was a big year for us! This year's Survey, like last year's, consists of three parts. Each contain questions designed to maximize our knowledge of potentially important drivers of honey bee colony mortality – 1. Colony Losses, 2. Beekeeper Management, and 3. Socio-economics.

Nearly 50,000 thousand survey respondents representing over six million colonies

To date the Survey has received more than 50,000 responses! The majority of these – over 40,000 – have come from Backyard Beekeepers. These folks manage fewer than 50 colonies. The remaining responses have come from Sideline and Commercial Beekeepers. The former group, which manages 51 to 500 colonies each, have provided nearly 2,000 submissions, whereas the latter group, which manages more than 500 colonies each, have submitted just over 1,000 responses. Despite having a greater number of Backyard Beekeeper respondents, by and large Commercial Beekeepers still represent more colonies. For example, during the 2015/16 Survey, 5,597 Backyard Beekeeper respondents collectively managed 39,170 colonies, whereas 98 Commercial Beekeeper respondents managed 655,623. Sideline Beekeepers were somewhere in the middle!

Just because we have received over 50,000 responses to the Survey over the years, it doesn't mean that each represents a unique beekeeper. We believe some participants re-visit the survey every year (and we thank you!!!), whereas others come and go. Because our Survey is anonymous, we have no way of telling for sure. One thing we do know is that we have received responses from beekeepers in every state.

Months of Preparation

Although the online portal of the Survey is open to beekeepers for the entire month of April, preparation for the Survey starts many months prior. A great example of lead time is demonstrated by this April *Bee Culture* article. We have to make a February 11th deadline! For many, you'd need a snowmobile or snow shoes to get to your apiary this time of year. The January national bee meetings usually mark the beginning of preparations for the upcoming survey. The rest of January and most of February are dedicated to survey design. The Survey is a collaborative effort between our epidemiologists, economists, and sociologists. We typically revise a draft several times to integrate lessons learned from past surveys in order to improve the flow of the survey. It is a juggling act between clarifying the meaning of questions and keeping them comparable across years. It's definitely a work in progress! During these months,

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[2]University of Maryland

we also start preparing our promotional efforts. We create advertisements that will run in major beekeeping journals like *Bee Culture* and the *American Bee Journal*, as well as on our website (**https://beeinformed.org/blog/**) and Facebook page (**https://www.facebook.com/BeeInformedPartnership/**). We also have many collaborators who remind beekeepers about the upcoming survey in their extension or outreach presentations. If you too want a personal email reminder, please sign up here: **https://beeinformed.org/newsletter/**☺.

In March, we test, retest, and re-retest the whole survey to ensure that we corrected last minute bugs to the online portal; we also finalize wording of the survey. March is also printing time. Several hundred copies of our paper survey are shipped out to apiary inspectors (so they can distribute them in their states), as well as to participants of other surveillance programs like the USDA National Honey Bee Disease Survey, as well as the Bee Informed Partnership's Technical Transfer teams (**https://beeinformed.org/about/tech-transfer-teams/**) and Sentinel Apiary program (**https://beeinformed.org/programs/sentinel/**).

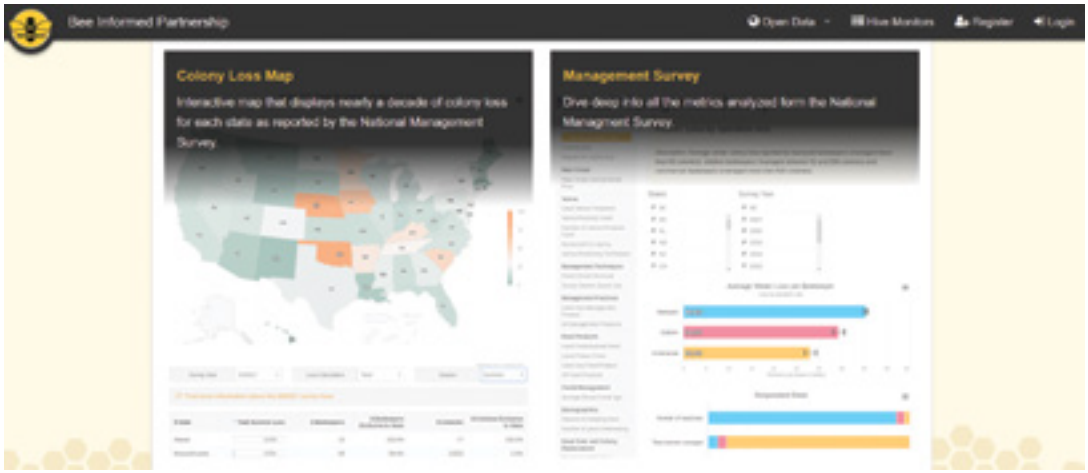
April 1st is go time; the online portal is open. If you are signed up, we will send you an email with a direct link. We are also very lucky to have a lot of support throughout the industry, so you might receive an invitation from the Apiary Inspectors of America, the American Honey Producers Association, the American Beekeeping Federation, Project Apis m., or maybe even your local and regional beekeeping clubs. Feel free to spread the word too! Throughout April we answer beekeeper questions to the Survey, and start preparing our analyses to be ready for the press release as soon as the survey closes. May 1st is a sprint. As soon as the survey closes, we run the numbers to use in the press release that is shared with media and our many stakeholders. Anyone can read the press release here: **https://beeinformed.org/results-categories/colony-loss/**. Even previous year's press releases are up there. Some paper surveys might still arrive throughout May, so those listed in the press release are not our definitive numbers, but they are close to it. Into May and early June, many hands help us enter all the paper surveys that were mailed to us. At the end of June, we analyze the data one last time and produce an updated state-specific map of colony mortality (**https://bip2.beeinformed.org/loss-map/**). From there, our dedicated graduate students start preparing peer-reviewed publications for one of the honey bee research journals. This on its own takes several months of analyses, writing, editing, and reviewing!

All in all, the survey is a complex machine that wouldn't happen without the dedication of many individuals, all of whom we greatly appreciate.

Baseline data, and so much more!

The Bee Informed Partnership's Survey represents the most comprehensive honey bee colony health survey data in the country, and quite possibly the world! You heard us. The world, and we're very proud of it! It's a powerful tool to estimate honey bee colony mortality, and it provides insight into how important factors like management practices and socio-economics affect our industry. Beekeepers are not the only ones interested in data generated by the Survey. Growers of bee-dependent crops like almonds check the numbers, so to do government officials at the USDA, crop insurers, policy makers, and even the general public. Each May, journalists from around the country inundate us with questions for their news articles aimed at educating the public. Researchers too are keen on the Survey results. Years of data collection are just now allowing data scientists to investigate trends of how beekeeping management influences colony health.

Ultimately, the Survey data are for you, the beekeepers. In fact, any beekeeper with access to the internet can see its data by going to **https://bip2.beeinformed.org/**. There you can customize which data you want to see! For example, the default page to the 'National Management Survey' reveals information concerning 'Loss by Operation Size' under the 'Overall Loss' header on the upper left. If you select this feature, and scroll down the page you can see that for all states and all years, Backyard Beekeepers experienced an average Winter loss of 41.4%, whereas Commercial Beekeepers lost on average 28.3%. This clearly shows that losses differ by beekeeping type. If you are interested to compare colony mortality between beekeeping using a known *Varroa* mite control product or not, simply click on the left menu 'Used *Varroa* Treatment' under the '*Varroa*' header. There you'll see that over the course of the surveys, that U.S. beekeepers using a *Varroa* treatment experienced an average winter mortality of



Screenshot of the Bee Informed Partnership's Research Portal. By clicking the 'Colony Loss Map' on the left or the 'Management Survey' on the right, beekeepers can explore many years' worth of data. The website address is ***https://bip2.beeinformed.org/****.*

Screenshot of the Bee Informed Partnership's Research Portal – National Management Survey page. By selecting links ont he left menu (e.g. Varroa – *Used* Varroa *Treatment), one can explore the Survey data in depth (e.g. by state and year). The website address is* ***https://bip2.beeinformed.org/survey/****.*

35.4% compared to 43.9% for those that did not. We work really hard to share the data that you all contributed to in a visually compelling way.

So there you have it, some Truths to the Bee Informed Partnership's Annual Colony Loss and Management Survey. Truth is, it is a powerful tool for understanding honey bee colony mortality in the U.S. The more beekeepers that participate, the more powerful it will be. So please, consider this a personal invitation to take the survey this April! If you want to see what questions you will be asked before you officially dive in, don't fear, there is even a 'Preview' link to ensure you will be fully prepped when it comes time for the real deal. If you include your email, you'll also receive a copy of your answers for your records! BC

From English Major To Honey Bee Biologist

Kirsten **Traynor**

Bees have fascinated us since before we had a written language. Cave paintings depicting honey hunts attest to our long-intertwined relationship with this insect that provides both sweetness and light. In 1945, E.B. White published "Song of the Queen Bee" in *New Yorker* magazine, a rhyming rebuke of mankind's meddling with nature. The poem opens with "The breeding of the bee," says a United States Department of Agriculture bulletin on artificial insemination, "has always been handicapped by the fact that the queen mates in the air with whatever drone she encounters." The promiscuous mating habits of queens high up in the air stymied breeding efforts until honey bee geneticist Harry Laidlaw, Jr. had perfected the technique of instrumental insemination.

I confess, I am one of the meddlers. Two Summers ago, I flew out to windblown Whidbey Island off the coast of Washington State. Known as *The Rock*, this island boasts a scraggly landscape of rolling grasslands edged by stalwart conifers standing shoulder to shoulder. For three days, I trundled from my converted garden shed room – complete with a circular stained-glass window, antique washstand, and sumptuous linens – at the Compass Rose B&B to Sue Cobey's farmstead and private honey bee insemination lab to perfect my technique of instrumental insemination.

I may be small and I'm just a bee
But I won't have science improving me,
Not me,
I'm a bee.
From E.B. White's poem "Song of the Queen Bee"

If someone had told me 18 years ago that I would have a career that involved sticking my bare hands into boxes of stinging insects, I would have burst out laughing. So how did I end up here, my brain filled with random bee facts?

The short answer is I won my first hive in a raffle. Not the bees, just the box. But unpack that box and there's a longer story inside. My beeline – a long and circuitous path – starts with a love of honey and wildflowers. I had no idea at the time I embarked that my path would take me through rural pockets of Europe to meet with bee breeders, the deserts of Arizona in pursuit of a PhD in bee biology, the heart of the Provence in France to better understand brood pheromones and as far as away as New Zealand, when beekeepers on the South Island were still reeling from newly arrived parasite *Varroa destructor*. My curiosity to better understand this insect we attempt to manage in our hives drove my unusual journey.

Where did that beeline begin?

In the middle of Winter, when I ached for sunshine, I attended a home and garden show at the state fairgrounds in Maryland. The aisles between booths were crowded, people jostling against each other in damp wool coats, tucking scarves and hats into expo bags overflowing with vendor brochures. I had recently graduated from college with a BA in English and was living on a farm in Frederick, Maryland. I had come for inspiration, seeking design ideas for bold swaths of flowers I wanted to grow. Instead I found vendors selling acrid smelling silver polish and an ergonomic mop, all in somber shades.

Trudging through building after a building, I felt as damp as the day, but plowed on past endless sleek booths seeking to extract my money. A homemade wood stand plopped down in the middle of the eddying river of attendees caught my eye. Jars of honey arranged in a haphazard pyramid threatened to tumble. Old bee boxes, weathered at the finger joints, held up a sign for local honey and homemade candles. The booth was manned by a gangly man in his late fifties, snarled in casual conversation with a customer.

I paused, eavesdropping for a moment, catching snatches about poor forage and the disappearance of tulip poplar, a once prolific nectar source in his neck of the woods. He caught my eye, dipped a wood stick into a sample jar, twirled it with a practiced motion, and handed me a dollop of honey without ever stopping his patter. I tasted the offering – delectable honey, earthy and sweet. I tossed the stick into the trash receptacle, still savoring the flavor.

"That's a Summer honey," he explained. "Clover and wildflowers."

"It's wonderfully complex," I responded. We struck up a conversation. He lived in the county next to mine and was always in search of good bee forage. At the time I was living on a rolling farm just shy of 24 acres and planting a wildflower garden in need of pollinators.

"Good spots for bees are hard to find," he said.

"So is good honey," I replied.

We struck a bargain and he agreed to bring hives to the property. I dubbed him Lanky Rick. Early that spring he trucked across my top field in a creaky white minivan and set up five hives. I lived along a stream in a valley loaded with black locust, where the back fields had returned to impenetrable scrub.

"A good place for bees," my beekeeper assured me and then drove off.

The bees seemed to like their home. I kept weeding and planting, not paying much attention to the towers of boxes out of view on the other side of my top field. The white minivan rolled back onto my property in late May and Lanky Rick popped out.

Queen insemination.

"I'm going to go check on the hives," he said. "Want to join me?"

He rummaged in the back of his van and pulled out an extra pith helmet and veil, holding it toward me. I walked across the field, as he drove his van to where his hives waited. He must have pulled out a hive tool and lit a smoker, but I was so excited that most of the details are a blur.

I was leaning against the old fence as he popped open a hive. He murmured to his bees. They had put on honey. He moved on to the second hive.

"Girls, girls, why did you do that?" He pulled out two frames. Instead of building out the foundation, the bees had drawn wild comb in the space between. He took a hunk of the light yellow comb with translucent white cappings in his hand, then brushed off the few remaining bees.

"Honey, fresh from the hive," he said, handing me a hunk. I pulled up my veil and popped it into my mouth. Bees keep their hive toasty when rearing young. The comb was still warm and the flavor exploded across my mouth. It tasted sharp, stealing my breath, a cacophony of flowers vying for attention, filling my nostrils. As my teeth sunk into the soft wax, silken honey spilling across my tongue, the flavor mellowed into a gentle river of vanilla tinged with lemon but more floral, as if a bouquet bloomed inside my mouth.

Sue Cobey.

I chewed on that comb.

The sun warmed my cheeks.

I felt deeply connected to the land. This spot felt like home. I had moved so many times in my life. Never had I stayed long enough to develop roots in any one place. This concentrated elixir – two million blossoms condensed into a single pound of honey, over 80,000 flowers exploding in my mouth – was home. This farm, ensconced in a rolling valley crisscrossed by streams, meadows and large fields of corn and soy, had fed the bees that made it.

I knew so little of bees.

But they pulled at me. I inched closer to the hives, wanting to see the inner workings. Lanky Rick pulled the cover off the next hive, puffed a few jets of white smoke over the open colony. I saw the bees dart down, moving away from us. He pulled off the top box, setting it down on the upturned cover on the ground. How had the bees turned nectar into something so delicious?

I watched Rick inspect frames. A jumble of bees clung to each comb, an undulating, chaotic mass that seemed to have no rhyme or reason. I heard him tsk and mutter, then saw him pull out a small manila envelope from his truck and sprinkle white powder into the hives.

"What's that?" I asked.

"Oh nothing," he said. "Helps keep the bees healthy." But his manner shifted. The smile and the friendliness evaporated. He quickly wrapped up his work and headed off, my first beekeeping experience over.

I returned to my work and my garden, but the bees stayed with me. That glimpse into the inner workings of the hive flashed in my mind as I pulled weeds, watered seedlings. One night while I slept, Lanky Rick returned under the cover of darkness, loaded up his hives, and drove away. I don't know exactly when they disappeared. All I saw was the shadow of their departure captured in the faint tracks his minivan cut into my field.

His hives were sick, though I didn't know enough at the time to recognize it. They had come down with American Foulbrood, a disease that requires an apiary inspection. Lanky Rick hadn't registered the bees as required by Maryland law. I was too curious for his tastes. And so he absconded, along with his bees. They hadn't been mine, but I missed them.

I needed to learn more. That following winter I signed up for an introductory beekeeping class taught in nearby West Virginia. Many short courses raise money through a raffle of donated prizes. I invested $10 and bought a few tickets. I had no intention of keeping bees that year. I felt far too overwhelmed by the deluge of details on the many ways my bees could die.

My small investment won me a Styrofoam Beemax hive, a newfangled insulated hive style that had recently become available in the States. "Bees are in your blood," the bee inspector who helped teach the class informed me. I had married into the name, but the spelling is somewhat

unusual, so everyone assumed I was somehow related to the California almond broker Joe Traynor.

If I ordered now, I could still get starter nucleus colonies for this Spring. And as any good beekeeper will tell you, you should never start with just one. A perfectionist, I didn't feel prepared for this challenge. I didn't know enough about how to keep my charges healthy.

That empty Styrofoam box glared at me. I stared back. The taste of last Spring's honey still warm from the hive taunted me. You can't bottle and buy that flavor. Only way to enjoy it again was to bring back the bees. I called a third-generation beekeeper known for high quality nucs. Yes, he told me, I could still order three. I became a beekeeper that spring, pushed into a bee suit before I felt I was ready.

Those three hives all survived their first Winter. The next year I helped the nuc seller and grew my three colonies into more. By year four I was up to over 20 hives. I started writing for the bee journals. To learn how to rear my own queens, I attended a queen rearing course with Marion Ellis and Marla Spivak in Lincoln, Nebraska, driving cross country because I couldn't find one closer to home. Lawrence Conner was at that event. A former Shakespearian actor, he recited E.B. White's poem, drawing bemused smirks from the audience at the line "If any old farmer can keep and hive me/ Then any old drone may catch and wife me." We were not old farmers, but a motley crew of bee enthusiasts.

On a long shot, I applied for a German Chancellor Fellowship from the Alexander von Humboldt Foundation. Marla Spivak kindly connected me with Otto Boecking at the Institute for Bee Research in Celle, Germany. Otto Boecking's specialty is varroa biology and he agreed to be my host. The institute where he is based teaches all the students, who wish to become professional beekeepers. These students, often only 15-17 years old, must come to the institute during the Winter months to learn the trade – Germany still has a guild system for some professions, including professional beekeeping. I was awarded the grant in 2006 and spent 18 months in Germany, traveling over 55,000 miles by car to meet with beekeepers, bee breeders and bee scientists throughout Western Europe.

During this time mysterious honey bee losses grabbed headlines around the world. European beekeepers were fearful this newly named Colony Collapse Disorder would soon hop over the Atlantic. I reached out to contacts back in the States, interviewing Dennis vanEngelsdorp and Jeff Pettis by cell phone as they crisscrossed the country collecting samples.

As my 18 months in Europe came to an end, I realized honey bees had snuck into my life and I felt most at ease when working a hive. I needed to learn more, keep exploring how that chaotic jumble in a hive communicated, self-organized.

Getting into a biology graduate program when you have taken zero college level classes in biology is no easy feat. I reached out to bee scientists I admired. Marion Ellis intimated he would take me on as a student, but he thought I should I find a course that would challenge me in different directions. Rob Page, who had recently moved from UC Davis to the School of Life Sciences at Arizona State University as its founding director, invited me out for an interview. As a graduate student Page had worked closely with Laidlaw, whose advances in instrumental insemination stimulated White's poem. At ASU, Page was building an interdisciplinary program and social insect research group. We talked. He showed me diagrams of gene maps I didn't understand.

"This is what we do," he said. "We investigate the genes that underlie behavior. If you're interested in that I will give you a chance."

At the time I had only a rudimentary understanding of gene regulation. I nodded enthusiastically despite my ignorance. Rob Page took a chance on an English major smitten with bees. He gave me one year to audit and attend as many biology classes as I wanted. At the end of that year, I had to pass the GRE Biology subject test to stay in the PhD program. I overloaded on classes and read the most highly recommended biology textbook cover to cover, all 1,200+ pages.

My PhD spanned both basic and applied biology, investigating how brood pheromones change honey bee physiology and influence foraging behavior. During my time at ASU, I won a Fulbright, spending an academic year in the lab of Yves le Conte, who first discovered honey bee brood pheromones. Bees, it turns out, are quite good at manipulating their caregivers. Humans have carried bees to every corner of the globe except the North and South Poles. But we shouldn't be surprised. They learn to manipulate from a young age. Young and old larvae have different nutritional needs. Young larvae need protein rich pollen, while older larvae need carbohydrates to complete pupation. And so the pheromones the developing young

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give off drives foraging behavior of the colony. Young larvae stimulate more pollen foraging, ensuring that the colony has enough protein rich food on hand to rear them.

Pursuing a PhD is a humbling experience. I have always feared failure. My first three years of research produced nothing. I ran several experiments. Bees have a way of surprising you and all my results were inconclusive. I was asking the wrong questions, trying to put bees in artificial settings that confounded their behavior. So I headed back to the drawing board and redesigned my experiments, building them up piece by piece on a strong foundation. The key to succeeding in science is not so much what you do, but how often you fall on your ass, pick yourself back up, brush off the dust, and try it again with a different approach.

While wrapping up my PhD, I became editor of *Bee World*, a quarterly magazine published by the International Bee Research Association. After graduating, I joined the lab of Dennis vanEngelsdorp working on how pesticides impact colony health and how to improve queen quality. I was editor of *American Bee Journal*, a position from which I resigned after 14 months. I'm currently in Berlin, Germany as a College of Life Science Fellow working on a book about honey bees and *Varroa*.

It's cold, grey and dreary – a typical Berlin Winter. On days like this I miss the Arizona desert, which bursts into gaudy bloom in late Winter. The early morning sun lights the tufted sky on fire. It sneaks over the parched ground, coaxing the desert to open its ruffled flowers. Cacti bloom infrequently, so luring in pollinators requires a stupendous display. Big, bold and bright is the motto, and I always admire the pops of hot pink, canary yellow, and Cheeto orange. Work in the bee yard starts early, as soon as there is enough light to see. Before starting my foraging experiments, I would stand next to a hive and watch the bees fan out into the sky. The bees often dart in myriad directions, zooming off to explore different patches.

Like the many different routes a single colony pursues, my path has not been a straight beeline; my fascination with bees has taken me on a circuitous globe-trotting journey. Sometimes I find myself scampering over rocky places and carving my own wild track. That's okay, I've learned. Failure forces us to find new paths. Besides, it's in these scraggly places that we find the most spectacular wildflowers. BC

Kirsten Traynor is an avid beekeeper, bee scientist and speaker. She puts together the FreeBee, a quirky, informative newsletter covering bees and scientific research. Sign up at ***www.mdbee.com/freebee.html.***

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Apimondia In September In Montreal

In 1999 Vancouver played host to Apimondia, the world's largest beekeeping scientific symposium and trade fair. Up until that point, the event was large, attracting a couple thousand or so international visitors. But those involved with the Vancouver event strove to make things bigger and better, and so they did, attracting nearly 5000 participants and setting the stage for larger Apimondia events. Spring forward twenty years and the Canadian Honey Council is proud to once again host Apimondia, this time in Montreal at the Palais des Congres, September 8-12, 2019.

Since winning the bid to host the event in 2015 in South Korea, thousands of man hours have gone into preparation and planning of a world class event. The President of Apimondia 2019, Pierre Giovenazzo is a renowned professor at Laval University and has worked tirelessly at setting the groundwork. Dr Stephen Pernal, an internationally well-respected researcher in his own right, is the Apimondia 2019 Science Co-ordinator, while at the same time, working at his day job as Officer in Charge of the Beaverlodge Research Station for the Government of Canada.

This core team has expanded, getting volunteers from across Canada to look after workshops, tours, publicity, volunteers and science advisors. In addition, all the provincial associations have been asked to help out at various Apimondia contests. The Canadian Association of Professional Apiculturalists and the Board of the Canadian Honey Council are also playing key roles.

Its only April, but the keynote speakers have been confirmed and it is an extraordinary lineup. Thomas Seeley is the Horace White Professor in Biology at Cornell University, has written five books on honey bees and has received numerous prestigious awards. Rufus Isaacs is Professor and Extension Specialist at Michigan State University and has done extensive work on sustainable management for pollinators. Gene Robinson is a faculty member of the University Illinois and pioneered the application of genomics to the study of social behavior in honey bees. Finally, Peter Rosenkranz is a professor at the University of Tubingen in Southern Germany and has specialized his work in *Varroa* control and honey bee communication.

In addition to the four keynote speakers, there will be well over 100 researchers and scientists speaking on topics set forth by the seven Apimondia Commissions. To "Canadianize" the program, there will be eight beekeepers from across Canada presenting on their operations, each with different specialties. Further to that, we have a number of evening workshops that, in part, supplement the science program. Sessions in apitherapy, honey tasting and urban beekeeping highlight these workshops.

The trade show will be the largest of its kind ever held in North America. At Api-Expo it is expected that over 250 booths focussing on all aspects of the industry will be participating. There should be something there for everyone no matter what size your operation or even if you are just trying to get information on how to start.

There are numerous contests in such areas as honey, meads, bee art, wax, and literature. Don't be scared to enter! The are pre and post event tours the will surely fill up quickly. The opening ceremonies will feature a Juno nominated band from Iqaluit, the Jerry Cans. This will be sure to excite a few people as they do a mix of up-tempo roots-rock music and traditional Inuit throat singing.

Those in the beekeeping industry realize that early September may not be the most convenient time but Apimondia 2019 will probably represent a once in a lifetime opportunity to see and hear world class activities in our own backyard. To register, to book accommodation, and to keep appraised of updated activities and events, check the Apimondia 2019 website at **http://www.apimondia2019.com**.

Rod **Scarlett**

Most of those who attended Apimondia 36 believe it to be the best organized convention of its nature ever. That's saying something, given the history of the International Federation of Beekeepers' Associations meetings, which stretches all the way back to 1897. Clearly, many of those attending the 1999 event in Vancouver have no way of knowing what went on during all the preceding events. But going as far back as my first Apimondia in Acapulco in 1981, I concur with this conclusion. So, the Canadian organizing committee for Apimondia 46 in Montréal has its work cut out for itself. I for one believe they will pull it off with aplomb.

I fondly remember Acapulco and readers will no doubt be interested to know that one can still read about it in some depth (along with several others noted in this article) linked to The Apis Information Resource Center https://beekeep.info. Here's a taste of what I wrote at that time:

"The theme for the 1981 Apimondia Congress, "beekeeping development in tropical areas," could not have been more appropriate than in the Acapulco setting. Mexico's beekeeping expertise has enabled the country to become a major world honey exporter, and its success may well be a model for many countries to look to while developing their honey industry. Mexico, therefore, richly deserved to be the meeting place for the 1981 Congress, the first ever held in a country with a tropical climate. Perhaps no part of the earth faces the beekeeping challenges this geographic area does at the moment.

"The seemingly inexorable advance not only of the controversial Africanized honey bee, but also its associated parasitic mites, casts an uncertain cloud on the very future of apiculture in the New World."

Some of the figures featured at the convention included Roy Weaver Jr. who chaired the Beekeeping Economy Standing Commission, the eminent Dr. Espina Perez of Costa Rica, best known for co-authoring the book *Apicultura en los Tropicos*, with the Cuban apiculturist, Gonzalo S. Ordetex, and Charles Mraz, pioneer in apitherapy technique.

"Dr. P. Wix from England discussed the present beekeeping development of Tanzania. He said the emphasis is now being placed on he role of extension programs, that have been lacking in the past. The extension advisers are intensively trained in Swahili, and one of their prime missions is to upgrade the local honey crop to compete in the world market, which in the end will be the key to Tanzania's apicultural development.

"In the following presentation, beekeeping development was discussed at length by a Venezuelan scientist who painted a rosy picture and claimed that small and large operators are able to recoup their full investment in beekeeping after five years. Unfortunately, the impact of the Africanized honey bees on the Venezulean beekeeping industry was not addressed. The presentation provoked a comment by Dr. Espina Perez, who said that development efforts are better invested in training full time professional apiculturists rather than small operators. A rejoinder by the Venezuelan indicated this was not relevant to the study because only the business side of the operations were studied. There followed closing remarks by Dr. H. Borneck, vice president of Apimondia from France. He supported the expression of differences by members present and emphasized the role of Apimondia as a forum for alleviating controversy, while helping the beekeepers of the world solve their problems."

Perhaps the most relevant and urgent subject of the Acapulco Congress was the focus on worldwide threats to beekeeping, especially the acarine and Varroa mites. The former critter had just been detected in the Americas a year earlier in the port of Veracruz.

"The Acapulco congress was attended by 1,519 beekeepers from 54 countries. Apimondia continued to grow with 83 Member Associations from 71 countries represented, the largest number so far. The new Regulations for Congress Organization were applied for the first time, seven contests were held and ApiExpo '81 consisted of 31 stands. At the eight plenary sessions 214 reports were presented. The suggestion to establish an Apimondia Working Group on beekeeping in developing countries and the recommendation to have the working group on Apitherapy changed into an Apimondia Standing Commission were presented to the General Assembly."

Following the Acapulco meeting, I was privileged to attend and report on Apimondias in Budapest, Hungary (1983) and Rio de Janeiro (1989) . An abbreviated history of the congresses from 1897 to 1997 can be found on the Apimondia website.

I also reported on subsequent conventions in Vancouver (1999) as noted above, Durban, South Africa (2001), Melbourne, Australia (2007), Montpellier, France (2009), and Kiev, Ukraine (2013). In spite of the glitches that inexorably happen when events of this magnitude are planned, most Apimondias have exceeded my expectations.

So what can we anticipate with reference to Apimondia 46? Plenty it appears, starting with keynote addresses by Dr. Gene Robinson on honey bee social behavior, Dr. Rufus Isaacs on integrated pollination, Dr. Peter Rosenkranz on honey bee health, and Dr. Tom Seeley on Darwinian beekeeping.

The Scientific Program will cover a wide range of

APIMONDIA 46

themes, grouped within the seven Apimondia Standing Commissions: apitherapy, bee health, bee biology, beekeeping economy, pollination and bee flora, rural development, and technology/equality. New to the Montréal Congress is the addition of "Cross-Cutting" symposia which will encompass topics spanning the purview of two or more of the standing commissions.

"Highlights among the many symposia at the Montréal Congress will include: Advances in Honey Bee Genomics, the Impact of Pesticides on Bees, Breeding for Mite and Disease Resistance, the Detection and Prevention of Honey Fraud, Technical Innovations in Beekeeping, Honey Bee Nutrition, the Status and Conservation of Pollinators, Treatment-Free Beekeeping as well as Citizen Science and Bees. The Montréal Congress will also host two symposia sponsored by the OIE, the World Organization for Animal Health, on topics related to bee diseases, pests and the world-wide movement of bee stock.

"In addition to symposia, the convention has formally-organized round tables which address emerging matters of interest. Round tables permit the interchange of ideas between audience members and selected panelists. Examples include: the Social Impact of Bees, Beekeeping with Stingless Bees and Honey Adulteration."

Eight specialized workshops are tentatively scheduled. Two of interest to most that are free include integrating beehives in the city and how to create a successful beekeeping development project. Both have an enrollment limit of 100 people sign up during the registration process. Several others with more limited participation will provide certificates of completion for a fee.

Two special registration options exist, both ending 30 March 2019, the early registration deadline. The Ambassador Program provides a ten percent discount on full registration. Those reading this can use the following password (APIAMBPROG2019) and code (0031) to take advantage of this. A Company Area Group Registration is also possible for groups of at least 10 individuals.

Three post congress technical tours have been organized:

MIELS D'ANICET, (departure: Friday, 13th September – return: Saturday, 14th September) features a wide range of products and services related to beekeeping.

MONTREAL HONEY (13th and 14th September – Tours in AM or PM): The city of Montréal has two major actors in urban beekeeping, Montréal Honey being among these, with more than 2000 hives on the island.

INTERMIEL known internationally for its honey and mead products (13th September – Tours in AM or PM); I visited this outfit in 1998. My report at that time provided insight into Canadian beekeeping prior to Apimondia 36 in Vancouver. Two areas of historical interest were the view of mite research at the time, along with the status of the Canadian Bee Research Fund, both reported by Mark Winston (now employed at Simon Frazier University). In addition, read about the controversial situation regarding border closure with the U.S. at the time, prohibiting all imports of honey bees into Canada. The remains in effect.

Two Canadian apicultural institutions will be highlighted in Montréal. They are the envy of most beekeeping organizations worldwide. One reason for this is the Canadian government's generalized support for beekeeping-related activities.

"The Canadian Honey Council, according to its website, was formed first as the Canadian Beekeepers Council in 1940 to assist in negotiating fair practices for labeling, grading, and marketing honey at the national level. The fledgling organization was underfunded and slow to communicate. It was difficult to respond to issues or develop the international markets that the members wanted. It was clear that there was a need for a higher profile and increased international recognition. In 1970 The Canadian Beekeepers Council decided to change its name to Canadian Honey Council (CHC). Currently, the CHC membership consists of representatives of Provincial Associations with the total number of beekeepers at approximately 10,000 managing over 750,000 colonies."

Among its programs, the CHC is well known for its quarterly magazine, *Hivelights*. The website contains an archive of past issues dating back to 2013. It also sponsors the Canadian Bee Health Roundtable (BHRT), "committed to producing, through inclusive discussion, an increased understanding of the risks involved where agriculture and apiculture intersect, and undertaking timely activities aimed at reducing or eliminating these risks. The group is made up of a cross-section of stakeholders including those from industry, academia, provincial and federal governments." This reveals the interconnectedness of Canada's academic, industrial and regulatory communities.

Many of the activities of the CHC are also carried out in conjunction with the Canadian Association of Professional Apiculturists (CAPA). Like the CHC, CAPA has gone through a metamorphosis. Originally founded as Canadian Association of Apiculturists (CAA) in 1959, it decided to federally register and "professionalize" in 1975, renaming itself to fit its new image.

CAPA meets annually in conjunction with the Canadian Honey Council (CHC) to develop educational material and organise professional initiatives. Examples of CAPA professional initiatives include: dissemination of

apiculture information (i.e. extension), consultation and communication with CHC and professional apiculturists in North America and abroad, co-administering the Canadian Bee research Fund (CBRF) with CHC, awarding an annual Student Merit Award, development of 5-year research priorities. Compiling and publishing statistics for Canadian honey bee colony losses. Assisting in hosting Apimondia and other meetings of importance in the country.

CAPA consists of members from both the education (extension) and regulatory arms of both the Canadian provincial and federal governments. There is no organization comparable in the United States.

"The Canadian Bee Research Fund (CBRF) is a joint project of the Canadian Association of Professional Apiculturists and the Canadian Honey Council. The Board of Directors is comprised of four members, two from CAPA and two from CHC. The Canadian Honey Council takes direction from the CBRF board of directors and administers the fund as required.

"The CBRF has been set up as a long-term endowment fund. Interest generated by the CBRF is made available for annual grants. Beekeepers direct the type of research that they want to support. The CBRF is entirely supported by donations from the apiculture industry and is a unique partnership between CAPA and CHC members."

In an effort to make U.S. stateside communities more relevant for beekeepers, the American Association of Professional Apiculturists (AAPA) was created in the 1980s, modeled as much as possible after CAPA. It currently sponsors the American Bee Research Conference each year in conjunction with conventions by the American Beekeeping Federation and American Honey Producers Association.

Attendees at Apimondia this year in Canada will be helping to celebrate an extraordinary international event. Those in North America missing this year's congress will rue not taking part in an event that only has taken place three times before on the continent. So far it looks like Apimondia 46 will rival, if not eclipse, Apimondia 36. BC

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Phages are a virus that eat bacteria.

Gerry **Hayes**

At the 2019 American Honey Producer Association (AHPA) held in Phoenix, AZ I was rewarded as usual by being able to renew old friendships and begin new ones, all the while learning more about honey bees. You all have heard me say this before but anyone who says that they know everything about honey bees is a liar. So, I am glad to learn more always and the AHPA Conv. is a wonderful place to do that.

American Foulbrood disease (AFB) is probably the most significant bacterial disease that infects Honey Bees. It can kill colonies. It is difficult to ID in its early stages from European Foulbrood (EFB) and Parasitic Mite Syndrome (PMS). Antibiotics can control the actively infective growing 'vegetative' stage of AFB. But, the AFB organism, *Paenibacillus larvae*, is a skilled survivor and when the infection reaches a certain stage it forms a protective 'spore' which is a kind of hard-shelled seed that is impervious to antibiotics, changes in heat and humidity, time, and even radiation. This spore can stay alive for decades waiting for the right place and conditions close to honey bee larvae to germinate and infect as an efficient opportunist. It is super tough. Antibiotic control methods we have used for decades were OK but imperfect.

Back in 2017 in the Journal of Invertebrate Pathology, there was a paper titled, "Bacteriophages as an alternative to conventional antibiotic use for the prevention or treatment of *Paenibacillus larvae* in honey bee hives" (**https://www.sciencedirect.com/science/article/pii/S0022201117302872**) by Dr. Sandra Hope, Dept of Microbiology and Molecular Biology, Brigham Young University, (BYU).

I love serendipity. At the AHPA Convention, a person had set up a vendor table right next to where my table was set up. My shy gene is less functional the older I get so it was easy to introduce myself and ask who she was and why she was there. Let's start there;

Q) Now that I know who was there . . . nice to meet you, Dr. Hope. Let's start out and get some background **(CV kind of**) info to set the stage for the Great work you have done. Who are you?

A)I am a professor in the Microbiology & Molecular Biology department at BYU and I've been there for about 14½ years. I did a Master's Degree in Bioveterinary Science at Utah State University where I studied synthetic drugs designed to treat virus infections. I then did a PhD in Veterinary Science at the University of Kentucky studying virus infection and the immune system response in horses. After graduate school, I worked at the Medical School at the University of Kentucky in the Microbiology, Immunology & Molecular Genetics Department and worked on a project to make a better mouse research model to study the role of a certain white blood cell that is key in helping people fight infections. I was hired as a faculty member by BYU in 2004 to teach classes and to run a research "core" center for the College of Life Sciences, which is called the RIC facility. Being the director of the RIC is wonderful because I help many students and faculty across campus with their research projects and I have a lot of freedom to pick what I want to do in my own research as well as how much or how little research I do. I started the research project in honey bees in 2012. Considering my research history, I think it is pretty funny that I started in horses, then mice, and then bees – it just seems like my research subjects are getting smaller and smaller over time!

Q) Ultimately BYU has not been known as a hotbed of honey bee research in the past. How come you decided to be a honey bee health researcher? And will you always be one?

A)This is a good point! In fact, I don't believe any honey bee research was done at BYU before I started my project. As I described above, my profession has always focused on viruses and the immune system. In 2009, I worked with another BYU professor to get a grant from Howard Hughes Medical Institute (HHMI) and begin a research program at BYU to study a new way to combat bacterial infections. HHMI's focus was on a bacteria related to Tuberculosis, and the HHMI grants expanded to over 100 universities in the U.S., which meant pretty tough scientific competition since we were all focused on the same bacteria.

As our grant was coming to an end, I sat down with my colleagues and I proposed we pick a new bacterial target. That's when I got a brilliant and exciting thought in my head – I could combine my own love of honey bees with my love to do research! At the time, my colleagues didn't know that I secretly was a backyard beekeeper at home. I love bees! I love learning about and caring for them. When I told my colleagues that I wanted to do research in *Paenibacillus larvae,* they both looked at me and asked, "What disease does THAT cause?" In the end, the other two professors picked their own bacterial targets and I was excited to get to work on American Foulbrood.

Q)Explain to us what the title of your paper actually

tells us. What is a bacteriophage? And why should we care?

A)The title of the paper is "Bacteriophages as an alternative to conventional antibiotic use for the prevention or treatment of Paenibacillus larvae in honey bee hives." The word 'bacteriophage' derives from the Greek word 'phage' which means 'to eat', so the name 'bacteriophage' literally means 'to eat bacteria'. Phages, as we like to call them, are a specific category of viruses that can only infect bacteria. Phages are completely inactive towards plants, animals, insects, and anything really, except for bacteria, and are very, very specific for the bacteria that they can kill. Because phages can infect and kill bacteria, they are being studied in greater depth as a new treatment approach to infections rather than using antibiotics to kill bacteria.

One of the most exciting parts about phage research is that the phages are so specific to the bacteria that they kill, so that phages attack a dangerous bacterium and completely ignore any other bacteria – this means that healthy bacteria are not affected. This specificity of phages is different than antibiotics because an antibiotic typically kills bacteria in a broad sense, which means an antibiotic can kill the dangerous bacteria as well as the healthy bacteria.

The other exciting part about phage research applied to a bee disease is the very nature of phage inactivity against everything else. A phage against *Paenibacillus larvae* is not only organic, but is recognized by researchers as well as the FDA as completely safe for human (and bee) consumption. Phages can be given to bees anytime during the year, no veterinary regulations will be needed, and they are safe regardless of whether it is for spring feeding, during a honey flow, or at Fall feeding to prepare for Utah Winter!

Q)If what I read and understood in your paper is correct you have identified a group of these bacteriophages that can prevent or control AFB without antibiotics. is that right?

Yes. This paper nicely lays out the safety and efficacy of the phages in beehives, but I have to admit that there's a lot of research that lead up to this particular paper. For instance, just the capture and identification of the phages specific to *Paenibacillus larvae* has been an amazing scientific journey for me. To capture phages for the project, it took hundreds and hundreds of samples of dead bees (from healthy and infected hives) donated by beekeepers across the country, and from survey samples and from state apiarist samples – these samples were essential for my students to do the work in the lab to try to find and then identify naturally-occurring phages that were going to be useful for a treatment. After all of the sample processing, phage identification, and lots of DNA sequencing and testing in bacterial samples in the lab, my students and I were able to pick out the most potent natural killers against AFB and then plan to test those phages for the study that is presented in this research paper.

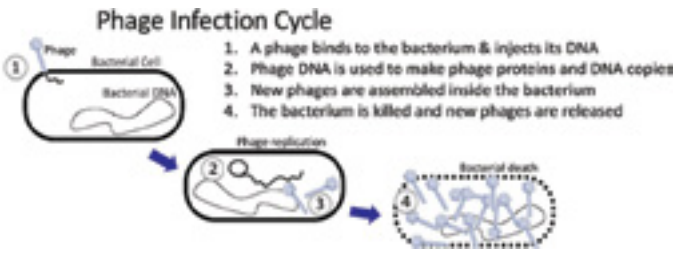
This particular research paper was so exciting for me because it provides the first scientific evidence of using phages to effectively treat American Foulbrood in beehives, and the efficacy even amazed me! Prior to this paper, we had captured and tested other phages, through some amazing work of a former graduate student, Bryan Merrill. Our results of the first types of phages were moderate and more similar to using antibiotics. But after making broad changes to our approach and starting again with hundreds of bee samples to find different phages, we obtained the phages used for the new study presented in this paper, and these phages were a like a laser beam of destruction to AFB! We were able to show that the phages could reverse the damage of infection within three days and completely clear up the infection within 10 days, and recurrence was not detected at any point during the 10-month study.

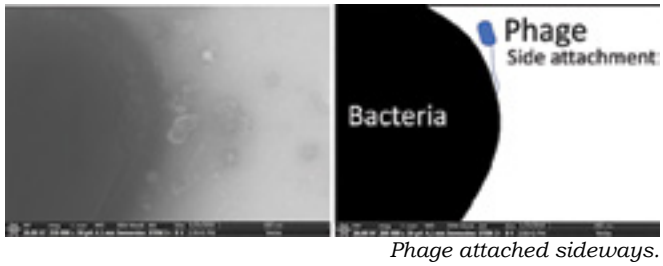
In this paper, we also showed that the phages given to healthy hives that were at-risk of infection during an outbreak were able to completely prevent the spread of AFB where the transmission rate was otherwise very high. All of these results were done without using antibiotics and the results were far superior to any antibiotic treatment. In the phage treatment reported in this paper, AFB had occurred in a mid-summer outbreak so phages were given during honey flow. After phage treatment, the apiary experienced no more AFB that year, all hives produced honey, and the honey was safe to be harvested and consumed. The hives were strong in Fall and overwintered without issue and without AFB recurrence when observed the next Spring.

Q)Please take as much space and explain to us how these bacteriophages can control AFB. (**Photos, diagrams whatever you have to sequentially and visually show how these work would be great)**

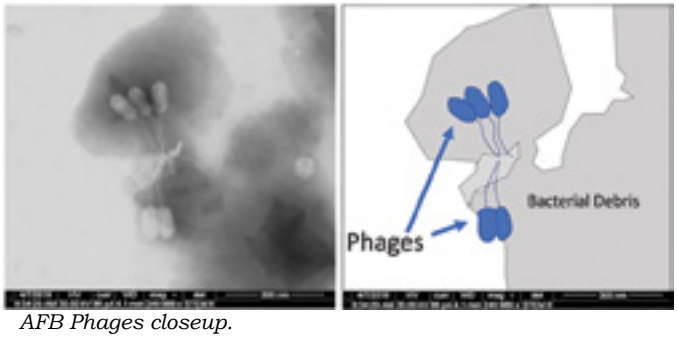
A)As I mentioned before, phages are a type of virus, which is why my particular scholarly training has prepared me well for research in this area. Phages look different than any other virus – I've included an electron micrograph of some phages for you to share with the readers. The phages have an oblong head that contains DNA information, and a long, thin tail with small fibers at the end of the tail that can specifically stick to the bacterial target. In this picture, there are five phages each grabbing onto a fragment of bacterial wall (from a bacteria they had just killed). If you want to compare sizes, phages are much smaller than bacteria.

Phages kill bacteria much the same way that a cold virus kills cells inside your nose. The phage will first stick to





Phage attached sideways.

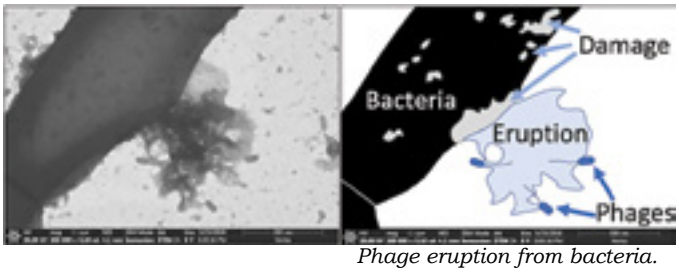


AFB Phages closeup.

the outside wall of the bacteria. Sometimes it will stick on the bacteria sideways until it gets a good grip, and then it stands up and injects its DNA into the inside of the bacteria. The phage DNA will take advantage of the equipment inside the bacteria to generate new phage proteins and begin assembling many, many copies of the phage. After a while, the inside of the bacteria will become quite full with newly-formed phages. The production of the phages is very energy-consuming to the bacteria and it will begin to feel pretty starved! After all, the phages are eating the insides out of the bacteria. Ultimately, the phages release proteins that destroy the wall of the bacteria so that all of the newly-formed phages explode out of the dead bacteria and are now able to stick to any nearby bacteria to start the process again.

This process is obviously extremely destructive, so I know it may sound shocking that phages can be as safe to use as they are. There are several features that contribute to phage safety. First, phage DNA can only be read by the machinery inside a bacteria. This means that other types of species, such as people or plants or animals or insects, do not even have equipment that could read or use the phage DNA. If we eat a phage, it just gets digested. If a piece of phage DNA gets into one of our cells, it can't be used, so it is destroyed by the regular cellular digestive process for recycling as if it were something like cow DNA or chicken DNA (here you see that I like to use examples of foods I enjoy eating).

The next safety feature is that the tail of the phage and the fibers at the end of the tail are very bacteria-specific. The fibers cannot stick very well to unrelated bacteria, and if the fibers don't stick exactly right to make the phage stand up, then the phage can never inject its DNA into a bacteria. This means that the phages cannot infect unrelated bacteria such as lactobacillus or other beneficial bacteria. The fibers that bind and inject DNA, as well as the DNA sequence itself, is so customized that some phages cannot even infect and kill all the different strains of the bacteria that they target! For example, in the research lab, my students have found many phages that act like wimps. They can infect one or two versions of *Paenibacillus larvae,* but are completely useless when tested on other versions of the bacteria. Quite a bit of our research has been to test every phage we capture with as many strains of *Paenibacillus larvae* as possible. It was quite a task to find just the exact phages that could, in combination, kill every possible strain we challenged them against. Then if these phages are put with any other bacteria, they can't infect, they can't reproduce, and there is absolutely no bacteria-eating at all! I love that this specificity makes phages as safe as they are for our use, while being a silver bullet to AFB.



Phage eruption from bacteria.

Q)You were at the AHPA Convention representing a company named Boodsafe. Is that your company? Do they make the bacteriophages?

A)The company making BroodSafe is called Esplin Biotechnology, LLC. This is not my company. The company was formed by the Esplin family as one of their investments. The Esplin's recently made a license agreement with Brigham Young University for one of my patents pending and the permission to grow and sell the phages captured and identified by my lab. The company also licensed a patent from the University of Nevada, Las Vegas, for phage use in beehives. I have worked in collaboration for several years with UNLV and we have multiple research publications on our DNA sequencing results from the *Paenibacillus larvae* phages. As part of any licensing agreement, the university requires that a company gives a certain percentage of benefits to the scientist, so it does means I have interest in the business, but I do not own or run the company. However, what scientist doesn't want their discoveries to be a success?! This is why I was at the AHPA Convention. One of my graduate students, Scott Brady, was hired by the Esplin company immediately upon graduation to help manufacture and quality control test the production of the phages. Scott was the other person at the AHPA Convention with me and he is incredibly skilled at growing phages, preparing them for packaging, and running the control-test protocols to ensure that the phage product will be active as expected. The company makes big batches of phages, far more than I ever made in a research flask, so they are prepared to produce the phages for bulk sales in hopes that their investment will be a success.

Q) So there is an actual product that people can buy? How is it used?

A)The BroodSafe website now takes pre-sales orders for their first batch of phages that they are producing this month. They plan to package and make the sales official as soon as possible and keep producing phages to supply the demand from beekeepers. The company is able to sell the phages as a "feed additive", which is a specific category that the phages fit into without restriction by the FDA. Once the batch of phages are grown, they are freeze-dried into a powder and mixed with a small amount of powdered sugar to package for sales. Even in the package, the phages will be quite concentrated, so the beekeeper can use the phages in one of two ways: 1) mix the phages with more powdered sugar and sprinkle in a hive, or 2) mix the phages right in with liquid feed to feed to the bees. The

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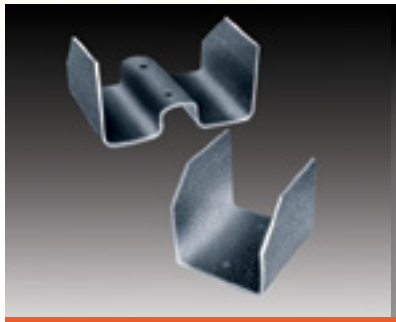

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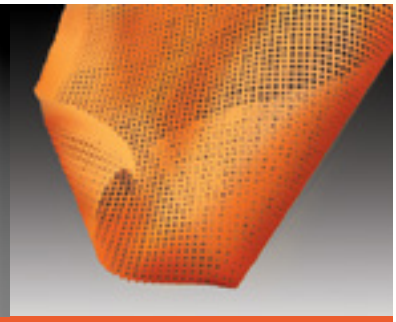

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company anticipates that most keepers will simply stir the amount of powdered phages for their hives into a batch of sugar-feed since this makes it easy to feed to the bees (instead of dusting inside the hive). According to the research results, it is best to give three feedings of phages to the bees, with anywhere from three-days to three-weeks in between each feeding. It is best to give three feedings in order to provide the best chances of distribution of phages to the bees and larvae in a hive. The phages are sensitive to sunlight, so it will not be a good idea to put the phages into glass feeders that are on the outside of the hive where sun can hit them, but an in-hive trough or top-hive bucket feeder will work great.

Q) How good is it at controlling AFB. Is it a standalone and we don't need antibiotics anymore?

A) According to my experimental data, the phages are superior to antibiotics at controlling and preventing AFB. However, the Esplin company is specifically not advertising or selling the phages as a treatment, but only as a feed additive. This technicality in distribution and instructions for BroodSafe is due to the fact that the FDA already approves phages to be sold as a feed additive due to their safety as an additive. To sell the phages with labelling as a treatment or preventative for AFB, there is a lot more paperwork needed for the FDA's stamp, which will likely take years to complete. In light of the current need for managing AFB and the recent restrictions on antibiotics for a feed additive, the Esplin company did not want to delay any longer at getting phages into the hands of beekeepers. Therefore, the company decided to minimize the labelling claims to that of simply a feed additive rather than as a treatment or preventative so they could sell phages now, even though the research data supports what these phages can do.

As an approved feed additive, the beekeeper can decide when to use phages in their supplemental feed. The company (and I) highly recommend that the phages be included in the supplemental feeding in the same place where antibiotics used to be used – for northern states, this is usually a Spring and Fall feeding, and for southern states or migratory bees, it would be prudent to include phages anytime that supplemental feeding is offered. When phages are included in the feed, the phages can be detected in the hive at a high concentration for the first day after feeding. The amount of phages gradually reduce daily until the number of phages returns to the low level that is naturally found in hives. A phage feed additive for AFB management will need to be repeated in the event of new exposure and also in the event of left-over AFB spores that are very hearty.

Because of AFB spores, it is highly unlikely that AFB will be eradicated, but the use of phages for management is far safer and less irritating to bee health than the use of antibiotics for management. Phages obviously add a level of safety to the bees, honey, and other bee-related products compared to the use of antibiotics where any bee products must be discarded if produced during an antibiotic feeding. It would be wonderful if phages

could replace the use of antibiotics so that there was no need to destroy such precious products of the hive. As for whether antibiotics are needed anymore . . . just remember, these phages are specific only to the bacteria that causes AFB. These phages cannot touch other bacteria, so they absolutely cannot help with European Foulbrood. Another aspect of phages is that bacteria do have a slow mutation rate and it is possible that over time (say 10 years), the bacteria could evolve to survive the current phages.

Q)Can it be improved?

A)The nice thing about phages is that, like bacteria, the phages can also evolve, sometimes faster than bacteria. With diligence to ongoing testing and phage selection for the BroodSafe product, effective phages should be available on an ongoing basis. Another recent improvement of the current phages is the new research data from my studies at the university showing that these phages can actually bind to AFB spores. I am currently working on a research manuscript to publish these results, so this is a bit of a sneak-peak at the science. The exciting thing about spore-binding phages is that the phages remain active and once the spore begins to germinate, the phage can infect and kill it. So in one way, phages are similar to antibiotics in that neither a phage or an antibiotic can kill a spore. In another way, phages are superior to antibiotics because the phages can wait-out the spores and are still active once the spore begins to germinate whereas an antibiotic will decay and become inactive over time. We hypothesize that the lack of recurrence of AFB in the phage-treated hives of the research paper was due to the spore-binding properties of the phages. This is an extremely exciting prospect and more research will need to be done to see just how well phage treatment can prevent recurrence and/or how phage treatment on a spore-laden object might work at preventing future infection.

Q)This is pretty cool. What's next?

A)Believe it or not, I have not decided what I want to do next! I am turning over the R&D work to the company and into the capable hands of my former graduate student, Scott Brady. I still have a few more publications (such as the spore-binding paper) to get into scientific journals before I'm done with the *Paenibacillus larvae* phage work at the university. I recently used the last of my grant money designated for bee research, so at this point, I need to give thought to what my next focus is and then work on some grant-writing! I have kicked around a few ideas about pursuing phages for European Foulbrood, I've had a ton of people recommend I take on the *Varroa* challenge, although phages can't infect insects, so I don't know what approach I'd take on that. I've had others ask me about pursuing phages for other bacterial infections in farm animals or humans. I really haven't decided anything yet, and today I just have on my mind to prepare what I need for lecture in the biology class that I'm teaching this semester. BC

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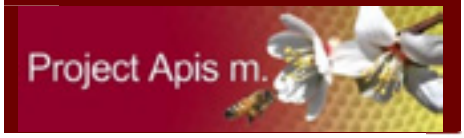

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Thermal Efficiency

Derek **Mitchell**

How much honey is spent making honey?

Honey bees collect flower nectar to make honey, but that is only the beginning. It can be shown that they can need more than 50% of the energy in the nectar they have collected to evaporate the nectar into honey[1].

Although the research paper goes into some detailed maths, it was previously a visual presentation to beekeepers, and before that a simple thought experiment in my front room, made real with some props. This was to make sure to myself and the sceptical beekeepers that the very surprising result was genuine.

Figure 1. *10kg of honey as 8kg sugar and 2kg water.*

Let's do that thought experiment again. Imagine a shallow super of honey: to make the numbers simple yet realistic, let the honey weigh 10 kilograms (kg). If it has a a typical 20% water content that means 8kg of sugar and 2kg of water (figure 1).

Figure 2. *At 20% nectar concentration each kg of sugar in nectar has 4kg of water, 5kg. total.*

The honey bees typically collect nectar at 20% to 40%[2] concentration of sugars, so let's take 20% concentration as our example, again to make calculation simple yet realistic. Then each kg of sugar they collect in nectar, comes with 4kg of water, a total of 5kg (figure 2).

Then we can see, that to get the 8kg of sugar in the 10kg of honey, they need to collect 8x5=40kg of nectar as shown in figure 3.

Figure 3. *10kg of honey has the same sugar content as 40kg of nectar at 20% concentration.*

After the honey bees collect the nectar they convert it into honey. To do this they remove 30kg of water to convert the 40kg of nectar into 10kg of honey.

They use a similar process, evaporation, and it takes a similar amount of energy (slightly larger in fact), as if you tried to do it on your kitchen stove. Anyone who has tried a recipe where it says "add a bottle of wine and reduce by half," or made jam or marmalade can attest to the amount of gas or electricity and time that takes i.e. a lot of energy. It takes 0.61 kilowatt hours (kWh) to change one kg of liquid water at 100°C into water vapour at 100°C. So it would need 18.3 kWh on the stove to change 30kg of liquid water at 100°C in to vapour. They do not use a stove but lap at it with their tongues for a few minutes, then heat the air gently with their bodies and move that air by fanning their wings for hours to drive off the water content. It takes 0.67kWh per kg to evaporate water at 40°C. That means 20kWh of energy to make 30kg water at 40°C change into vapour. They don't use electricity or gas as fuel and can't just pay a big bill to a utility company. They have to go and fetch the fuel themselves in the form of sugar in the nectar they collect. Sugar contains energy at about 4.4kWh per kg so 20kwh is the energy in about 4.5kg of sugar or 22kg of nectar. Including the original 40kg of nectar that constitutes the honey means a total nectar weight of 62kg (figure 4)

Figure 4. *10kg honey needs 62kg of 20% nectar at 100% thermal efficiency of evaporation.*

But 62kg is assuming 100% thermal efficiency in the process and therefore no losses of heat. The losses depend on the outside temperature and the design and material of the hive or nest the bees reside in as well as the detailed behavior of the honey bees. So a reasonable value for a wooden hive without many shallows or supers, at an outside temperature of 25°C might be 50%[1]. This then doubles the 22kg of nectar fuel needed. With 50% thermal efficiency, the 44kg of nectar evaporation fuel plus the original 40kg of nectar means a total of 84kg needs to be collected for the 10kg of honey.

Figure 5 is what 84kg of nectar looks like. You can see why I had to go to these lengths and not just work it out as maths exercise. If a colony produces 100kg of honey per year that's an energy bill of 400kWh per year or nearly a metric ton of nectar.

Our thought experiment illustrates just one nectar concentration and one level of thermal efficiency. We can use maths to give values for all reasonable values of nectar concentration and thermal efficiency and draw a graph of the amount of nectar for each unit of honey, figure 6.

The red M line shows the nectar to honey ratio if the conversion from nectar to honey needed no energy. From this graph you can see that improving the thermal efficiency reduces the amount of nectar the honey bees have to fetch for the same nectar concentration, and for the same effort they can collect a weaker nectar if the thermal efficiency is higher.

If we take away the nectar burned up by the bees flying there and back to a nectar patch six kilometers (just under four miles) away, we get the graph in figure 7. This has moved all of the black lines in the graph up and to the right compared to figure 6.

Together these graphs show that to fly further, the honey bees have to collect a more concentrated nectar, or have a higher thermal efficiency nest, or collect even more nectar. The vertical distance from the x-axis to the red "M" line compared to the vertical distance from the x-axis to the black efficiency line gives the relative amounts of nectar constituting the honey and the total used making the honey.

What is thermal efficiency

Thermal efficiency is the ratio of the energy that succeeds in evaporating water to the amount of energy the honey bees actually put into the process. This depends on a combination of the outside temperature, the concentration of the nectar and the level of insulation of the nest or hive occupied by the honey bees. Lets look at those factors in more detail: the first factor, temperature, is dependent on the weather; the second factor, nectar concentration; the honey bees try to optimise[3]; and the third factor, nest selection.Honey bees put a lot of effort into nest selection[4] (and arguably less by bee keepers), because in the wild, honey bees have thick walled (average 150mm) tree nests, man made hives on the other hand have thin walls (19mm) (figure 8) and heat losses up to seven times greater[5].

Why is it important?

We have seen how thermal efficiency can change how far honey bees can fly to forage and what flowers they can collect from to make the same amount of honey from the same amount of nectar. In basic survival terms, a high thermal efficiency means in times when the forage is poor they can fly further, find and utilise less rich food. Thermal efficiency impacts the good times as well. Let's consider that honey bees wings wear out, (we can see that by looking at the bees crawling from the hives with ragged wings, no longer able to fly). So every wingbeat a honey bee takes is a colony resource being used up to collect supplies for the colony[6]. This resource can only be replenished when new honey bees emerge. If we increase thermal efficiency of the nest it takes less nectar to make the same amount of honey, this means less wing beats flying to fetch the nectar. However, an enormous number of wing beats are being expended in the hive to remove the water content. Anyone who has listened to a hive during a nectar flow, knows that level of noise, which can be heard several metres away, involves a lot of wing beats. Those wing beats in the nest may actually wear the wings out faster than flying as it is being done so close to the hive surfaces and other honey bees[7]. Consequently, thermal efficiency changes how many honey bees lives are needed to make jar of honey.

Figure 5. *10kg honey needs 84kg of 20% nectar at 50% thermal efficiency of evaporation.*

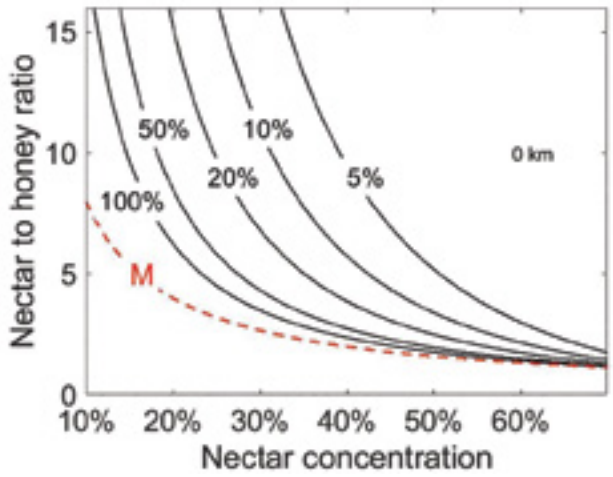

Figure 6. *J nectar to honey ratio versus nectar concentration at various thermal efficiency percentages, distance hive to nectar patch zero kilometers.*

Conclusion

By improving the thermal efficiency of the hives and the bee keeping practices we use, we can make the honey bees job of converting nectar into honey easier. This can mean significant improvements in survival of of colonies and greater honey yields as confirmed by one of the largest bee farmers in the UK, who has thousands of expanded polystyrene and wooden hives to compare.

Honey bees exploit thermal physics on a prodigious scale to make honey, by following their lead we can use thermal physics to improve their thermal efficiency and so we help them, to help us. BC

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Understanding Honey Bee Removals And Cut-Outs Part 1

Albert **Chubak**

A removal of a honey bee colony from any space can be an overwhelming undertaking with life-threatening risks and unforeseen financial consequences. Learning all you can prior to a "cut-out" or "removal" is essential. Threats, risks, problems, tricks, liability issues, are areas that need to be reviewed and considered prior. By definition a Swarm of Honey Bees are groupings of thousands of honey bees that have not yet found a home/hive and are seeking a suitable location. A Colony of Honey Bees has found a home and are performing housekeeping. A swarm is moving and a colony has ended the journey Removing a colony from within a structure can be a difficult challenge. Nothing yet known to man will cause a queen to up and just leave a hive. There are tricks that can encourage absconding. Each trick is worth considering instead of performing an invasive "cut-out".

Understanding the Feral Hive and the Colony Problems with construction

Historically in Europe recesses in stone walls were constructed for colonies of honey bees in skeps to reside in. The stick frame style of building today has provided ample areas for insects, rodents and fowl to hole up. In the case of insects, our homes are their homes too. Some insects are tolerated, whereas others are sought out and exterminated. There are homes in such a condition they pose as an amusement park and high-density housing to insects, with holes and accesses in abundance. Honey bees seek out:

1) Cavities where they can regulate the temperature and humidity,
2) Spaces they can defend, and
3) Areas with ample room initially and room to expand.

Buildings in essence have "for rent" signs and are inviting beacons to honey bee scouts. Examples are poorly fitted soffits, uncaulked exterior gaps and holes like cable wires and air-conditioning lines, gas pipe holes with ample space, cracks, wood-pecker and mouse holes as well as places with decay. A newly constructed high-end home can have flaws unnoticed by the builder and inspectors. Honey bees seek out floor-joists, dormers, basement walls, as they regularly have little to no insulation or spaces between the insulation where they can

live. Areas where insulation isn't used, every area between walls and roof are potentially "available rent free." A new venture can be inspecting and repairing properties prior to a honey bee infestation.

Supporting Organisms and the Feral Hive's Ecosystem

There are many types of organisms that live in a beehive, some are invasive, others are temporary, still others live in harmony and are supportive of the honey bee. Historically we failed to understand there was a microscopic diverse life in each hive, some quite unique to each hive. Today we need to consider each time we enter this delicate world; our involvement may result in a "Christopher Columbus" change. Colonies that are cared for en masse are treated like livestock and are cared for as a group preemptively as well as after the fact, but together. Feral colonies may have lacked this type of interaction and as a result evolved independently at least for a time. Bees are quite social insects with interaction between nearby colonies daily. Interaction between colonies via a beekeeper should include care not to transmit disease from one to another. Beekeeping hygiene is a new practice where hive tools are cleansed or torched preventing organisms or disease from one hive inadvertently migrating to another. In the feral bee world these bees have lived at least in part, independently of a beekeeper's care. Take precautions with using noncommunal equipment and try to keep the materials the bees lived on and made in their new location. Quarantine and separate the new transplanted colony at first from other unrelenting colonies which would viciously rob them. Relocated colonies may have exposed honey which is a sign of a weak colony to other bees. Chose an isolated hive location at first away from other colonies. The rule of thumb is bees will fly two to three miles, but realize they are opportunists. A nearby apiary with 10 or more vibrant colonies may be a key to failure in relocating a feral colony. In Spring, blooms abound so bees go for fresh nectar instead of robbing "stale honey jerky", but during a dearth they test each other daily for weaknesses. Consider if this removed colony is sick a subsequent robbing frenzy may distribute this sickness to all other nearby colonies.

Pesticide Applicators Make Things Worse When Honey Bees Are Involved

Each person has a job to do that pays their bills. Honey bees evolved differently than other flying stinging insects, in that they produce an abundance of wax and honey in the space they took up residence. A pesticide application may kill the bees but leave their spoils and pantry unattended and undefended. The result is honey maybe leaking from the honeycomb, which a healthy colony would not tolerate. This undefended honey generates a robbing frenzy where bees from miles away join in the looting. This activity is aggressive and is a free-for-all by all interested insects until the stores are depleted. Sadly, the pesticide exposed insects may live long enough to return to their home, exposing their family to the honey laced with chemicals.

Another situation commonly exists where the active colony moves further into the cavity abandoning their initial work. Some pesticides have a time sensitive lifespan after which they are inert. Once the chemical is no longer a threat the original colony expands back into the original area. Repeated attempts may cause the colony to expand further complicating an eventual extraction and cleanup.

A Question to Consider "Do I kill, do I save, or do I leave alone?"

There is no one answer when determining the fate of a feral colony, rather a mix of options that mix with local conditions, needs, risks, threats, future management, and so on. Many places exist for honey bees to homestead in any given area. Rarely will a colony remain the same as every colony will adapt and evolve. The colony will initially grow, possibly swarm, eventually die and then their home will be identified by local scouts for another interested colony. If extermination is the option, then what happens to their spoils, reserves, pantry? If removed, how and by whom is the removal performed and are they truly qualified to rip into any structure? Does the structure pose risks for the beekeeper and the owner, and who is responsible in an event of an **"Oh no! This is bad, really bad."** If left alone, subsequent swarms will break from this colony each year posing a risk to nearby residences, so swarm/bait traps should be set to alleviate some further home invasions.

Honey Bee Residences

Honey bees are content to live in a variety of residences, including the following:

1. **Tree** – Various reasons exist for why a cavity exists in a tree, one of the uses of this cavity perfectly meets the needs of a honey bee colony. The entrance to this cavity can be a single hole or several holes and can face any direction. The key is can the bees regulate the temperature, humidity and access. If a cavity exists in a tree suitable for a colony of bees, understand the tree or at least this section of the tree is dying. Eventually during a good wind, heavy snow-fall or just as a matter of time the tree will collapse. In this environment bees remove materials softened with decay or devoured by carpenter ants. Concerns exist with how high the cavity is, how the tree is leaning, power lines, nearby structures, and how long the bees existed in

the tree cavity. Thick tree walls insulate well for Winter. Typically, a vertical hive.

2. Floor – Honey bees seek out empty cavities about the size of one to two five-gallon buckets. A floor poses many issues to consider. Floor joists rarely have insulation and are built 16" on center or 14½" from joist to joist. Bees are opportunists and will commence building within 1'-3' of their entrance. Access can't be complicated or the scouts exploring the cavity will be lost and fail to notify the relocating colony. Electrical wire, water lines, loose lumber joints, hose lines and duct work enable bees access to additional cavities, making identification of the entire colony sometime elusive. Understanding home construction related to structural supports, electricity, water – all pose serious risks to health and structure. Adequately cooled and heated by home owner who pays the bills. Typically, a floor represents a vertical hive.

3. Wall – In many areas of the United States walls are built with insulation, but areas exist and buildings exist with hollow walls. When scouts are seeking out a new home usually they will not compete with insulation. A standard stud wall has a cavity 14½" wide and is 3½" deep and can be 8' or more long. The highest point in this type of cavity is chosen for the original cluster. Like the floor cavity there can be electrical wire, water lines, loose lumber joints, hose lines and duct work that enables bees access to additional cavities, making identification of the entire colony sometime elusive. An understanding of home construction is required. Structural supports, electricity, water – all pose serious risks to health and structure. Wall colonies can extend into soffits, floor joists, build-outs around fireplace and bay windows, roof and dormers. Building materials for the exterior of a building can vary from siding, to brick and stone, to stucco, with other materials varying regionally. A question that always needs to be asked, **"how is it going to be repaired afterwards",** and **"how expensive is the repair"**? If you don't know then perhaps consider more research or walk away. Typically, a wall represents a vertical hive.

4. Chimney – The most confusing choice of locations and the most difficult to remove is a chimney flue. A size of about 8"x8" with room to expand up or down with warm air venting in the Winter and cool air venting in the Summer. Most chimney colonies are unprotected from the elements yet do well. The best way to rid the bees from this space is through inducing a robbing frenzy (this will be discussed in a bit) with the lower fire box sealed up with plastic. An additional way is to line the fire box with duct-taped plastic and then push the entire colony and comb down on to this plastic. Starting a fire with smoke in the fireplace usually backfires as the bees block the passage causing all smoke to re-enter the home! Typically, a vertical hive.

5. Porch Ceiling – Exterior porches can fall into disrepair easily due to exposure to the elements. The exterior ceiling does not have insulation so is a wonderful cavity for bees due to a protected environment that is off the ground. Bees are skilled flyers so ceilings entrances are accessible. Some exterior ceilings are made of plywood, tongue and groove materials, also soffit materials made with plastic or aluminum. Removing some materials are impossible to reinstall without damage, so discussion with homeowner should be considered. Typically, a horizontal hive.

6. Roof – A colony needs to regulate the humidity and temperature, so an open attic is not an ideal location but may rarely be chosen out of desperation during swarming. Roof colonies exist due to access points being available ranging from poor construction to woodpecker holes and over-grown vines. Variation of roof coverings exist, tar, clay and cedar shingles with others being covered in a rubber bladder. A roof can cost an enormous amount initially so giving access to remove a colony may not possible. Dormers are a secondary build-out on a roof which equals a tight confined area. Chimney areas may have access points through poor flashing and angles cut sloppy in sheeting and coverings. There are two ways to get into a roof, directly through the exterior coverings, or the drywall ceiling inside the structure. Pros and cons need to be weighed in both circumstances. Can be a mix of a vertical and horizontal hive styles.

7. Soffit – This is an overhang usually covered in plywood, tongue-and-groove materials, modern plastic or aluminum coverings. Bees access holes about the diameter of a pencil. This area is considered exterior so insulation is not used. This is a perfect cavity out of the sun where the bees can regulate their environment. Most soffits can be cut and repaired but the modern plastic and aluminum styles inter-lock and in cases where the coverings span large areas it is easy

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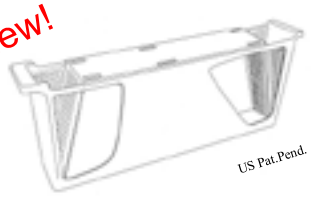

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to inadvertently damage it. Once the aluminum soffit material is bent or scratched it looks awful. Soffits can be a mix of vertical and horizontal hive styles.

8. Open-air – Depending on availability of a location during relocation of a colony and if the colony is "Africanized," comb may be commenced hanging in open view. These majestic structures have virtually no chance of survival in Winter. Most non-beekeepers will see a grey nest hanging and consider it a beehive. Honey bees build a wax structure and cover it, whereas a wasp-type bug chews up materials to form paper and live inside the structure.

9. Places that are impregnable – Areas exist where access is impossible or can be an extremely expensive undertaking. These removals may incur a huge cost. Many will spray and repeatedly try to kill in hopes of solving the infestation with minimal costs, only to realize later the queen was laying faster than they were killing. Forging bees get replaced daily, so exterior bees for a time are expendable to a colony. Poor results from poor choices include honey and wax dripping beneath, with some areas beneath being electrical panels and cedar tongue and groove materials. Options exist for these types of areas is discussed under "inducing robbing".

10. Columns – Exterior columns are similar to tree hives as well as the Langstroth system of beekeeping. Most column structures are hollow and work well for bees. Diverse types of coverings are used as options in building a column, stucco, cultured stone, real stone, wood, siding (aluminum, wood, and hardened backerboard). Some of these materials can be removed for access but repairs can be unsightly or expensive. Bees will be in the highest chamber of the section of the column they are in. Some columns have caps that can be removed for access and extraction. Other columns are built in sections so the bees may be in a top area of a lower section. Typically, a vertical hive style. BC

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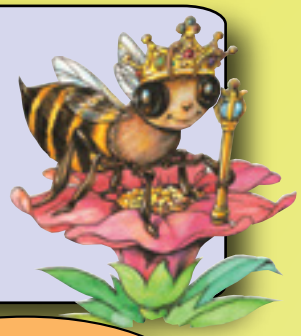


Bee B. Queen Challenge

Plan an event for Pollinator Week June 17 - 23, 2019.

Photo by Cindy Kunst

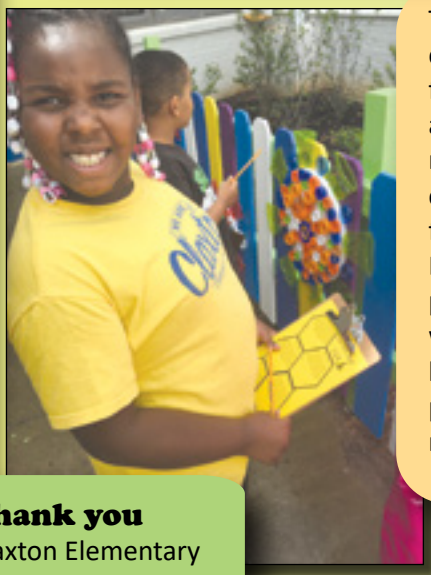
Bee Day organizer, Amy Brown, with students eager to learn more about bees. Students and staff add to the festivities by dressing in black and yellow. Wings and antennae were everywhere!

Bee Day!

Claxton Elementary School in Ashville, North Carolina is a buzz about bees as they prepare for their fourth annual Bee Day celebration on May 17.

It all began when the school received a grant for an observation hive through BeeCause Project. "When the bees arrived, we immediately planned our first Bee Day to welcome them", says Amy Brown, media coordinator and event organizer. "It's really interesting what the observation hive has brought to our school. When it first came, it was not uncommon to have kids look at it say 'Oh, those bees are going to sting me! Oh, I don't like them!' Nobody says that now; the kids teach each other about it."

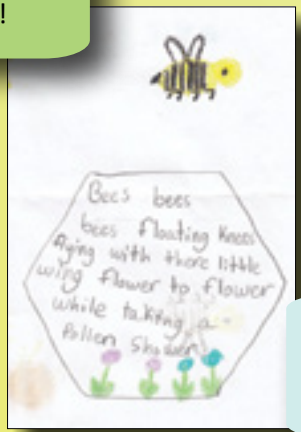
This year Bee Day will focus on Colony Collapse Disorder (CCD), how to support pollinators, and the unveiling of the school's new butterfly garden. Let's learn more about Bee Day at Claxton Elementary through photos.



The 5th grade science classes created a garden fence using colors that attract honeybees and reused materials like cups and caps to create flower decorations. Leading up to the project, students Skyped with Matt Willey to see how his murals promote pollinator and environmental awareness.

Thank you Claxton Elementary for being a friend to our honey bees!

The 5th grade science classes partnered with Asheville Greenworks to create a pollinator garden at the entrance to the hive.



Mack says, "The bees have been dying because of parasites and people putting pesticides on plants. I can't wait for Bee Day because it is educational and fun!"

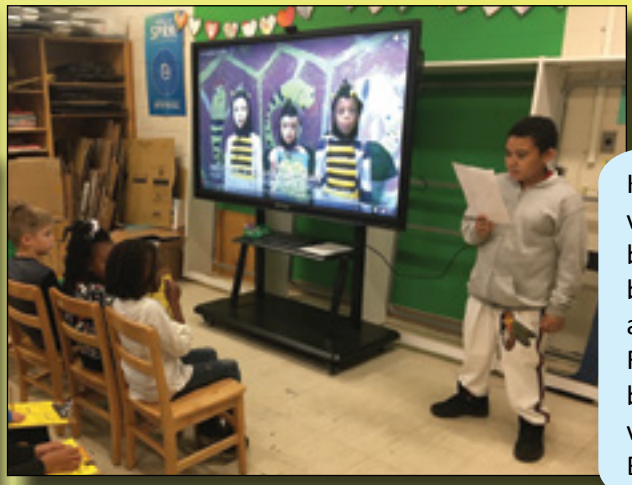
Student Ava Kenney, age 9, shares her poem and artwork.

... Bee kid's corner

Produced by Kim Lehman
www.kim.lehman.com
www.beeculture.com

April 2019

This class is about to engage with technology to hear student produced bee poetry. Poems were coded to interact with Makey Makey circuitry boards.



Kindergartners were video recorded reciting bee poetry from the book "unBEElieve-ables" by Douglas Florian complete in bee costumes. The videos were shown on Bee Day.

Zeke says, "I love the day we got the hive at the school."

Aevein says, "I'm glad to have bees so we can have food."

Miles says, "I really like trying on the beekeeping suit and gloves. I like the tools and the smoker and how beekeepers use them and how bees react to them. I like learning about the bees."

Tricia Johnson, the school's beekeeper, on Bee Day. Local beekeepers set up shop for kids to explore their tools, try on bee suits, taste honey and answer questions.

The 5th grade students presenting their bee research during Bee Day. Notice the "Bee Line" in the back (yellow hexagons where students wrote their favorite honeybees facts).

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Times Have Changed

Finding a good apiary site – simplified – yeah, right!

One Tew Bee, LLC

I'm struggling here

I always speak openly with you in these articles. That is a daunting thing, because that openness lives on and on in back issues and essentially forever on the web. You do not need to be reminded that beekeeping recommendations and procedures are a relative thing. They are not exact. They never were. There are nearly endless ways for doing the nearly endless tasks. We laugh about that characteristic. *"Get three beekeepers in a room, and you will have three strong but different opinions on any beekeeping subject."* That's funny, but also true.

My purpose in my comments below is to say that there are established golden rules for perfect beeyard characteristics. May I suspect that most of us just do the best we can when searching for a site for our bees? My second point in the following comments is that I personally have – over time – developed a few nearly non-negotiable requirements for a new apiary location. In my article title above, I wrote that times have changed. In reality, it is not necessarily the times that have changed, but rather, it is I who is evolving in my beekeeping craft. I change my rules and expectations as I change. That is what I am trying to say below.

Telling is not the same as *doing*

Telling a beekeeper what to look for in a great yard location is not the same as actually finding that great yard location. Somewhere in my long list of previous bee magazine articles are several dated pieces discussing the reasonably simple task of finding and establishing a bee outyard. Ahh, I distinctly remember the various yard characteristics I listed. If all characteristics were met, it would have been the bee yard in heavenly environs. It should be known that I never found such a yard having all my glorious requirements. However, I have never stopped looking.

Some of those perfect out-apiary features were: no confounding gates or restrictions to the yard (i.e. seasonal standing water, watermelon crops, etc.), near pollen and nectar sources, accessibility to dependable water sources, no direct pesticide applications nearby, morning sun and afternoon shade, sheltered from wind and weather, scenic vistas, dependably accessible, and (mostly) protected from human and animal interactions. Who of you have found such a yard? If you feel you have one, I wish you would send along a pic for the rest of us to enjoy.

While I do not yet consider myself to be aged person, I am not as youthful as I once was. Those earlier articles listing yard characteristics were written by a younger Jim Tew for you. At that time, I did not realize that all the readers would not be searching for the same kind of beeyard. Now I fully realize that there were some older bee people in my reading audience who were *not* taking my comments to heart. It was not practical for them – then or now. *(Note here that I am not trying to speak for all older beekeepers.)*

Now as an increasingly accomplished beekeeping senior citizen, I only have about three non-negotiable characteristics for a remote yard. The remaining desirable characteristics are not imperative for me.

1. In no particular order, I want only one out yard – not the multiple yards I wanted before. My requirement on this point is easy. Just search for one outyard. I can handle that requirement.
2. But not so easy is that I require that the apiary site be

My very first hive in my very first yard. Clean and simple.

within five-10 miles of my home apiary. At my present stage of beekeeping, I have no interest in driving all over the countryside to get to multiple apiary sites.

3. Finally, I require that I am able to get to my single outyard when I need to or when I simply want to go to the yard – year-round. That's a killer requirement here in the Midwest and in other areas as well.

Finding such a seemingly simple site has been surprisingly difficult for me. In fact, as of today, I have not found one, and I have been looking for a couple of years. Dependable accessibility is a very limiting factor.

For me, this *dependable access* characteristic was little more than an annoying requirement thirty to forty years ago. I could trailer my small tractor near the yard, or if the mud and slush were too great, hike in. Life's energy and stamina were plentiful during those times. Now I really insist that I want to essentially drive right up to my colonies. The closer, the better. I have always worked alone, and my solitary beekeeper status carries right to this moment. I do not want to stumble around carrying heavy equipment. I don't want to walk back a great distance for a forgotten hive tool. Neither do I want to spend significant amounts of time mowing and trimming within the yard. I no longer use herbicides for killing vegetation around the five to 10 colonies that I will have there. I would like for my time with the bees to be enjoyable.

Now, I'm just rehashing my points

I have the luxury of owning a 4-wheel drive pickup. It's not new. While not truly an off-road machine, it certainly gets better traction that a two-wheel drive vehicle. But a high traction vehicle means you just become much more mired in more difficult places. Another 4-wheel drive vehicle will most likely not be appropriate for towing my stuck truck out of the mud. I speak from embarrassing experiences. Yes, several times in my bee life, I have even had to ask to borrow a tractor. You get to make new friends that way. *(Long story reduced to its essence – at night, I drove my loaded bee truck into a shallow pond. I thank my brother for that ground guidance. Thirty years later, find the guy who came with the tractor to tow me from that pond, and he will remember that story today. I made a friend. That location was not a perfect yard, but I kept it.)*

As did much of the U.S., during February, 2019, many beekeepers experienced brutally cold weather. The worst my colonies had to endure was -14° for a couple of days. Knock on wood – knock on wood, at this moment, all my colonies are alive. Some of the wintering colonies are too high up on their honey stores and will need feeding before Spring is here. My intent for the past few years has been to keep fewer bees but to manage them more consistently. Ergo, I want to be able to get to them when I want. In fact, I need to get to them right now.

It's not just Winter and Spring mud that restricts my access. My obstinacy on this point is that during my 46 years of bee tinkering, I have had to deal with cattle[1] in my yard, locked field gates, row crops too near my apiary, hillsides, standing water and vandalism.

My present yard requirements and characteristics are a noticeable stepdown from features that I once wanted, but it's not just apiary sites. Other aspects of my beekeeping efforts have evolved, too. I don't want as many colonies. I'm not sure what I would do with a huge honey crop. I will never move a colony unless absolutely necessary. I can't afford to buy every new beekeeping book that comes out. I just use my old ones. I know how to requeen my colonies, but I do not do it as often as I should. I still love bees, but in an ever changing way. I have developed a moniker for this type of beekeeping that I have never heard before – *Codger Beekeeping.*

You see, I have a plan

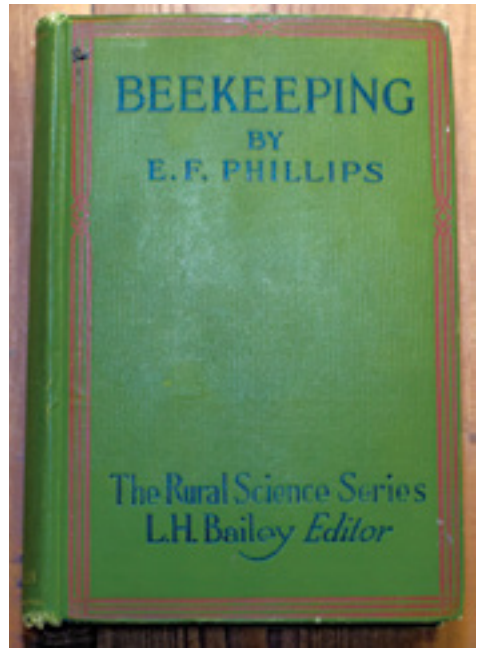
You see, I have a plan, and it may involve some of you who are still reading to this point. I have a home yard, and I am looking for one outyard that meets my criteria. I want to use these locations and the bees at these locations to write, photograph and video for you and for me. Now that I have retired from my university affiliations, I need to drift in other directions. I hope some of you will drift along with me. I **need** that outyard.

An abrupt subject change…

Mr. Charles G. from Indiana wrote me telling me some his philosophies of his bee life. In summary he said:

1. Be not the first by which the new is tried, nor the last to lay the old aside.
2. In solving beekeeping problems, think like the bees.
3. Do what is best for the bees, not what is best for the beekeeper.

I quite agree with Mr. G's philosophy. He gives the bees the rights and privileges of those ascribed to an independent species. In most instances, I try to write or say, "the bees" rather than "my bees." The bees really are not mine. We are coexisting – for the moment. Mr. G. seems to agree with that concept.



Mr. G. also indicated that he was a fan of the book *Beekeeping*[2], by E.F. Phillips a book that was published at least by 1915. It has been through many editions. Since the original book is reasonably easy to find, it must have been a popular book. Indeed, it is presently available on Kindle and reprinted in paperback. Dr. Phillip's place in beekeeping history is established, but I feel

[1]In one instance, I actually had the gate key and let myself in to a pasture in order to get to my distant beeyard. As I relocked the gate, I heard an odd noise – maybe something like a deep, distant, thunderous grunt. I turned to see a huge bull within the cattle herd that had a negative opinion on my presence. He was only about 50 yards away and was pawing the ground. That was my first time seeing a bull perform that behavior in a real world setting. As I fumbled trying to unlock the gate, the farmer, knowing what the noise was, showed up to tell me I really had to get out of there. I had already figured that out. He monitored the bull while I got my truck backed through the gate. The bull was there to do what bulls normally do. Before I could get to my bees, I had to wait a week or so until the bull business was finished. I relocated that yard.

[2]Phillips, E.F. 1917. Beekeeping. 457 pp. The MacMillan Company, London, England

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that he is still a bit of a historical sleeper and, compared to Langstroth, Dadant, and Root, Phillips needs to be reintroduced to modern-day beekeepers. That is too much for this piece, but thank you Mr. G, for bringing the book and the man back to my attention. You know this will be a future article topic.

Well, I didn't mean to go this direction . . .

While Phillip's book continues to be a worthwhile text, the quiet book, *The Behavior and Social Life of Honey Bees*, by Ronald Ribbands had a significant effect on my early beekeeping instruction. The reprinted book in still available.

While pursuing my MS degree, my major professor, Dr. Paul Estes, pulled this book from his shelf and said, *"Here, you've gone crazy for bees, and I will never use this book."* I read and reread every word of it. This book was a true gift that gave my budding bee interest the traction that it needed.

The book opened the depth and breadth of the bees' world. The review of the literature presented in this book is now very dated, but still useful. Much of it would now be considered "the basics." I did make an unfortunate error. I erased by professor's name and overwrote it with mine. Now the book means a lot to me from several angles, and I mutilated it. I wish I had left it as it was. At the time, I wanted to be sure that no one thought that I was heisting my professor's books.

Dr. Ribbands first reported the extensive concept of bees transferring food between themselves. This was, in essence, the pinnacle of his career. After a remarkably distinguished career, at age 53, Dr. Ribbands died in a car accident in 1967. For a fuller discussion of his achievements and the success of his text book, see the obituary[3] posted in the footnote below.

[3]C.R. Ribbands obituary. **https://link.springer.com/content/pdf/10.1038/2141171a0.pdf**

A video chat
https://youtu.be/19CarQUzu4A

Without a doubt, my most significant beekeeping book is the 1963 edition of *"The Hive and Honey Bee"* edited by Roy Grout. Yes, it is an early version of the same text today, but that particular book was my ***first*** bee book. It was the assigned text for the first beekeeping class I ever took. At the time of that class, I had no interest and no inclination toward beekeeping. The bee world was opened to me. The little blue book is hardly one-half of today's *"The Hive and the Honey Bee"*, but at the time, it was the bee knowledge of the world to me.

I have not lost sight of the foundational text for *Bee Culture* magazine – *ABC & XYZ of Beekeeping*. That text was the second bee book I ever owned, but sadly for me, someone many years ago felt that they needed that text worse than I. It has been gone for many years. Not to worry. Of various and sundry publishing dates, I must have 15 ABC copies – from the 1800s until the present.

ABC, as it is usually called, always had a different ambience for me. It had (has) a human personality providing bee information whereas The Hive and the Honey Bee is a solid, information text book. Both are great books, but both are different. BC

I'm done

I'm done for this month. With all the other great information in *Bee Culture*, I deeply appreciate the time you took to read this.

Dr. James E. Tew, Emeritus Faculty, Entomology, The Ohio State University and, One Tew Bee, LLC; **tewbee2@gmail.com; http://www.onetew.com**

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So when is this "Old Enough To Know Better" supposed to kick in?

SUSTAINABLE BEEKEEPING

Are you part of the solution? Part 1

I used to keep a small flock of sheep, and I would go through a lot of hay. One day when I was buying hay from a neighbor, a truck pulled up to buy a load of hay to take to Texas. That same week, our other neighbor purchased hay from Minnesota at auction. In Michigan, even though we have plenty of hay in our state, we sometimes ship our hay to Texas and buy it from Minnesota. Large-scale commodity farmers can find themselves in these absurd and seemingly inefficient distribution cycles, because wholesale buyers are chained to big contracts and national pricing. On a small-scale, however, this practice of shipping the same product into and out of the same area seems absurdly wasteful. As a small-scale farmer, I didn't need to be tied to the national hay market, and I could purchase all of my hay locally. Similarly, as a small-scale beekeeper, I shouldn't have to be tied into the national market. Commercial bees need to travel around the country to provide pollination services so we can have fruits and vegetables. These commercial beekeepers need a model that maximizes economies, so they can have sustainable businesses. Small-scale and hobby beekeepers, on the other hand, have absolutely no reason to participate in this cross-country movement of bees, and should be able to source their bees locally.

Many people get into beekeeping as they strive towards a more sustainable lifestyle; we garden, plant for pollinators, buy local food, and focus on living with less impact. However, when it comes to beekeeping, it seems these values of sustainability fly right out the front entrance. Many small-scale beekeeping operations are completely unsustainable, with high levels of bee death, high costs, and high environmental impact. Even worse, unstainable practices have become completely normalized in hobby beekeeping. It is normal and completely acceptable to have high losses, year after year, and replace your bees in the Spring with nucs and packages from across the country. Truckloads of bees arrive each Spring, trying to fill an almost insatiable demand of hobby and small-scale beekeepers replacing lost hives. Think of the carbon footprint of this event – trucks crisscrossing the entire country to make sure that every local bee club can fulfill their bulk orders of replacement bees. What would happen if hobby and small-scale beekeepers separated themselves from this national exchange and focused on what was available locally? If small-scale beekeepers could no longer buy bees from out of state, we wouldn't run out of bees. Instead, we would be motivated to make the most of the bees that we already have. We would become more sustainable, and we would be forced to be better beekeepers.

Take a moment to ask yourself if the way you keep bees lines up with your values. Are you comfortable in your role in transporting bees across the country? Does it feel like the way you keep bees is good for bees in your area? Are you helping the local community of beekeepers?

If your beekeeping is not in line with your values of animal welfare, economic sustainability, and a smaller carbon footprint, it may be time to retool and rethink your strategy.

Here is my definition of a sustainable apiary:

- My bees are kept in good health and free from preventable illness, so my losses are minimized;
- I anticipate my losses and prepare for them, so I don't have replacement costs;
- My excess bees are made available to beekeepers in my local community.

Every beekeeper has the capacity to make bees available to their neighbor, because bees naturally produce more bees. Every colony that comes through the winter strong can produce (minimally) one split that can be made available to local beekeepers. Unless you are perpetually expanding, you have excess local bees that could support local beekeepers. I have literally heard a beekeeper say that they didn't want to split their hive because they didn't want more bees. They let the colony swarm, losing the bees to the trees, and their neighbor beekeeper had to purchase a package from out of state. How great would it have been if that

If your beekeeping is not in line with your values of animal welfare, economic sustainability, and a smaller carbon footprint, it may be time to retool and rethink your strategy.

beekeeper made a split of their hive for their neighbor instead?

I do sometimes get frustrated by how wasteful and unsustainable many small-scale beekeepers are with their bees, and how quick they are to purchase replacement packages, rather than use the bees that they have. However, as my great-uncle Charlies always said, "Any old ass can kick down a barn, but it takes a really special donkey to build a shed." In other words, it is really easy to point out when people are doing something wrong, but it takes a lot more work to help think of a way to fix the solution. In 2015, I was awarded a small SARE farmer rancher grant to address this issue, and I have found a system that made my beekeeping much more sustainable, and more in line with my values. It involves three steps: 1) Accounting for (and being accountable for) my losses, 2) Making up replacement colonies from within my own apiary, and 3) Making my excess bees available to my local community. In this article I'll cover step one, and over the next two months I'll cover in detail the second two steps.

Accounting for losses

To make beekeeping more sustainable, we need to focus on two things: supply and demand. First, we need to reduce demand by getting a handle on our losses. Many small-scale beekeepers still suffer from incredibly high losses--many bee clubs report ridiculously high colony losses of 50-100% annually. (Sadly, this is another thing that has become normalized – you should not be okay with such high losses). If you are losing more than 15% of your colonies every year, you need to reevaluate your management strategy BEFORE you purchase more bees. Right now, the bee season is stretching before us, and we are ordering packages with the best intentions and high resolutions (This is going to be the year!). By July we go on vacations, have soccer practices, injuries, etc., and the care of our bees gets pushed aside. When we procrastinate on our feeding, *Varroa* treatments, and supering, our bees don't survive. Rusty Burlew wrote a lovely article that should be required reading for beekeepers: **https://honeybeesuite.com/overwintering-success-the-one-thing-i-do-differently/**. She has great success with her bees, and when asked what she does differently she states, "The thing I do differently is simple: I never procrastinate. If something needs to be done for my bees, I do it. And soon . . . Years ago a wizened old beekeeper told me that keeping bees doesn't take much time, but the things that must be done, must be done on time. That simple idea became my beekeeping mantra, and I believe that ethic, more than anything else, has helped me to be successful."

Most beekeepers lose their bees because they do not do the things that need to be done in time. The worst case is with controlling parasites, and beekeepers let *Varroa* mites build up to deadly levels in their hives. Timely intervention also applies to swarm control, feeding and supering. This year, the best thing that you can do for your bees is to honestly assess how many colonies you can care for *well.* If you know you have a busy Summer ahead, or you haven't been able to keep up in years past, then skip a year, reduce the number of hives you'll manage, or set up a plan to have help. Order your bees, and vow that you'll actually do what needs to be done to give them the best chance of health and success;

These nucs are ready to go into Winter. If I lose any hives this year, I won't have to buy packages. I can put the bees from these nucs into the deadouts. Any ones that I don't need can be sold to local beekeepers. A good rule of thumb is to have one nuc for each hive that you are overwintering.

these lovely animals deserve your commitment to their care.

While we strive to reduce our demand by reducing our losses, we can also be working on our supply. At minimum, we should be able to supply ourselves with our own replacements (in the best-case scenario, we also supply our community with locally available bees). Supplying your own replacements means that you make enough excess colonies to cover any losses you may have over winter. You don't replace dead colonies with packages from across the country, you use the spare colonies you have made in anticipation of a winter loss.

The first step to controlling replacements is to be realistic about losses. If you have lost 30% of your colonies every year, you should not be surprised if you lose 30% of your colonies this year. No single beekeeper managing multiple apiaries in the U.S. has 100% success every year. Be prepared for what you can expect to find in the Spring. Let's say you're a beekeeper with 10 colonies and you want 10 next season. If you incur a 30% loss, you'll have seven in the Spring, three less than desired. Many beekeepers in this situation will buy three more packages to get them back up to 10 hives. (Though replacing colonies this way is very wasteful, it is common; I get requests for these type of replacement colonies every year.) Another, more sustainable strategy would be to make up the losses by splitting your own colonies in the Spring. Even better, we can plan ahead, by making excess colonies the season before. In the Fall we overwinter extra nucleus colonies, so we know we have extra bees in the Spring. If I make a nuc from each of my 10 hives, I can overwinter 20 colonies. I can then take even a 50% loss and be at the number I want, without having to purchase bees. If I have better survival, I'll have bees available to sell to members of my local club.

The possible profit from this approach is compelling. Consider your 20 colonies, made by splitting your original 10. Even after a 30% loss, you have 14. In my area, nucs sold for $150-$200 in 2018. If you want 10 colonies, sell the extra four at $175 each, a profit of $700. Even if you have a bad honey year, you have already brought in extra dollars.

Comparing the two systems for a beekeeper with 10 hives and an average 30% loss:

- Current system: Overwinter 10 colonies, lose three, purchase three replacement packages at $135 each = Loss of $405 / year.
- New system: Make late-season splits to overwinter 20 colonies. Lose six, replace those with colonies you've made and sell remaining four extra = Profit of $700 / year.

The balance difference for this beekeeper is over $1100 for just 10 colonies in just one year. For most small-scale beekeepers, that is more than enough to cover replacement equipment, feed, and medications and to have a small profit, even before considering honey. Beekeeping is no longer a money sink: spouses are happier, and the new fishing boat has become a possibility. For small-scale farmers, this balance difference of $100 / hive in the spring can completely change the profitability of their operation.

There are other benefits besides the saving money and lessening the environmental impact of your beekeeping. While producers selling packages and nucs do a good job of controlling disease (their business depends on it), colonies are not sterile. A nuc taken from even a healthy colony can carry pathogens than can cause disease. Cross-country transport is stressful on bees; queens and brood especially have health consequences from temperature changes, and quick shifts in climate. This stress often leads to stress related diseases – some that can plague your operation for years to come. The sooner you stop bringing in outside bees, the safer you are making your environment for all of your future colonies by reducing the risk of disease importation.

Never buy bees again! Your goal should be to make up all of your own losses or growth from within your own apiary. If you are practicing sustainable beekeeping, you would only need to buy bees in three scenarios:

1) It is your first year, and you are just starting beekeeping (welcome!)
2) You purchase some queens to add in fancy genetics.
3) All of your hives were destroyed in a natural disaster or by bears.

If you are purchasing bees outside of these scenarios, it means that you are doing something wrong, and you want to rethink your approach. By definition, your operation is not sustainable.

It's a lot more work to be a sustainable beekeeper. It's easy to dump a package in a hive, let it die, and replace it each year. It is a lot more work to keep them in good health, overwinter big clusters, and become confident in making splits. While it requires much more learning and work, I think you'll find it rewarding, and you'll feel better about the way you keep bees. When I closed my operation and really pushed myself to expand without buying bees, I became a much better beekeeper, my balance sheets looked much better, and I felt much happier about the way I kept bees.

In the next few articles I'll outline the exact methods that I use to make nucs for overwintering and for sale and to make the most out of my bees. If you or someone you know has a great system or good success, please let me know your story. BC

Thank you to Charlotte Hubbard and Ana Heck for your useful and kind edits.

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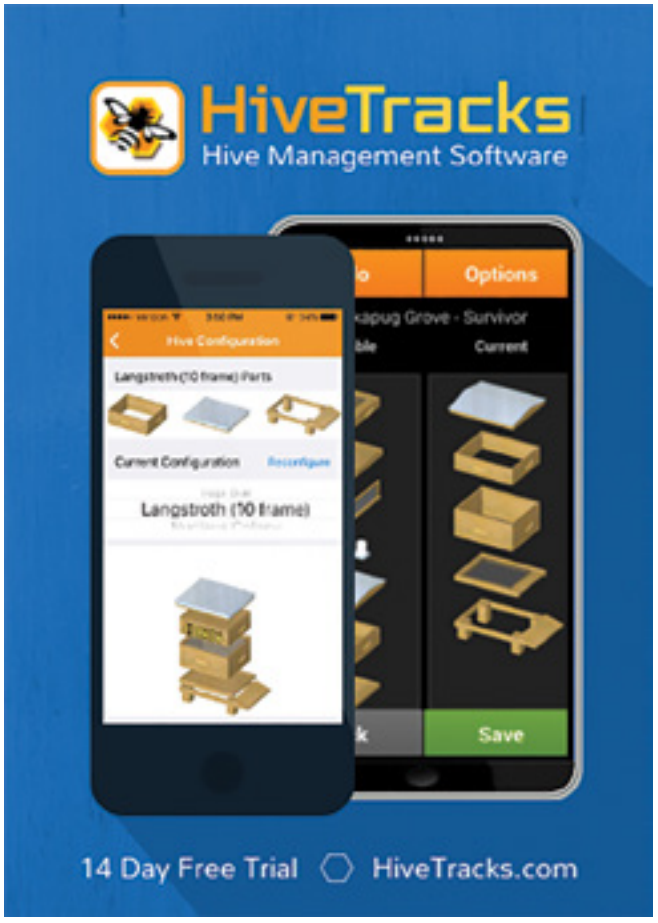
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Beekeeping In Michigan's Upper Peninsula

D&S BEEKEEPERS

345 Miles North Of Detroit

Alan **Harman**

Michigan's remote Upper Peninsula is the Garden of Eden for honey bees and *Varroa* is the serpent.

And the serpent is winning.

Beekeeper Dane Wallis says his Sault Ste Marie-based D and S Beekeepers business has in just a few years gone from being profitable to an expensive hobby.

This as his and other area beekeepers' over-wintering losses have gone from a manageable 10% or 15% to 100%.

"*Varroa* is extremely critical," he tells *Bee Culture*.

No livestock farmer has to do what beekeepers have to do, the 20-year beekeeper says.

"Any farmer, sheep, cattle, chicken, who every year had to replace the entire stock, wouldn't survive."

"You can't make a living from bees up here," he says. "It's a very expensive hobby, but to me it's worth every penny.

"To make a living, pollination is where your money's at. There's no pollination up here. Farmers approach me, ask me to put the bees on their crops as a favor."

Many beekeepers from the local Superiorland Beekeeping Association on America's northern frontier continue to believe *Varroa* is not their problem.

"At the bee club, I had to bring *Varroa* in a vial to show them they are real," Wallis says. "If you don't think you have them, you're nuts."

Two years ago, Wallis tried keeping his hives in indoor storage for the Winter with temperature and humidity controls.

Northern frontier beekeeper Dane Wallis.

"It was an expensive operation," he says. "They went in around Thanksgiving – it's a long time for them to sit from Thanksgiving until April."

Wallis says the bees were doing great at the beginning.

"Slowly, like dominoes, they fell to nothing. It was very frustrating. It was purely *Varroa*, not a glitch in the system. Everything was monitored, and I kept records."

He recounted his efforts to the beekeeping association.

"I told them I don't know it all by any means, but if you don't have the *Varroa* under control, I don't care what you do for Winter preparation, no matter what you do – they're dead.

"You might as well call them 'gunnadie' bees – it's inevitable, they're going to die."

Wallis says some people claim to have bees that are resistant to *Varroa*.

"That would be great if that truly ever happens," but for now we have to treat."

Wallis treats for *Varroa* Spring and Fall.

"I go in and monitor their numbers after the treatments," he says. "*Varroa* is still there, but the numbers are coming down.

"Winter is here now, and I've got my *Varroa* numbers down to where I feel the level should be tolerable – a position where the bees can handle them."

Wallis says the diseases that were there when he was young beekeeper are still there, but they're not the hot topic.

"The hot topic is *Varroa*. It has to be handled."

Increasing treatments to three times a year does work, but Wallis says it means there will be residue in the honey.

"You want to have your *Varroa* count down prior to your honey flow," he says. "Then, after the honey flow, get it down again.

Last year, when the honey flow ended, Wallis found his *Varroa* numbers were higher than they should be.

"I thought it better to do some treatments, get it under control," he says.

"Within the first week I had a huge spike in the *Varroa* count. I thought I had fertilized these things – they went the wrong way. Then in the next couple of weeks they diminished, down to where they were tolerable."

Wallis says he doesn't find the treatment results as immediate as some claim.

"I could be missing something," he says. "We are all in a rush world where we want results now – put your *Varroa* tray in and expect to have snowdrifts of mites.

"I'm not seeing that, but with treatment continuation and monitoring the numbers will come down."

With 100% losses restocking is expensive.

Wallis pays $130 to $200 a package, buying 50 to

Hives at work on the northern frontier.

60 each year and splitting some to stock his 70 hives.

Splitting, though, may not be a viable option.

"Very seldom up here, unless you have a very robust queen and a strong colony," Wallis says.

"We don't have the time," he says. "The season is from April to August and then you better start putting the feed on them for the Winter."

His honey target for a single box is 80 lb. to 90 lbs. Double boxes are not efficient because of the short northern season.

"The bottom is almost always empty – they don't have time to backfill," he says.

Wallis speaks from experience.

"I have had them side by side, a single chamber and a double brood box," he says. "I will get more production off the single box every time.

"They don't have the time in our area to make that a 150 lb. to -160 lb. box."

For the bees of the Upper Peninsula, summer is golden,

"The nectar flow comes on gang-busters," Wallis says. "We get a little bit of a dearth, for maybe at the most two weeks, and then it is on again.

"Diversity is huge for the bees and we have that," Wallis says. "We have wild flowers, and we don't have big monoculture farms so they're not using the sprays and the pesticides. The bees are getting what they need. We have abundances of everything up here, but time.

This includes colony collapse disorder.

Adopt a hive in action.

"I have had bees that look great. They look sharp, viable and hardy. Then, where did they go? It's the Fall and they disappear.

"The vanishing bee – I'm thinking this is CCD.

"It's not the cost; it's the problem. Why are they going?"

Still, the Summer brings good times.

"You can randomly drive any direction, it doesn't matter, set a beehive and you're in business, it is that abundant here," Wallis says.

"It's perfect except for the weather, and even the weather is tolerable. Bees are very resilient, but they're not resilient enough to fight off that *Varroa* mite.

"I'm going to come back to that *Varroa* mite every time. "It's going to win. It's what they do. They are a huge problem. It is a monster."

For this Winter Wallis went to great lengths getting his *Varroa* numbers to where he believes the bees can survive them.

Then he set up a Winter-long experiment.

"I typically put all my eggs in one basket," Wallis says.

But not this time.

"I am putting some indoors in a controlled environment," he says.

"I am putting some out traditionally. One of the yards has an open south-facing wall. I am going to wrap the bees in the traditional tar paper, give them southern exposure and box them in with Styrofoam

"I am going to have some out in the field, and I am going to have some that are half in and protected.

"It's a major experiment," he says. "If, miraculously I come through with 50%, I will be doing cartwheels."

He gave all the bees the same *Varroa* treatment.

"I want to see what kind of impact is going to happen between my indoor, halfway or outdoor bees."

Last Summer, Wallis brought something new to UP beekeeping by setting up an adopt-a-hive program.

His beekeeping daughter Abbie VanSloten suggested it, but Wallis at first was hesitant.

"I looked into it and found it was very popular in Europe, but not in the United States," he says.

He decided to give it a try, built a website and talked to people who visited his muffler shop.

"People said beekeeping was something they always wanted to do, but didn't know how to do it," Wallis says.

He charges $300 and that covers the bees, the equipment and his time.

"I supply everything," Wallis says. "All they need is a backyard.

"I bring the bees and the hive, and we set it up together. We check to make sure the bees are not a nuisance to neighbors.

"As I said before, everywhere is good. The nectar flow is never an issue."

He has protective suits for adults and children.

"I install the bees and show how to set the queen. There's lot of interaction from people that had never seen this."

After a couple of weeks, he returns and shows the new beekeepers how the hive is working.

"Honey is harvested up here once in the Fall," Wallis says. "I can average 100 lb. of honey a hive. I give them 10 lbs. of raw honey, bottled.

"They typically want more until they see a case of

Upper Peninsular honey on display.

Abbie VanSloten in her honey shop, Northern Harvest Creations in Sault Ste. Marie, MI.

honey and realize 10 lbs. is a lot of honey."

This last Summer 13 people took up the adopt-a-hive offer.

"It could have been more," he says. "I want to do this right, and it takes more time than you think. My goal was an hour a visit. The enthusiasm overwhelmed that goal.

"I got a great response."

Wallis says it was his responsibility to replace a hive if there was a collapse or a disease and failed. It happened twice.

"Probably 50% have already said they want me back next year," he says.

He is spending the Winter pondering whether to increase the number of hives he'll make available for the program next Summer.

"I know I could because the interest is there, but I want to do it properly," he says. "I want the people to have a good experience.

"There is a passion there. They worry when you're doing a hive inspection about squishing the bees. It's collateral damage, it's going to happen.

"You've got too many things going on that you can't avoid squishing the occasional bee."

He got phone calls and texts telling him what the bees were doing. He found that after work, the adopters went out and watched them. They tell Wallis it's very relaxing.

The "S" in D and S Beekeeping sentimentally stands for Steve Kyle.

Wallis met him a few years ago at a July 4 celebration at a friend's house.

Kyle had a couple of hives and the two became the closest friends.

Then, two years ago, Kyle died at age 45 of a heart attack,

"We were on the edge of merging our bee operations together – he had a passion for the bees," Wallis says.

"In remembrance of my dear buddy, I put the initial in the name of the business."

This past year, Wallis began selling 3lb. packages each with an Italian queen and her entourage.

"Everybody is on a rampage for bees in the Spring," he says. "I linked up with some wholesale suppliers out of Georgia."

Already, he supplies pretty much everybody in the area.

"It was my first year doing it, and I did it out of convenience for myself and everybody in the neighborhood," Wallis says.

"I want everybody to succeed in beekeeping and I want the bees to succeed. There is just some weird passion there. I don't know what it is."

Wallis raises his own queens using his strongest colonies.

He says Upper Michigan beekeepers don't have the time to carry weak queens.

"I am guilty of this myself," he says. "You have a queen that is just limping along – remember that time is the thing up here. We don't have it.

"If everything else is doing good and you decide to give her another week, you just took a large percentage of your whole season off. Have queens on back up, whether you raise them or buy them, and don't think about it."

Wallis has been breeding queens for about three years and sells them or uses them in splits.

"It's hard to do a robust split. You can split anything within reason, but you have to split up here so it's going to turn into something."

Wallis sells his honey locally and is considering branding it as Upper Peninsula honey.

For many Americans, especially Michiganders, the Upper Peninsula is a mystical destination, much like Connemara is across the Atlantic in the remote west coast of Ireland.

"My daughter opened a store called Northern Harvest Creations on the main strip of Sault Ste Marie this Summer to sell local bee products, and it was very successful.

"There are a lot of people who come to UP and they want memorabilia.

"Our honey is something different," he says, "I don't know if it is because we are so much closer to nature or so much wilder."

Wallis's location in Sault Ste Marie is 345 miles north of Detroit and 470 miles northeast of Chicago, making him one of the most northern beekeepers in the eastern United States.

Winter temperature drop as low as -37°F and routinely spend days below zero.

"People refer to the North as cold," Wallis says, "but we just have flat-out crappy weather.

"There's lots of time in the Summer when the bees can't fly. Last year it was too wet, rain every day. Terrible. There was no pollen.

"We've got everything going against us, and we still do it.

"Beekeepers are weird – we have to do it." BC

What Will Happen Next?

Ann **Harman**

I turn the calendar page and there it is – my favorite day of the year – April Fools' Day! It would be nice to be the one to play a prank but I seem to be always on the receiving end. At least in beekeeping. Will this year be any different? I guess I'll have to wait and see.

My package of bees arrived three days ago, on March 29. The package was shook on March 28. The recommended day to install in a hive is today, April first. The package has been well cared for – in a relatively cool, dark place, misted with syrup and looks good. A look out the window first thing in the morning showed a heavy cloud cover. The weather report promised heavy rain throughout the day. A little later it really is pouring rain so installing the bees will have to wait. Mother Nature's April Fool prank played on me and my package of bees. The forecast promised that tomorrow will be better.

The rain stopped during the night so today the package was installed in a brand new hive, new foundation and the new hivetop feeder full of syrup. A visit to the beeyard the next morning revealed a clump of bees, about the size of a small melon, hanging from the underside of the screen bottom board. The queen should still be in her cage placed between two frames so just what are those bees doing there? Some of the clump fly away and some fly to the clump. All seem happy; no fighting visible. So as long as they are happy, it's probably better not to disturb them.

Although it was a bit too soon to see what is happening inside the hive, it's probably best to have a quick look. The smoker was lit. Probably won't need it but it's a good idea with that mysterious clump of bees. Top cover and inner cover removed. The wooden tank-type syrup feeder seems fairly full. However upon picking it up a small dribble of syrup was seen on the same side as the clump of bees. Yes, the syrup is leaking out! Dribble running through the brood chamber and dripping through the screen. Somehow bees discovered the drips. Another feeder will have to be used. Perhaps this one can be repaired or maybe exchanged for another style. But it is important to get a feeder back on soon. Spring nights can be chilly and the foundation needs to be drawn.

Now it is three days after installation so time to see if the queen has been released from her cage. Yes, she is out of her queen cage. The cage seemed to feel a bit sticky when removed from the package but it is empty of bees and queen. Perhaps the candy was a bit too soft. I hope the queen did not get coated with soupy candy. Her attendants can keep her clean. Still – it's just not good to have a sticky queen. With the syrup feeding corrected and a new feeder installed, the workers have drawn some comb so the queen can start laying some eggs soon.

A week has passed and the weather is suitable for a good look at progress inside the hive. Comb is being drawn but the central frame with the queen on it shows only a bit of scattered larvae. The package queen is there but is just not doing well at all. A new queen is needed quickly (if not instantly). The population is slowly declining so new bees are needed. Quick! Make some phone calls to find a queen – any queen – she can always be replaced later. Fortunately a beekeeper nearby has a one-year-old queen that is actually doing very well. She is in a hive that he plans to requeen with a locally-raised queen. The queens he ordered have just arrived so time is not being lost. With the introduction of a good laying queen the package can be saved.

The addition of more young bees would certainly help. With Spring well underway a frame with soon-to-

In-hive feeder.

emerge workers can provide a good workforce for the replacement queen. Some strong hives can be found in the beeyard so the population of the package colony can get the boost it needs. The one hive that has been a bit grumpy off and on could be the best one for contributing a frame. It's been a good strong colony that really needs to be requeened so the bees become more pleasant. Well, today was not a good day to disturb them. After receiving several unexpected stings on fingers holding the frame, the frame crashed to the ground. Fortunately some of the bees few into their own hive. Another frame will have to be selected. The crashed frame was returned to its original hive for the bees to clean up any problems. The grumpy hive finally got a frame of drawn comb to replace the frame of brood stolen from it.

Drawing comb seems to have slowed down so perhaps it is time to mist some of the untouched frames again with Honey-B-Healthy as a stimulant. So the spray bottle is prepared; the hive is gently smoked and opened. Misting the foundation is going very well – until the top falls off the spray bottle and most of the contents are dumped into the main part of the brood. That cheap spray bottle will be replaced with a much better one on the next visit to the hardware store's garden section.

How are the bees and the queen after that deluge? The queen seems just fine. But a small section of open brood looks a bit wet. If the queen did get wet she was immediately groomed and should have no problems. However some open brood might suffer. These package bees are really off to a bad start.

The warm April sun means the bees are busy during the day. It's a good day to check the progress of the colony. Comb drawing is making good progress. The "substitute" queen is doing very well. Uh oh – did I just see a rapidly disappearing dark "spot?" The other hives in the apiary do have small hive beetles. Since the soil is sort of a heavy mixture of loam and clay, the shb problem is not a terrible one. With lots of wild birds patrolling the area, any larvae of the beetles may not survive if they have to travel a long distance, thus shb problems are not severe. Since the bee population is still growing there is no purpose disturbing them to search for shb. The dark "spot" was probably one. Since the bees are still settling in to their new home, shb traps will be the best approach of control.

The months have passed by and the colony is now established and seems to be doing very well. It is now July – the time for a *Varroa* check. So the alcohol wash equipment was assembled and ready for use. The initial wash showed five *Varroa*, a bad sign. Actually a sign to do something! So a treatment was selected, one appropriate for the hot weather expected in the last half of July.

After the treatment time ended it is time for another varroa check so that the colony can go into winter with almost *Varroa*-free winter bees. The alcohol wash system worked very well in the past so it's time for another. Success! A second wash was done since the first one showed no *Varroa*. Success also on the second wash. Perhaps this colony will live through the Winter and be productive next season.

As Autumn approaches there's not much more to be done except to make sure enough winter stores are available. Activity at the entrance seems a bit diminished but there should be nothing to worry about.

Small hive beetle. Louque photo.

After a few days of clouds and rain a sunny day will be a good one for checking the colonies.

Uh oh. The package colony has no young larvae, no sign of eggs, just some old capped brood about to emerge. Where is the queen? She just has to be in there somewhere! But all signs say "queenless." How? When? What happened? Think back. The last time the hive was opened was for the alcohol wash tests. Two were done. Did one of those scoops of bees have the queen? Probably. Was any search of the alcoholed dead bees done? No. What next?

An extended search reveals an emergency queen cell on one frame. At this time drones have declined in all the colonies. It is just not a good time for a virgin queen to emerge, be successfully mated and begin to lay eggs.

The package colony, at least part of it, did manage to survive quite a few problems. It will now become part of one of the other colonies in the beeyard. So now it is time to select a good colony to receive it. The grumpy colony will not be the one chosen. It probably would not welcome the addition of nice bees. "Grumpy" is scheduled for requeening in the Spring. Murphy's Law says it will overwinter in fine shape.

Combining the package colony did go well, with no mishaps. After all its problems during the Spring and Summer it now has a good home for the Winter with plenty of bees and food stores. I am looking forward to its good honey crop next year. BC

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Making Foundation

The creation of beeswax foundation for helping to guide the bees in comb building, is one of the inventions that led to the establishment of the beekeeping industry.

Making foundation from your own beeswax is one of the most difficult and potentially rewarding activities you can attempt in beekeeping. When it comes to getting bees to build strait, perfect combs filled with worker cells in wooden frames for our modern bee hives, nothing is as easy for getting the job done than using beeswax foundation. First invented in 1857, foundation can be strengthened by imbedding wires in it and the use of foundation allows the beekeeper to have significant influence over the size of the cells that the bees will draw out to produce the final comb.

Costing as much as $2.30 a sheet, beeswax foundation is not inexpensive. This along with the growing interest in sustainability and being able to produce what you need yourself, is inspiring beekeepers to experiment with making their own foundation.

I recently had the opportunity to spend some time with Kirk Webster, of Champlain Valley Bees and Queens in New Haven, Vermont as he produced the 1500 - 2,000 sheets of beeswax foundation he uses annually in his operation. Kirk has always approached beekeeping very meticulously and the process he has developed to make his foundation reflects this same painstaking attention to detail.

Webster first decided to produce his own foundation over concerns about the ubiquitous contamination of commercially available beeswax with pesticide residues and fears over what it might be doing to his bees. While it turns out that his worries over foundation wax pesticide contamination and its impact on honey bee health do not appear to be too much of a problem, he continues to enjoy making his own foundation now that he has worked out all the kinks in the process. By his own admission his system is "crude and primitive" and is basically the same process that Dandant and Root used when they first started making foundation over 100 years ago.

Starting with his cappings left over from the honey harvest, Webster lets his bees rob out all the residual honey in them. He has two melting tanks he had fashioned with immersion heaters threaded into their bottoms. They each have a water jacket and act like a large double boilers for melting wax. Once melted, he will filter the wax through an old T-shirt as he transfers the melted wax from the first tank into the second tank. He uses two tanks so that he can constantly be melting new wax in one, while he is continually making foundation from the other. As the wax level in the tank he is working out of drops, he periodically refills it with the melted wax from the other tank.

Webster has a set of three 1/16th inch lauan plywood boards cut slightly larger than the size of the foundation he wants to make that he soaks in very cold water for at least an hour before he begins his work. When ready, he lifts the boards out of the soak tank and lets them drip for a moment before wiping all six sides down quickly with a sponge to remove most of the surface water. He reports that when there is too much water on the board when he dips it into the tank of melted wax, it can cause the resulting wax sheet to crack.

He then dips the boards into his vat of melted wax. Webster gets the best results by keeping the wax liquid at a temperature of around 160^{0}F (71^{0}C). He learned through

In order to ensure that the sheet of beeswax will not stick to the wood and is easy to remove. The wooden boards are soaked in cold water prior to dipping them into melted beeswax.

The beeswax on the edges needs to be cut off in order for the sheets of wax to be removed easily.

trial and error that the final thickness of the wax sheets is controlled by the amount of time he leaves the boards in the wax and has developed a feel for the right amount of time to leave the boards in to produce a sheet with a thickness that works for him (about five seconds). After dipping the resulting wax sheet is slightly thicker at the bottom than the top, but he finds that it doesn't seem to matter to the bees.

After removing the wax covered boards from the melting tank, he waits several seconds for the wax to solidify and then trims the wax off the edges of the boards with a knife. The wax sheets are then peeled off the lauan boards. The freshly formed sheets of wax are placed in a tray of water that is kept between 110-120^{0}F (43-49^{0}C). Meanwhile, the rollers on the embossing machine are kept cold by the constant drip of cold water over them. The temperature difference between the sheets of wax and the rollers prevents the wax from sticking to the rollers as it passes through the embossing machine. Webster also uses a piece of plastic to prevent damage to the leading edge of the sheet of foundation during the embossing process.

As Kirk tells it, the process he went through to figure out how to produce foundation was nearly the end of him. Part of the problem in trying to learn how to make foundation, was that he got a lot of bogus information that led to a lot of dead ends and difficulties. To make matters worse, the first embossing mill that Webster purchased featured angles at the base of the cells that were too flat and not steep enough to meet the bee's needs. As a result, the initial sheets of foundation that he made with this original mill were drawn out by the bees into a mish-mash of misshapen comb that was not workable. "I worked on this over a period of two to three Winters and it gave me a headache practically every night," he says. "I survived *Varroa* but I thought this stupid wax thing was going to put me out of business."

Webster's breakthrough came when he got in touch with Myron Krupf, a Mennonite from Arkansas. Krupf had experienced the same problem that Webster had with the miss-shaped combs built from foundation made from a commercially available foundation mill. As a result, Krupf taught himself metallurgy and machining so that he could make his own set of foundation mills with the correct angles at the base of the cells. Although Krupf was reluctant, Webster eventually convinced him to make a set of foundation rollers for him too. According to Webster, "He used some type of tin alloy and melted the metal for the rollers on his wood cook stove."

Webster says he needs about 250 pounds of beeswax in order to produce the sheets of foundation he needs annually so he can produce and sell around 200 nucleus colonies each year. Unfortunately, he ended up spending thousands of dollars going through the process of figuring out how to make foundation successfully. Now that he has worked out the kinks in the process however, Webster calculates that it takes him about seven days of work (producing about 300 sheets a day) along with one day to set up and another day to take down and put away the foundation making equipment. Financially he figures after the initial cost for equipment, he now pays approximately .07 cents a sheet, primarily for the electricity he uses to melt the wax.

Warm water is used to keep the sheet of beeswax warm as it passes between the cold embossing rollers on the mill. Webster uses a small piece of plastic to protect the forward edge of the wax from getting damaged as it goes through the mill.

A small hand clamp is used to help ease the sheet of foundation through the mill as the crank is being turned.

Webster reports that in hot weather, the foundation will not stay flat as the cells in the upper half of the foundation get stretched out causing the foundation to sag. This is because the foundation he produces does not have the vertical wires imbedded into the wax that is common with most commercially available foundation. In order to prevent this sagging, Webster uses an idea he found in the writings of early commercial beekeeper Charles C. Miller, who in the late 1800s and early 1900s used a series of five thin vertical strips of wood to prevent foundation from sagging. Unlike C.C. Miller, Webster installs his foundation using three horizontal strands of wire to help provide strength, and therefore finds that a single thin vertical strip of wood down the center of the foundation is enough to prevent sagging.

Webster feels that "making your own foundation is for fanatics only," and yet he will generously offer his time to anyone who wants to do this and contact him and discuss it and ask questions. He readily admits that for the average backyard beekeeper that only needs a few dozen sheets of foundation, getting a relatively inexpensive silicone mold or press for making foundation is probably the best way to go. There are a number of YouTube videos on line that provide a range of ideas on how different people go about the foundation making process. The large commercial operators on the other hand, will continue to simply purchase their foundation from one of the large beekeeping supply companies that manufacture it. The commercial guys (and gals) are often able to trade in their beeswax for credit towards their foundation purchase.

According to Webster, "It's fun doing things the way old-timers did, if you can create the illusion of it making sense." He finds old beekeepers and the way they approached beekeeping challenges is far more interesting and inspiring than most of what is available today." BC

Ross Conrad is the author of Natural Beekeeping: Organic Approaches to Modern Apiculture.


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If you've ever been anywhere with me before, you know I'm usually that person that way overpacks and usually has everything and anything you might need or want. Although I fly a lot, I prefer to drive if possible so I can take more stuff with me and have more control over my environment. I absolutely hate being in situations where I need something that I don't have, or I want something I could have brought with me. Sometimes it's about peace of mind knowing it's there. In *Alien vs. Predator*, there was a line near the beginning where the lady has a gun and someone was giving her crap about taking a gun (which was obviously a good idea). She tells them that it's better to have it and not need it than to need it and not have it. The line resonated with me because I feel that way about everything, all the time.

Some of it might be from growing up in a rural area, where you can't just run out and get something you need easily. Even when I was little, one of my favorite games was to pack my bag like I was going on a trip and decide what I would take with me.

A lot of people have a bit of disdain for the whole idea of preppers, part of which is probably from displaying the worst case scenarios on TV shows and thinking everybody is like that. In reality, it's about being prepared, period. It's not some zombie apocalypse coming, or the end of the world (I guess it can be for some people), but more of being able to be self-sufficient if help isn't there. In an extreme case, I'm sure people in Venezuela didn't think they'd be fighting on the black market to buy toilet paper and loaf bread, but here they are.

In reality, it's what daily life was like a few generations ago, and being able to take care of yourself and your family without relying on assistance. In practical terms as it applies to beekeeping, I have two specific instances of being prepared that I think could benefit nearly any reader. In all cases, a first aid kit of some size is involved, which carries some form of the following items:

- Band-Aids
- Neosporin/Triple Bac
- Antacid chews
- Pain/Fever relief
- Motion sickness meds
- Anti-diarrhea meds
- Gauze
- Medical scissors
- Ace bandage
- Allergy meds (non-drowsy)
- Poison Ivy cream/wash
- Sunscreen
- Tick tweezers
- Eye Wash/Eye Drops
- Burn Cream
- Alcohol Wipes
- Nail clippers
- Sharp tweezers

The Every Day Carry (EDC)

This is a common term in the prepper or survivalist world, but to be honest it doesn't cross my vocabulary very often. It's one of those things I was just doing that I didn't know had a specific term attached to it. I absolutely cannot carry a small bag, but I can sure overpack a bigger one so I have to limit myself. For an EDC, this is in conjunction with your "common" items that you normally take with you on a daily basis, like your wallet, phone, and your keys. The things in my bag may change slightly, or I might add even more to it, but in general, here are the things I always have with me:

- **A knife** (usually more than one because I like knives) – Knives are always useful in a multitude of situations. A small one with a 3" blade or so is compact and practical, unlike the bowie knife I sometimes carry because it's pretty. Folding knives are better because the blade is protected while it is being stored, and doesn't come off as a sheath might.
- **A gun** is almost always in my bag. I do strongly encourage you to either **NOT** do this if you do not feel comfortable with a gun because you will be putting yourself and others at a detriment if you are not able to confidently and properly handle a gun. You should never

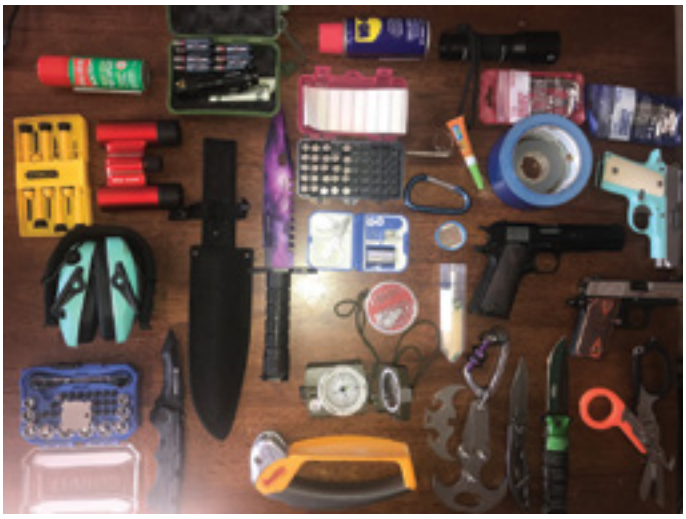
One of my first aid kits (assembled by me, not pre-packaged).

have a gun unless you are mentally prepared to use it if you need to, without hesitation. That being said, I know that having my concealed carry has saved me on at least one occasion and that one time was one too many for me to ever be without it.

- **Tape** is invaluable. I usually have electrical tape in my bag, sometime duct tape (always in pretty colors), but it depends on the size of my bag at the time. If I don't have it in my bag, it is usually close by.
- **Pens** are not something you think of in a survival situation, but they are always useful.
- **A phone charger** (both a portable charger and a plug-in speed charger with a cord) – even though it's very nearly a joke these days that people can't go without their phones, it's hard to argue the usefulness of a smart phone. You can use YouTube to look up how to do nearly anything in any situation, keep app guides for whatever you want, and obviously use it for contacting people in an emergency and keeping up to date on larger situations (like a car crash or shooting incidents or whatever is stopping traffic).
- **Small denomination cash** and a few dollars in coins – Sometimes you need a drink from a vending machine, and sometimes cards just don't work.
- **Wet Wipes and/or toilet paper** because how often do you use a public bathroom and there's no toilet paper left?
- **Hand Sanitizer** in individual packets to spread all over shopping carts or my hands – because the public is gross. Sometimes this includes a travel sized Lysol can too.
- **Small toiletry bag** – besides being a skincare fanatic, I often find myself staying in places longer than I mean to and feel better with a backup of travel sized skincare products, deodorant, and a razor at minimum.
- **Small first aid kit** – I have a self-made first aid kit that I use for travel and keep on me most of the time in some form or fashion. It has a few parts so I can divide it if I have more or less space. At the very least, I have some pain meds, Band-Aids, and some triple bac or Neosporin.
- **Flashlight**
- **Food and Gum** - snacks are always important, and you never know when you'll get stuck somewhere. The quantity and quality of food changes, but it's present nonetheless.
- **Hive Tool** – I am absolutely not kidding that in bee season, it's entirely likely that there is a hive tool in my bag, with some nitrile gloves and a ziplock bag... just in case.

Field Bag

A field bag can hold a lot more stuff than an EDC bag because it is there just to suit your needs. There are several different types of bags that you can use for this, depending on how you like to keep up with your stuff. I use a backpack because I can take it hiking with me and it's ready to go, but sometimes I pack a bigger bag to take into the bees just to have everything I want. Some of these items stay in the truck during bee season and don't come out unless they are replaced. Literally anything can happen when you're in the field or working the bees, so having a basic set of supplies with you at all times can be really helpful. Again, all of these things are what I like to have, but it's totally customizable based on your experiences and needs. This is in addition to the "basics" of beekeeping that I would expect you to have anyway, like a smoker and fuel and a lighter and hive tool, etc.



My standard "tool" assortment including electrical tape, binoculars, a grappling hook (just because why not), a sewing kit and WD-40.

- **Tools** – in some cases you may want to take an entire toolkit with you, but I always have a small set with me in my bag. I usually have a set of Allen wrenches, a ratchet set with screwdriver attachments, a tape measure, and a mini screwdriver set. These came more from experiences playing airsoft rather than bees, but they have come in handy in the bees a few times as well. I would include electrical tape and duct tape in this section, and I usually carry more than one roll of duct tape in the bees at all times. You should always have at least one extra ratchet strap with you as well if you use them in the first place.
- **Knife** (non-folding) – this knife is better to not be your favorite and not a folding knife. I'm not saying I haven't used a folding knife before in the bees, but I usually regret it due to the grossness of honey and wax and propolis getting inside where I can't clean it well, or getting sand or dirt stuck inside the sticky. I would include a sharpener with this as well.
- **First Aid kit –** This would include all the items on the original list, plus extra burn cream (you know you've burned yourself on the smoker before, don't lie), extra Benadryl, and an Epi-pen for emergencies. Most of my hive-related injuries have involved splinters, dropping something on my foot trying to get a stinger out, burning myself with the smoker, cutting myself with the hive tool, or heat exhaustion from the times I gave in and put on a jacket and veil. I keep things to treat these events at the top because they are so common – Band-Aids, Neosporin, sharp tweezers, pain relief, Benadryl, burn cream (minimum). I would also include at least a couple full-sized bottles of sunscreen in this list, of the unscented variety when

at all possible to avoid the wrath of the bees.

- **Water** – It doesn't have to be in the field bag necessarily, but I always have at least one bottle of water in my field bag as a backup. If I'm going to be in the bees a long time or with a lot of people, I'll take a cooler of ice with water and Gatorade. Working in the heat is no joke and if you ever get sick from it, you'll take it seriously from then on.
- **Ziplock bags** – just in case it rains, I have at least one dry place to store things like my phone. We usually have a roll of trash bags too so I can put my entire bag inside if I need to. They're also handy if you find something you want to take back with you for whatever reason. You should always take trash bags of some size to keep your apiary tidy as a practical common purpose.
- **Lighter/Matches** – The best thing ever are the jumbo matches with green tips. We use Falcon tubes, but you could use even a mini-mason jar or a regular sized one. You fill it with matches and put the striker inside the lid and they are always dry. A couple grill lighters are good to have on hand too, and if you have a lot of room, a blow torch is fun.
- **Extra clothes** – In particular, I usually have a buff with me (one of those that can either cover your neck, be used as a face mask, or as a head band to hold your hair back), a hat or visor, sunglasses, boot socks, underwear, camo pants, and a thin long-sleeved shirt. I don't like to be in the sun but it gets hot. Under Armour's Cool Gear works pretty well, and I have a few of their lightweight long-sleeved shirts with hoods that have never made me feel hot.

I'm sure I've forgotten a few things, and it always changes throughout the season, but hopefully it's given you a starting point for making your own field bag or EDC to be prepared wherever you go. BC

Jessica Louque and her husband Bobby run Louque Agricultural Enterprises, a contract research business specializing in apicultural studies. They also raise kids and bees and birds at their home in NC.

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♦CALIFORNIA♦

California Honey Festival May 4 10-5. For information visit **www.californiahoneyfestival.com**.

The 4th Annual International Conference on Pollinator Biology, Health and Policy will be held July 18-20 at University of CA, Davis. Reception July 17.

Early-bee registration is $325/person; $150/students. After May 15 $425/person; $250 students.

Keynote speakers are Christina Grozinger, Lynn Dick.

For information visit **https://honey.ucdavis.edu/pollinatorconference2019**.

♦GEORGIA♦

Young Harris Beekeeping Institute will be held May 22-25.

Speakers include Francis Ratnieks, David Tarpy and Wyatt Mangum.

For information and registration visit **www.ent.uga.edu/bees**.

♦ILLINOIS♦

IL State Beekeepers Association will hold their Summer meeting June 7-8 at McHenry County College, Crystal Lake.

Friday is the members-only Short Course taught by Keith Delaplane and Jerry Hayes. This session is limited in size.

Saturday is a day of presentations. For more information and to register visit **www.ILSBA.com**.

♦KANSAS♦

Northeastern Kansas Beekeepers Funday will be held June 1 in Lawrence at the Douglas county Fairgrounds.

Speakers include Judy Wu-Smart, Matthew Smart, Randy Oliver, Katie Lee and Marion Ellis.

For more details visit **www.NEKBA.org** or call Jo Patrick, 913.645.8947.

♦KENTUCKY♦

Heartland Apicultural Society (HAS) will be held at Western Kentucky University in Bowling Green, July 8-10.

Keynote speakers will be Jay Evans, Jerry Hayes, Reed Johnson, juliana Rangel, Jennifer Tsuruda and Geoff Williams.

For information visit **www.heartlandbees.org**.

♦NEW JERSEY

Bee-ginner's Beekeeping: The Basics of Apiculture, May 2-4; **Review of Basic Beekeeping**, February 16. Both held at Rutgers Eco Complex, Bordentown.

For more information visit **http://www.cpe.rutgers.edu/courses/current/ae0404ca.html**.

♦PENNSYLVANIA♦

The Capital Area Beekeepers' Association is offering its 32nd Annual Short Course May 4 and 11. Part I at the Dauphin County Ag and Natural Resources Center and Part II at Strites Orchard in Harrisburg.

For more information visit **www.cabapa.org** or **deb.bee.caba@gmail.com**.

♦SOUTH CAROLINA♦

EAS 2019 will be held at the Greenville Convention Center July 15-19.

Speakers include Dewey Caron, Dennis vanEngelsdorp, Kirsten Traynor, Geoff Williams, Meghan Milbrath, Jennifer Berry and Jay Evans.

For information **www.easternapiculture.org**.

♦VIRGINIA♦

Virginia State Beekeepers Association will hold their Summer meeting May 31-June 1 at Fredericksburg Hospitality House.

Speakers are Kim Flottum and Jennifer Tsuruda.

For more information visit **www.virginiabeekeepers.org.**

♦WASHINGTON♦

Washington State University Bee Lab will present a Queen Rearing and Bee Breeding Workshop, June 14-15 at Washington State University, Pullman campus.

Instructors are Susan Cobey, Brandon Hopkins, Tim Lawrence, Steve Sheppard, Nick Naeger, Jennifer Han and Melanie Kirby.

For information visit **http://bees.wsu.edu/queen-rearing-and-bee-breeding-workshop/**.

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If you are having an annual meeting or teaching a beginning beekeeping class, we are happy to send you magazines to give to your attendees and students. BUT – we need to receive your request four weeks before your event so that we have time to process your request. **Please email Amanda** at **Amanda@BeeCulture.com** with the number of magazines needed, a complete mailing address and a contact person.

It's early February as I write, and unlike last year, we have snow on the ground here in western Colorado. Up the road in Aspen, I can assure you the skiing is fabulous. Technically we're still in a drought, and the big reservoirs on the Colorado River are only half full, but Colorado farmers, ranchers, and beekeepers are breathing a small sigh of relief.

I take full credit for this year's ample moisture. You see, I bought federally subsidized beekeeper drought insurance that pays me when precipitation falls below historical averages. 2018 was dry and my bees didn't make much honey. I could have used the insurance, but of course I didn't have it. Now that I'm out on a limb for the 2019 premium, I'm sure to eventually need an ark to get to my bee yards.

I sent no hives to California for the almonds this Winter. I have my reasons. Rumors fly that almond growers are crying for pollinators. One culprit is the herbicide dicamba. It gets sprayed on dicamba-resistant GMO soybeans but then drifts onto non-targeted neighboring land, killing off bee forage. This has a dramatic negative impact on honey bee populations. Beekeepers also continue to experience major die-offs that they attribute to pesticides, especially fungicides and neonicotinoids. Some beekeepers – a lot of beekeepers – are delivering fewer bees to the almonds than they initially planned.

I started checking my own overwintering hives for honey stores at the end of January. This is easier said than done! I've been walking in to beeyards through two-feet-deep snow. Sometimes the snow supports my weight, and others I sink in to my knees. I use duct tape to seal the tops of my rubber boots. I throw a few frames of honey in a backpack and march in with a smoker and a hive tool. Yesterday a landowner drove me partway in on his snowmobile, but I had to post-hole across the creek and up the far bank the final 75 yards.

On warm days, I like to watch the bees flying in and out of hives half-buried in the snow. They splatter the virgin snow with golden droplets of bee feces, a lovely sight to any beekeeper. An occasional Winter bathroom break helps to keep the little darlings healthy. I don't mess with them. I don't go poking around looking for the queen or checking for mites. I rarely remove the inner cover. The bottom boards are frozen to the ground, so I simply crack the top brood super loose from the bottom brood super and heft one end of the top super. This time of year – remember, it's February in Colorado – most of the honey and most of the bees are in that top super. Because honey is heavy, comparing the relative weights of these top supers gives me a rough-and-ready idea of how much honey might be inside. This exercise goes pretty fast, once you get the hang of it.

I make sure all my hives are dead heavy with honey going into Winter, but some colonies have ravenous appetites. I find a light super now and then. I'll remove an empty frame and replace it with one of those honey-laden combs in my backpack. I save frames of honey from last year's deadouts for just this purpose. When I come across a Winter deadout, I generally leave it right where it is. Hopefully I'll find a deserving home for all the good honey inside, before the weather really warms up and the bees begin robbing.

So far I've only lost four or five of the 100-plus hives I've checked, but it's only February. March can be cruel. Yet even seemingly weak hives sometimes pull through. Last March I had a colony with a single frame of bees that not only survived but made a super of honey!

My gal Marilyn's 24-year-old niece is recovering from serious illness. The little waif needed shelter and a warm bed, so we took her in. She's been in and out of the hospital ever since. On Christmas Eve, we thought we might lose her. I initially told the emergency room nurse that she thought she was having a severe digestive reaction to my bean-based cooking, and that we brought her to the ER out of an abundance of caution. We were off the mark. The next thing I knew, her attending physician called for a helicopter. "There's nothing we can do for her here," he said.

As the flight crew wheeled her outside on a gurney in the snow, I button-holed the doc. Her long-haul chances? "Not good," he said earnestly.

But that was then. There's light in her eyes now, a hint of pink on her cheeks. The little innocent cooked for us last night, then nodded into dreamland on the couch in front of the woodstove. I kept the fire dancing all night long.

She amuses us with her quick wit and her gentle way. She's quite frankly adorable. This child is a gift from God.

She understands that her condition remains grave, that the road ahead lies fraught with peril, that she's a candle-flame fluttering. But she wants to live. When I told a beekeeping doctor friend that, he poked his finger in my face. "*That's* what matters!" he proclaimed.

Marilyn and I got ourselves into this. She summed up the situation: "We took a chance, and we fell in love."

Ed **Colby**

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