150 YEARS – USDA & LAND GRANT COLLEGES

Dec 2012

Catch The Buzz™

Bee Culture

The Magazine Of American Beekeeping

www.BeeCulture.com

Insect Pollination - Worth $29 Billion

Visit The USDA Honey Bee Labs

Assembling Wooden Frames

2012 Year-End Index

ROOT $4.99

12

Robert Wilder, Jr., of Venice, FL, caught a honey bee forager in mid air examining this thistle blossom. Already having visited other blossoms of the same variety of thistle on this flight, she's homing in on the size, color and aroma of this beauty.

Executive Publisher – John Root
Associate Publisher, Senior Editor – Kim Flottum, Kim@BeeCulture.com, 800.289.7668, Ext. 3214
Assistant Editor, Design Coordinator – Kathy Summers, Kathy@BeeCulture.com, 800.289.7668, Ext. 3215
Circulation, Advertising – Dawn Feagan, Dawn@BeeCulture.com, 800.289.7668, Ext. 3220
Publications Assistant – Amanda DeSimone Ashaffer@RootCandles.com, 800.289.7668, Ext. 3255
www.BeeCulture.com, Blog.BeeCulture.com

Contributors
Clarence Collison • James E. Tew • Ann Harman • Kim Lehman
Larry Connor • Connie Krochmal
Jennifer Berry • Ross Conrad • Audrey Sheridan

Subscription Information
U.S., one year, $27.50; two years, $49. Newsstand price: $4.99. All other countries, (U.S. Currency only), $15.00 per year additional for postage. Digital Edition $14.99. Send remittance by money order, bank draft, express money order, or check or credit card. Bee Culture (ISSN 1071-3190), December, 2012, Volume 140, Issue 12, is published monthly by The A.I. Root Co., 623 W. Liberty Street, Medina, OH 44256. Periodicals Postage Paid at Medina, OH and additional mailing offices.

Subscriptions, Book Orders
V800.289.7668 • V330.725.6677, Ext. 3220 • F330.725.5624
www.BeeCulture.com; email: info@BeeCulture.com

Advertising
Contact Dawn Feagan
800.289.7668, Ext. 3220; Dawn@BeeCulture.com

POSTMASTER: Send address changes to
BEE CULTURE, The A.I. Root Co.,
623 W. Liberty St., Medina, OH 44256

Bee Culture

FEATURES . . .

DEPARTMENTS & COLUMNS

www.BeeCulture.com

www.BeeCulture.com/Buzz

Contributor to Mother Earth News

Kudos From Vaughn

Ms. McNeil, you did a great job on the story about my work with honey that was just published in *Bee Culture*. Not only did you write it very well, but you get an A+ for accuracy! Not all members of the Fourth Estate are that good!

My father was an AP Correspondent for much of his life and I learned a lot from him about how good reporters write . . . he would have included you in that category!

Vaughn Bryant
College Station, TX

Customer Service

Just read your October editorial. Love the story. You hit the mark when you say you are the worst customer. You never go back. This is the essence of marketing, and you are powerful because you took the word of mouth, customer to customer, complaint to a million readers.

The labeling segment brings up the question of what is already law in many states, but lacks the enforcement. Most of us in the business are struggling with the demand of records and regulation. More restrictive requirements cost us and raise costs to our customers. I simply want inspectors to look at what is in the market and punish those dishonest purveyors of adulterated, and mislabeled honey.

Dan Conlon
South Deerfield, MA

New Beekeepers

We have a 30-acre farm surrounded by larger farms. We have an orchard with peach, pear, plum and apple trees as well as blueberry, black raspberry and seasonal garden vegetables. Our neighboring farms plant corn, various hays and soybeans. We plan to begin beekeeping in our orchard. We're excited and a little nervous.

Thank you for your informative site and the copy of *Bee Culture*. We have so much to learn.

Kim & Tim Flaherty

Tips On Bee Vacs

Bruce, "The Bee Whisperer" here with a tip that may help fellow beekeepers who use bee vacuums in the bee removal projects. I felt that the standard shop-vac hose, with all its ridges, was like sucking bees over a washboard or gravel road. So I went to a big box store and bought clear plastic hose by the foot to fit my shop-vac, bee vacs (I made a few different styles).

Great magazine!

Bruce Sabuda
Pinckney, MI

Russian Bee Breeding

I'm sure most of you have at least heard about the Russian honey bee. It was brought to the U.S. through the efforts of USDA-ARS scientist Thomas Rinderer. What he found in east Russia were honey bees and their keepers, who for the past 150 years had selected bees that were resistant to the *Varroa* and Tracheal mites. The bees had originated in central Europe and traveled with the settlers as they expanded the eastern frontier. What Dr. Rinderer brought back to the U.S. were bees, which in addition to being resistant to *Varroa* and Tracheal mites were good honey producers with excellent overwintering qualities and were later discovered to be resistant to American Foulbrood. More than 300 Russian queens were imported into the U.S. from the Primorski region of Russia between 1994 and 1997. After an extensive quarantine and selection process by the Honey Bee Breeding, Genetics and Physiology Laboratory, Baton Rouge, Louisiana, and three years of field testing, breeder queens were made available to the U.S. bee industry via Charlie Harper of Harper Honey Farm through a CRADA (Cooperative Research and Development Agreement). The USDA released all lines in 2007-2008, and transferred control of the stock to the U.S. Beekeeping industry via the CRADA. As the CRADA holder, Mr. Harper owned all of the stock, but he realized that he could not do all of the maintenance and selection himself, so he gave the stock to the Russian Honey Bee Breeders Association (RHBA) **www.russianbreeders.com**.

While most beekeepers have heard of the Russian bee I'm not sure how many have heard about the RHBA. I'm certain that few know the purpose and goal of the breeding association. The purpose of this letter is to inform the beekeepers about the "Russian queen breeders." We are simply what we say, an association of beekeepers who are breeding Russian honey bees. Few, if any, of the original members would have called themselves breeders of honey bees when they joined, but those of us who remain have become more than queen breeders. I do not like that term because too many today have misused it and abused it. We do much more than simply rear mated queens to sell. In fact we do relatively little of that. Each member is required to maintain at least 30 colonies each of his two lines and evaluate them for mite resistance and other qualities such as honey production, overwintering ability, gentleness, and other qualities. He is required to swap queens with the other members so that each has the adequate number of drone sources to maintain genetic diversity. The number of queens required for the complete program is a little less than 600 each year. Any queens produced beyond that number are typically for sale to the public.

We are truly a unique group. Nowhere else in the U.S. is there a group of individuals who have joined together to provide a service to their industry. Provide what service you ask? Our service to the industry is stated in our bylaws as; "The primary purpose of the corporation will be to maintain and improve the genetic lines of Russian honey bees through propagation and selective breeding." I don't know one certified member whose goal it is to sell Russian queens. We are members so that we can have them for use in our business, most sell them so that others can utilize this stock.

Steven Coy
Jonesboro, AR

Two Cents On DDT

I read with much amusement the rehash of *Silent Spring* and the DDT scare. I MUST add my two cents worth.

I was born in 1946 and DDT was very much in use when I was a child. I lived in Galveston, TX and we had plenty of mosquitos for everyone. The city sprayed every city block at least twice a month with that great killer DDT. As boys, about 10 years old, the neighbor kids and I got on our bikes and followed behind the trucks as they fogged the neighborhood, SO CLOSE WE SOMETIMES RAN INTO THE TRUCK because we couldn't see it for the fog of DDT. We loved the smell of the DDT. I did this for many years until Ms. Carson's book warned we would all be killed by it and it was banned.

As I said, we followed these trucks, inhaling as much poison as

we could get into our lungs, every time they sprayed for years. If her book was right, I would have died within a year or two. I am now 66! I smoked 50 cigarettes a day (two and a half packs) for 40 years on top of all that poison. I have no lung problems. I haven't died. I don't have any cancers. No problems except a little high blood pressure. Maybe DDT makes you eat too much? Maybe I can sue somebody and get rich! So much for the DDT scare from a crazy lady.

Frank Chamberlin
Asheboro, NC

Water Issue Solved

This is in reply to the email from Norris Childs, Walnut Creek, CA

I also am an urban beekeeper in Coeur d'Alene, ID. We recently moved and my bees are located on a concrete pad on the south side of our garage mainly due to the east/south exposure.

I have set numerous containers for my bees to get water. These range from aluminum pie pans to the bottom of planters, either

plastic or tile, etc. This year I had a few pepper and tomatoes (probably about 12 - 14) plants in four inch pots setting in a metal bread tray.holding the water drainage. All summer the bees were constantly on the moist soil in the four inch pots, and they appear to be drinking! The bees do not ingnore the other water containers, but I was amazed at the number of bees that were on the soil in the four inch pots. They would number from two to four per pot.

Next year we plan to expand this idea, and use the bread trays with moist soil in them to see if the bees will accept them as a water source.

Frank D Gunseor
Coeur d'Alene, ID

Intelligent Honey Bee

On October 19, my wife Leslie, and I gave a presentation on beekeeping to 10 girl scouts from Troup 2108, Howard County, MD. As Leslie was demonstrating the use of the honey extractor, and I was getting the equipment ready to take to our apiary, I noticed that a honey bee had entered the basement through the open sliding glass door.

In an attempt to regain her freedom, the honey bee was flying into the glass door. After a few futile attempts, she turned around and began pummeling the glass with her back from about 1/8 inch away.

I was amazed at the intelligence of this remarkable insect. I have never witnessed this behavior in an insect before. After watching in awe for a few seconds, I helped her out the doorway.

Ross Englehart

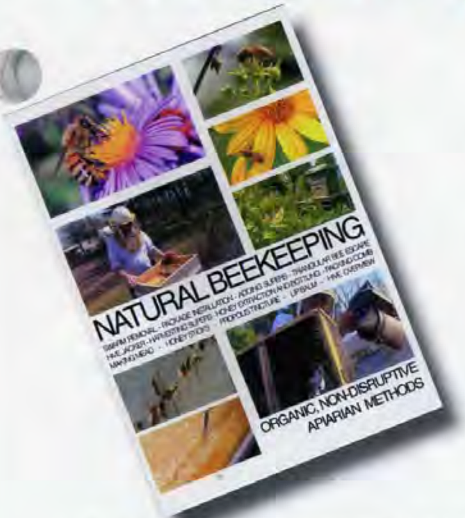
Pollen In Honey

Thank you so much for your wonderfully written article on Vaughn Bryant and his work, in the October issue of *Bee Culture*. This is the type of topic that could leave me in the dust, as scientifically it's much over my head. You wrote with great clarity, making difficult concepts lucid.

It's not often that I make notations, but I've marked up your article in lots of places. Years ago, when *Bee Culture* was more poetically named – *Gleanings in Bee Culture* – I would save every issue, but the stack got too high pretty quickly. So now I just cut out the articles that I may want to refer to again; yours will now be among them.

Jeffrey Hamelman
Hartland, Vermont

For The Beekeeper On Your Holiday List –



Natural Beekeeping, 88 Min DVD. Produced by Great Lakes Production, with Jerry Dunbar. DVD for $19.95, Blu-ray for $34.99, on his blog: **http://honeyfarm.blogspot.com/**

Jerry Dunbar has more than 40 years experience keeping bees, and has developed beekeeping techniques that work for his way of keeping bees. But don't take the title wrong. With all the talk about Natural Beekeeping these days, one expects to hear about no chemicals, no feeding, nothing the bees don't do for themselves . . . Well, this isn't quite that strict.

Jerry talks about starting a hive – first by catching a swarm, but what he really does is remove a hive from a house wall – it was a swarm at one time, but it's a full blown colony when he takes it out. But he installs a package, adds supers, and checks his bees, like we all do.

He always uses a queen excluder and has a plastic grain sack for an inner cover. I can't argue with those at all. When removing honey he uses a hive Jacker – not sure where to get one of those – to insert a triangle bee escape, not a fume board, uncaps with a scratcher, strains and bottles. He uses a foundationless frame to make cut comb, then cuts that comb to fit an oyster shell container, but you'd be wise to drain the edges before you do this so the bottom doesn't fill with liquid honey. It's messy if you don't. And he winter feeds only honey, not HFCS.

He also makes mead, honey sticks with a Ketchup pump and plastic straws, propolis tincture and beeswax lotion. Seeing how others keep bees can only be enlightening, and having made a bunch of these types of videos over the years, I can say the quality is excellent, and the background music just as good.

Kim Flottum

T-Shirts Available From Golden Bee Products

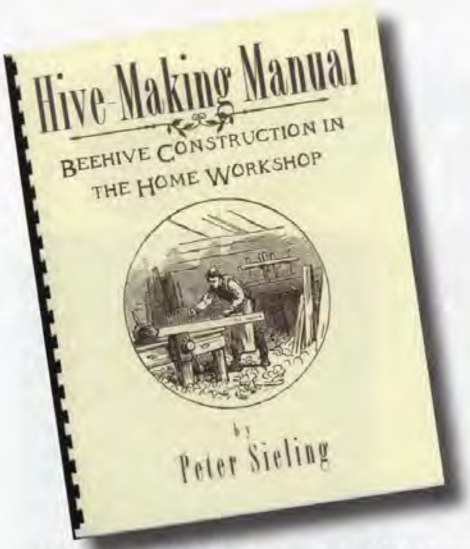
Bee T-Shirts are now available from Golden Bee Products in small, medium, large and extra-large, for $18 each. Add $3 per shirt for shipping.

To order please call Susie Lemoine, 504.456.8805 or 504.715.7947 or email **GOLDENBEEPRODUCTS@YAHOO.COM** or visit **www.goldenbeeproducts.com.**

The BBKA Guide To Beekeeping. By Ivor Davis and Roger Cullum-Kenyon. ISBN 978-1-4081-5458-8. Published by Bloomsbury Publishing Plc, 50 Bedford Square, London WC1B 3DP. 9-3/4" x 7-1/2", 182 pages, color throughout. www.bloomsbury.com. About $25.00 plus post.

This is another of the many beginner's books that have appeared recently. What separates it from the others however is that it is the only book endorsed by The British Beekeeper's Association, which, of course, has little meaning on the surface. However, Ivor Davis is a past president of the BBKA, a Master Beekeeper and one of the few people to hold the National Diploma in Beekeeping. This is significant. *Bee Culture* magazine has just completed a series of article by Ann Harman on Master Beekeeper programs in the U. S., and one of the things she just barely touched was the National Diploma in Beekeeping that can be attained in the U.K. This is beekeeping in the extreme, with courses...yes courses and then exams in microscopy, anatomy, physiology, diseases, behavior...it leaves anything done in this country short of a college degree completely in the dust. And Dr Davis has completed this course. So, though the book is similar to others, and very basic, you can safely rely on the information presented with a bit of a British flare to boot.

Kim Flottum



The Hive-Making Manual. Beehive Construction In The Home Workshop. Peter Sieling. 8-1/2" x 11", 70 pages. Color and black and white. Available at www.makingbeehives.com. $19.95.

If you are an even casual reader of *Bee Culture* you are familiar with the dual personalities of Peter Sieling. He is an excellent woodworker, and makes a living running a specialty lumberyard in upstate New York. He's also a beekeeper, so much of his woodworking skills are turned toward making beekeeping equipment. If you visit his web page you'll see plans for many pieces of equipment, and interestingly, furniture made from beekeeping equipment. We are fortunate to have many of these pieces adorning our home.

But Peter's also a writer. A very good writer, tending toward humorous, and sometimes introspective, but always entertaining...and mostly about bees, beekeeping, beekeepers and his local beekeeping club. So now, join the two...an entertaining writer and an excellent woodworker...and you have The Hive-Making Manual.

It is written for beekeepers that have a workshop, from just a table saw to a full scale woodshop. There's a section on the moveable frame hive, problems encountered with commercially produced equipment, wood moisture, lumber grades and seasoning wood. There are plans for different bottom boards, covers and 10, eight and five frame equipment... with references to his *Bee Culture* articles, Jim Thompson and even The Backyard Beekeeper. Along the way he refers to advice by Langstroth, C. C. Miller, Gene Killion, Laidlaw and Page, A. I. Root, Roger Morse and many more. And if it can be make out of wood and is used in beekeeping...there's at least one here, in usually more than one style.

It is interesting to read...I enjoyed it though I will never, ever make any of the things he has here, and the illustrations are exceptional...he is a computer-assisted genius, as you may have already seen in his articles, and even my books.

Kim Flottum

2013 Busy Business of Bees Calendar, with fine art photography by Kodua Galieti, design by Cindy Henderson of Mediashine.

12 months, 12 extraordinary photos, 12 fantastic stories. Open size 20" tall, 12½" wide. 28 pages total. Available at **www.koduaphotography.com**. – $17.99 includes domestic postage.

Many of Kodua's photos were taken on the Almond Odyssey last year, and some of the stories are written by the good people we met on that trip.

The Powerblanket Honey Heater revolutionizes heating honey in 55 gallon drums, buckets and totes by solving the problems associated with the traditional band heater. Band heaters create hot spots on the surface of the barrel and have the tendency to burn honey. This can be a costly mistake. Our Honey, insulated, barrel wraps utilize a heat spreading technology that evenly heats the entire surface of the container, ensuring that you will never burn another batch of honey again. Each heater includes a digital thermostatic controller allowing you to precisely set your desired temperature. The bee keepers that are currently using this product all say that they will never go back to the old way of heating honey.

WWW.HONEYHEATERS.COM
Shannon Hodges 509-554-6561

Applications
- Melting Honey
- Separating wax from honey
- Warming syrup in barrels & totes
- Warming syrup storage tanks

Sizes
- 55 gallon drum heater
- 5 gallon bucket heater
- 275 gallon Tote Wrap
- 33 gallon Tote Wrap
- Custom designed wraps for larger storage tanks

INNER COVER

Nearly a quarter of our magazine this month highlights the 150th Birthday of both the USDA and the Morrill Act, that congressional mandate that created Land Grant Colleges in every state.

We have three exceptional stories that cover much of those historical events. Ms McNeil does as good an overview of both of these acts as could be done without writing a book – and I suggest she pursue that project now that she's done much of the research. Ann Harman takes a long look at the history and current status of the USDA ARS (United States Department Of Agriculture, Agriculture Research Service) Honey Bee Research Labs. We too often take these facilities and scientists for granted though they continue to work on our behalf, and they are one of our industry's too-limited contacts with the USDA. And Jennifer Berry examines the history and current status of just one Land Grant College, hers, at the University Of Georgia. We could have chosen any of the many Land Grant Colleges – Cornell, Maryland, Minnesota, Michigan – but Georgia has an especially interesting past, being the very first Public University in the country, favoring meritocracy over aristocracy, then later becoming part of the Confederacy and finally one of the last to get hooked up with the Morrill Act program. Combined, these stories explore much of our past, and share where we come from and what is happening today. It is worth your time to experience all of these.

I am especially beholden to both of these government programs. I graduated from UW Madison, Wisconsin's Land Grant College, and while an undergrad worked for four years for the State Entomology Extension Specialist for Small Fruit, Large Fruit, Turf, Ornamentals and Greenhouses. We covered a lot of ground...our standard response when asked what we did all year.

You will learn of the relationship between Land Grant Colleges and Extension in Ms McNeil's article. It has a rocky past, but they were a smooth running machine by the time I got there in the mid 70s. And it was certainly smoother then than today, with Federal and State Education funding tightening ever more every year.

But back then it was a wonderful place to be. My responsibilities covered pretty much everything that needed doing as far as backyard, field, bog, greenhouse, orchard, and golf course entomology research was concerned. I grew flower and vegetable gardens by the acre and tested pesticides galore on them (in the vernacular of the day I was one of the department's nozzleheads). I grew an All America Garden every year, produced blooming poinsettias in mid-summer to teach growers about insecticide damage, sprayed apple orchards for mite control, then counted mites to see if the sprays worked – heck, I was counting mites under a microscope 15 years before beekeepers were. I grew, sprayed, harvested and ate cranberries by the ton, produced ginseng as a crop, grew every kind of house plant, cut flower and greenhouse crop imaginable, saved the Greater Milwaukee Open one year when they had a turf problem they couldn't solve, and once, diagnosed a pumpkin field disaster as not a disease, but a lightening strike.

Back then the University, a State run business, working with Extension, a State and Federal hybrid, had a deal where the University deducted a portion of my Extension salary every month for University tuition so that by the end of a semester it was paid. Imagine two educations, one practical and one in the classroom, and no debt at the end of the day. I don't think you could find a better deal anywhere anymore.

We did our field work on aUniversity and Federal Experimental Farm on what was then the western edge of the city. It's gone now but at the time the farm had both university and extension programs going for agronomy, dairy and vet science, horticulture and we shared space with the USDA Honey Bee Lab that was there, too. They had several buildings with a honey house, offices, a well equipped shop, a small lab for grafting, a place to eat lunch and lots and lots of colonies, both on site in town and in nearby and far away outyards.

We, our Extension team, during the Winter it was just me, but during the Summer we had several students for Summer help, had a simple shed next to the Bee Lab. That's where we kept the tractor, rototiller and lots and lots of hoes, shovels, pruners and sprayers, so it was easy to work with them, and whenever anything broke, their mechanic, a talented and funny guy named Lester Whitefoot, fixed it for us.

When I graduated with a degree in Horticulture the Extension gig was over and it was time to get a real job. But the Bee Lab, run then by Dr. Eric Erickson, had just received a four year grant to study soybean pollination and they needed someone for those four years who could grow soybeans in a greenhouse, growing chamber, and in the field for them to study. It was easy to move from the

Covering Lots Of Ground

garage to the Bee Lab, and it was like I never changed jobs. Except for one thing – one of the requirements was that I had to learn beekeeping – to help out the rest of the crew there when they needed grunt labor. So for four years I did plant work and learned bee work – and you know, after those four years I never seriously looked back at the world of plants and greenhouses. And though they're still a part of what I enjoy, it's dealing with bees and beekeepers that I get to do, everyday. And every day I wonder how lucky can you get?

So now I've been immersed in that world for over 30 years, and I truly owe Mr. Lincoln and Mr. Morrill for a lifetime of unimagined joy and opportunity, certainly a debt I can never repay. But maybe what we've written here this time will help people new to the bee world appreciate all that we have. So Happy Birthday to The Department Of Agriculture and every one of the Land Grant Colleges. Here's to another 150 years of making lots of things better for us all.

•

I've been talking to a lot of commercial and sideline beekeepers lately, plus folks with smaller operations but a keen interest in what's going on with the bees, and some of the science folks at a few of those Land Grant Universities and USDA Bee Labs. I spend a lot of time on the phone, but not as much as I'd like when trying to gather in what's going on. When you put all of these conversations together, you get kind of a bigger picture, but often even that isn't as clear as I'd like. I want a 1000 pixel resolution that's National Geographic quality, and what I've got is 72 pixels good enough for the web.

But even so, when you look at what all that these folks are saying – and this group looks at "Bees" from a lot of different perspectives – what comes up is one word – unsustainable. How can beekeepers, whether 1, 10 or 10,000 colonies continue to keep bees when they have to keep splitting the splits they just split to keep numbers up. And for every one of the splits they'll have at least one, usually two or more queens during its very short life. Catch up splits don't make honey and they don't make money. And when it takes nearly $200 just to keep a working colony alive for a year, and you have to replace every colony two, three times, how long can that go on? Sustainable? This industry is no longer sustainable. And you can't keep that up for long.

•

We've got two other articles this month you should pay attention to. A few months ago Dr. Nick Calderone published the update on the Contributions Of Insect Pollinators to U. S. Agriculture. This was last done by Dr. Roger Morse and Dr. Calderone more than a decade ago. That original paper has probably the most quoted dollar figure associated with beekeeping ever published – it's that $19 Billion figure, the value of pollination you have heard a million times.

Dr. Calderone has updated the data collection techniques and other basics, and has divided pollinated crops into those requiring or benefiting directly from bee pollination (think almonds) and those that do not require pollination but that are grown from seeds that result from pollination (think cotton), plus 10% of the value of beef and dairy production resulting from the consumption of legume hay. The first, says Calderone, has a value of $16.35 Billion, that's with a "B", while the value of crops grown from pollinated seed is worth $12.65 Billion, again with a "B". When you remove the value of those crops pollinated by insects other than honey bees, think alfalfa leaf cutter bees, what remains is the value of honey bee pollination...and that figure is an even $20 BILLION.

Though the number seems to have not moved much, you have to realize the differences in how the data was considered – last time the value of the dairy and beef was added to the mix, not just 10% of the hay they ate. Still, $20 BILLION is a significant figure for JUST honey bees, and certainly worth making known.

When you calculate the total value of insect pollination, the figure is astounding – $29 BILLION. This is the first of several articles Dr. Calderone is sharing with us looking at the crops and the analysis for us. It is truly a landmark event, and when anyone who is concerned about what's happening to our pollinators, they now have a real world figure to use – $29 BILLION worth. That's what gets threatened every time a new pest or disease comes along, a different species of honey bee is inadvertently brought in from another country, or a new and uncharted pesticide is released upon the earth.

So, how was breakfast today?

•

Finally, there's a second installment in the 100th Anniversary of Scotland's Beekeeping Association. You might think it odd that we feature this, but with just a little digging you will find that thousands of people came to this country from Scotland, and with them they brought a long history of keeping honey bees. Their descendents are well represented in the U. S. Beekeeping community today, and their contributions have not been minimal. And besides, anybody that makes it to 100 deserves special recognition. So Happy 100 to all of you with a wee bit of Scot in your blood.

And last, but certainly not least all of us here at *Bee Culture*, Kim, Kathy, Dawn and Amanda wish you and yours a safe and happy Holiday season. Stay tuned for a lot of good things in the New Year – we're going to cover a lot of ground.

Kim Flottum

DECEMBER – REGIONAL HONEY PRICES

What difference does a year make? Take a look at December 2011 prices compared to today. Check out your region. Are you keeping up, or leading the way. Honey prices are outstepping most food items, and you should be taking advantage of this.

REPORTING REGIONS - 2011

	1	2	3	4	5	6	7	8	9	10	11	12	SUMMARY Range	SUMMARY Avg.	History Last Month	History Last Year
EXTRACTED HONEY PRICES SOLD BULK TO PACKERS OR PROCESSORS																
55 Gal. Drum, Light	1.72	1.90	1.72	1.51	1.74	1.72	1.68	1.70	1.79	1.75	1.67	1.70	1.51-1.90	1.72	1.82	1.56
55 Gal. Drum, Ambr	1.86	1.73	1.86	1.49	1.75	1.60	1.91	1.70	1.61	1.49	1.58	1.60	1.49-1.91	1.68	1.75	1.41
60# Light (retail)	149.00	161.00	162.00	145.25	159.00	156.67	143.86	151.25	127.50	139.80	158.00	182.50	127.50-182.50	152.99	146.10	130.59
60# Amber (retail)	155.00	151.00	167.00	150.60	162.00	160.00	138.00	146.67	141.00	144.61	154.33	177.50	138.00-177.50	153.98	142.47	125.45
WHOLESALE PRICES SOLD TO STORES OR DISTRIBUTORS IN CASE LOTS																
1/2# 24/case	63.36	77.43	54.00	61.80	69.65	60.00	52.48	72.00	69.65	56.00	58.50	87.87	52.48-87.87	65.23	62.51	61.60
1# 24/case	115.20	99.36	91.60	79.15	84.00	93.31	84.45	91.70	82.00	111.48	92.10	118.48	79.15-118.48	95.24	90.27	79.44
2# 12/case	94.30	81.51	85.90	81.33	88.00	86.32	96.00	90.00	81.25	86.16	76.50	88.50	76.50-96.00	86.31	73.81	70.89
12.oz. Plas. 24/cs	91.28	93.26	74.20	67.12	72.20	80.50	76.64	81.40	76.00	74.08	72.00	77.87	67.12-93.26	78.05	73.76	62.98
5# 6/case	141.00	98.51	89.20	78.68	96.00	118.00	91.81	97.00	82.00	88.98	87.19	99.33	78.68-141.00	97.31	83.44	79.29
Quarts 12/case	126.13	156.23	142.80	113.75	122.00	123.90	106.80	104.75	126.13	137.64	121.40	135.33	104.75-156.23	126.40	111.20	106.86
Pints 12/case	96.38	82.98	84.60	84.25	72.00	61.43	77.83	74.10	80.75	110.88	65.40	79.00	61.43-110.88	80.80	76.29	67.66
RETAIL SHELF PRICES																
1/2#	3.00	4.24	3.03	3.38	3.53	3.00	3.09	3.03	3.53	3.25	3.48	4.00	3.00-4.24	3.38	3.33	3.25
12 oz. Plastic	3.75	4.95	3.43	3.82	4.48	4.25	3.58	4.12	4.00	3.63	4.51	4.83	3.43-4.95	4.11	4.06	3.99
1# Glass/Plastic	5.50	5.74	5.49	5.95	5.04	5.70	6.52	5.57	5.00	5.13	5.28	7.44	5.00-7.44	5.70	5.40	4.80
2# Glass/Plastic	10.00	8.39	10.52	9.23	7.59	8.60	8.25	8.07	7.50	9.13	8.40	11.33	7.50-11.33	8.92	8.99	7.96
Pint	7.72	7.59	8.00	6.62	6.54	6.66	7.31	7.37	6.25	8.40	7.14	9.87	6.25-9.87	7.46	7.38	7.75
Quart	13.05	13.05	14.00	11.33	10.25	11.25	11.77	11.61	13.05	13.77	12.08	15.95	10.25-15.95	12.60	12.63	11.99
5# Glass/Plastic	23.75	18.89	25.22	18.70	23.00	22.00	17.62	20.83	21.00	16.22	18.99	23.00	16.22-25.22	20.77	20.62	18.63
1# Cream	6.75	6.74	6.80	6.15	6.75	5.85	6.17	6.62	6.75	6.17	6.99	6.95	5.85-6.99	6.56	6.10	6.26
1# Cut Comb	7.50	7.32	7.80	8.00	8.18	5.83	8.18	6.68	7.92	12.00	8.50	10.25	5.83-12.00	8.18	9.28	6.79
Ross Round	7.30	6.95	4.75	5.50	7.30	6.50	8.50	7.00	7.30	7.30	7.50	8.50	4.75-8.50	7.03	7.00	6.52
Wholesale Wax (Lt)	3.25	5.00	3.75	3.28	3.30	5.51	4.87	4.50	4.50	4.95	4.40	4.13	3.25-5.51	4.29	5.01	3.91
Wholesale Wax (Dk)	2.25	4.15	2.70	3.11	2.15	4.50	3.49	3.50	3.49	4.49	3.72	3.75	2.15-4.50	3.44	3.97	3.37
Pollination Fee/Col.	90.00	112.50	75.00	44.50	55.00	66.67	56.14	75.00	88.58	88.58	58.00	103.75	44.50-112.50	76.14	80.28	81.98

REPORTING REGIONS - 2012

	1	2	3	4	5	6	7	8	9	10	11	12	SUMMARY Range	SUMMARY Avg.	History Last Month	History Last Year
EXTRACTED HONEY PRICES SOLD BULK TO PACKERS OR PROCESSORS																
55 Gal. Drum, Light	1.85	2.10	1.85	1.61	1.83	1.81	2.07	2.00	1.85	2.05	1.93	2.00	1.54-2.10	1.89	1.87	1.72
55 Gal. Drum, Ambr	1.78	2.03	1.78	1.62	1.73	1.70	2.00	1.85	1.55	1.78	1.84	1.93	1.50-2.03	1.80	1.73	1.68
60# Light (retail)	192.50	182.00	150.00	158.20	160.00	160.00	166.50	155.00	125.00	138.00	116.00	201.67	100.00-240.00	165.64	158.93	152.99
60# Amber (retail)	176.67	170.00	150.00	162.33	160.00	146.25	171.75	140.00	125.00	154.70	118.75	182.50	90.00-215.00	156.91	152.90	153.98
WHOLESALE PRICES SOLD TO STORES OR DISTRIBUTORS IN CASE LOTS																
1/2# 24/case	72.71	90.82	48.00	66.87	72.75	56.25	51.98	72.75	72.75	49.92	67.92	90.00	37.20-120.00	66.89	63.58	65.23
1# 24/case	113.98	124.74	115.50	85.53	117.00	106.13	84.42	86.40	76.00	120.80	95.94	122.73	72.00-212.00	105.10	101.46	95.24
2# 12/case	113.72	86.01	78.60	76.00	84.00	82.96	80.47	96.51	63.00	86.16	103.00	101.27	62.00-144.00	90.03	89.57	86.31
12.oz. Plas. 24/cs	101.79	99.22	63.10	76.40	72.00	75.20	67.06	71.40	66.00	64.08	84.30	81.60	48.00-144.00	80.39	80.31	78.05
5# 6/case	122.85	101.49	93.00	84.23	105.00	91.25	92.35	84.80	72.00	88.98	108.25	111.00	62.50-150.00	98.44	105.81	97.31
Quarts 12/case	170.00	201.94	144.14	113.90	102.00	103.10	106.65	105.00	144.14	108.96	103.00	133.33	60.00-275.00	120.77	118.35	126.40
Pints 12/case	85.50	95.65	96.00	77.75	78.00	64.57	75.28	59.70	60.00	111.00	66.60	78.00	40.00-144.00	75.95	78.01	80.80
RETAIL SHELF PRICES																
1/2#	4.38	4.81	3.30	3.70	4.06	3.66	3.22	2.59	4.06	3.25	3.73	5.00	2.15-6.50	3.80	3.65	3.38
12 oz. Plastic	6.30	5.28	4.14	4.15	5.25	4.36	3.90	3.21	4.25	4.44	4.96	5.10	2.99-8.00	4.64	4.57	4.11
1# Glass/Plastic	6.51	6.31	6.51	5.33	6.25	6.55	4.73	4.36	5.50	5.96	5.93	8.08	3.00-10.00	5.97	5.88	5.70
2# Glass/Plastic	11.58	9.74	10.97	8.85	10.00	9.77	8.20	6.44	8.50	9.57	8.79	13.33	5.50-15.00	9.66	9.54	8.92
Pint	7.75	8.99	10.85	7.10	6.50	7.88	8.46	5.76	5.00	7.08	8.02	9.44	4.00-15.00	7.95	7.62	7.46
Quart	14.33	17.32	15.11	12.13	12.00	11.31	11.36	10.97	15.11	13.65	11.38	16.26	7.00-28.00	12.71	12.45	12.60
5# Glass/Plastic	25.38	20.78	24.10	21.33	25.00	25.00	20.09	18.99	23.39	19.00	20.27	25.00	14.35-36.00	21.60	20.43	20.77
1# Cream	9.77	7.74	8.10	6.61	7.58	5.75	6.09	5.59	7.58	5.04	8.04	8.25	4.00-12.00	7.16	6.85	6.56
1# Cut Comb	9.93	7.65	8.60	6.13	8.71	7.33	7.28	6.50	8.71	9.25	9.50	13.60	3.00-15.00	8.43	8.63	8.18
Ross Round	8.11	5.98	8.19	6.27	7.31	7.00	6.00	7.31	6.50	7.25	10.17	7.20	3.00-12.00	7.12	7.67	7.03
Wholesale Wax (Lt)	5.40	5.23	4.60	3.74	4.00	4.69	5.37	5.00	5.00	8.00	3.13	4.50	1.75-8.00	4.65	4.57	4.29
Wholesale Wax (Dk)	5.75	4.82	4.60	3.53	2.90	4.50	5.16	4.35	4.35	4.35	2.57	4.00	2.00-7.00	4.19	4.08	3.44
Pollination Fee/Col.	83.00	108.00	83.33	56.00	90.00	63.75	54.60	88.34	88.34	88.34	90.00	103.33	35.00-165.00	76.68	78.58	76.14

It's Summers Time –

Hurricanes And Holidays

We had a "Sandy" adventure this week. Of course, nothing compared to the folks on the east coast, but we had more wind and water than I've seen in a long time. I was very surprised. I thought we would be far enough removed, but northeast Ohio felt a good bit of Hurricane Sandy's force. Flooded roads, power outages, down trees (some landing on homes), school cancelled. And cold and damp and wet. It started raining on Friday and didn't stop until Thursday afternoon.

We discovered that with gale force winds coming straight at the windows, the chicken coop got a little damp on the inside. But the girls stayed nice and dry and weathered the storm. The most bothersome thing to them was that they couldn't go outside. Every morning they wait by the door that goes out to the pen. They love being outside. Today is day six of not going outside and they seem to have adjusted to the new routine. The coop now has plastic on the windows, we've installed another perch up high, so there is room for all 12 without being crowded. There is straw all over the floor and they have plenty of room to mill around and not be in each other's way. Not as much room as outside, but enough room. This is the first Winter for us and the chickens so it's a learning experience for me and them. I'll have to be more diligent about cleaning the coop, making sure there are no more leaks, making sure they are warm enough on those really cold Winter nights. And just spending time talking to them. Not as comfortable and easy to do in the Winter, but not terrible. They are very social creatures. They start talking as soon as they hear me whistle.

We're getting on average nine eggs a day, so my holiday baking this year will include fresh eggs. Hopefully with artificial daylight we can keep that going all Winter. It's such a treat to have fresh eggs. There really is a difference.

I have mixed feelings about Winter in Ohio, yes, even after 30+ years of living here. I don't mind the cold and don't even mind the snow so much – if I just don't have to drive in it. I've never mastered being comfortable driving in snow and icy conditions. So if I don't have to drive anywhere I'm quite happy. My children learned to drive in Ohio so they are not bothered by it – in fact it's hard to get them to stay home even when it's really treacherous. And of course Kim learned to drive in Wisconsin so he is the master of driving in adverse Winter conditions.

Otherwise I love Winter, especially the holidays. Our Thanksgiving meal is sometimes not very traditional and some years not even on Thanksgiving Day. It depends on how and where adult children have to split their time. And sometimes it's meatloaf instead of turkey. It depends on the mood we're all in. This year it's looking like turkey, actually on Thanksgiving Day. And we almost always have extra children around our table. That to me is the best part, including someone who maybe doesn't have parents close by or for whatever reason needs a family to be with.

Then shortly after 'Turkey Day' the Christmas tree goes up. I like to enjoy it for as long as I can. And the radio station I listen to starts playing Christmas music continually until New Year's Day. I love it. It drives others around me a little crazy, but I really enjoy it.

I try my best to keep the Christmas season calm and relaxing. I do some baking which I enjoy, but I don't go crazy like some folks I know to the point where they dread it. And this season opens up the door for more volunteer opportunities. Lots of hungry, lonely and misplaced adults and children. A couple of years ago I did something I had never done. I spent an afternoon ringing the bell for The Salvation Army. It was cold and damp, but it certainly lifted my spirits to see the giving side of folks. We stood in front of a small grocery store here in town and I have to say the bucket was filled several times that day. And I spent time with a friend. What could be better!

Christmas Eve and Christmas Day my ultimate goal is peace and calm. The last few years we've started a new tradition of opening gifts on Christmas Eve because this made it easier for those adult children who have several places to visit on Christmas Day. So a simple meal and off to the Christmas Eve service at church, my favorite part of the day. It's one of the few times we all make it there together. And the California son will be coming home this year for Christmas, so an extra blessing.

I wish you all a wonderful holiday season filled with family, friends and peace.

Kathy Summers

A Closer Look

STIMULI TRIGGERING HYGIENIC BEHAVIOR

Clarence **Collison**
Audrey **Sheridan**

The efficiency of hygienic behavior is affected by the ability of bees to recognize infected or infested brood by chemical and physical cues.

Worker honey bees that perform hygienic behavior have the ability to detect, uncap, and quickly remove brood infected with bacterial (*Paenibacillus larvae*, American foulbrood) and fungal diseases (*Ascosphaera apis*, chalkbrood) from the broodnest before the pathogens sporulate (produce spores) (Woodrow and Holst 1942; Rothenbuhler 1964). They also uncap and remove a portion of brood infested with the parasitic mite *Varroa destructor* (Boecking and Drescher 1992; Spivak 1996). This behavior limits the spread of infection, and reduces the reproductive potential of mites.

Hygienic behavior is performed by bees between 15-20 days of age and prior to foraging (Arathi et al. 2000). The efficiency of hygienic behavior is affected by the ability of bees to recognize infected or infested brood by chemical and physical cues. Gramacho and Goncalves (2009) found great variability in the sequence of behaviors associated with hygienic behavior. Within two hours after the cell capping is perforated with a pin, perforating the brood inside, the workers detect the dead or injured pupa and start to make small holes in the brood cell capping which is the beginning of hygienic behavior. Uncapping of the dead brood cell reached maximum values from four to six hours after perforation; after 24 hours, practically all cells were already uncapped. Another variable, called brood partially removed, was analyzed four hours after perforation, after the cells had been perforated, which involved uncapping, followed by partial or total removal of the brood. Maximum values of brood partially removed were found 10 hours after perforation, though such cells could be found up to 48 hours after perforation. The most frequent sequence of events in both colonies was: capped cell – punctured cell – brood partially removed – empty cell.

Early work on the genetics of hygienic behavior proposed that the trait was controlled in a Mendelian manner by two recessive loci (Rothenbuhler 1964). Gramacho and Goncalves (2009) proposed a new model of three pairs of recessive genes (uncapping u1, u2 and remover r) in order to explain the genetic control of hygienic behavior. Another study, however, using molecular techniques and quantitative trait loci (QTLs) suggested there may be at least seven QTLs associated with hygienic behavior, each controlling 9-15% of the total phenotypic variance (Lapidge et al. 2002). Thus, hygienic behavior is probably inherited in a more quantitative manner than once thought. In addition, the expression of the behavior can be variable both on a colony and individual bee level. The rapidity and efficiency of the removal of abnormal brood can be influenced by resource conditions (Thompson 1964; Momot and Rothenbuhler 1971) and by the percentage of bees in the colony capable of performing the task (Arathi and Spivak 2001).

"Differential olfactory sensitivity and responsiveness among hygienic bees could lead to the apparent partitioning of the behavior into uncapping and removing components."

"Among the various factors that have been studied that could influence the detection of cells with dead or diseased brood, visual cues have not been investigated."

Gramacho and Spivak (2003) hypothesized that within a colony bred for hygienic behavior; there would be differences in olfactory sensitivity among bees of the same age. They predicted that bees that initiate the behavior by perforating and uncapping brood would have greater olfactory sensitivity to the odor of the diseased brood, and would be better able to discriminate between odors of healthy and diseased brood, compared to bees that complete the behavior by removing the brood from the uncapped cells. Electroantennogram recordings of 15- to 21-day-old bees from three colonies demonstrated that bees collected while uncapping dead brood had significantly greater olfactory sensitivity to all concentrations of diseased brood odor compared to bees collected while removing brood. Proboscis-extension reflex discrimination conditioning demonstrated that 15- to 21-day-old bees collected while uncapping discriminated significantly better and generalized significantly less between the odors of diseased and healthy brood compared to bees collected while removing brood, when the odor of diseased brood was rewarded, but not when the odor of healthy brood was rewarded. Bees collected while uncapping brood that had been pierced with a pin had significantly less olfactory sensitivity than bees collected while uncapping freeze killed brood, most likely because the pierced brood had greater stimulus intensity. Initiation of hygienic behavior depends on the olfactory sensitivity of the bee and stimulus intensity of the abnormal brood. Differential olfactory sensitivity and responsiveness among hygienic bees could lead to the apparent partitioning of the behavior into uncapping and removing components.

Three volatile compounds, collected from larvae infected with the fungal pathogen *Ascosphaera apis* and detected by adult honey bees, were identified by coupled gas chromatography-electroantennographic detection and gas chromatography-mass spectrometry (Swanson et al. 2009). Three compounds; phenethyl acetate, 2-phenylethanol, and benzyl alcohol, were present in volatile collections from infected larvae but were absent from collections from healthy larvae. Two field bioassays revealed that one of the compounds, phenethyl acetate is a key compound associated with *Ascosphaera apis*-infected larvae that induces hygienic behavior.

Among the various factors that have been studied that could influence the detection of cells with dead or diseased brood (Arathi et al. 2000), visual cues have not been investigated. Morais et al. (2010) examined the light transmittance characteristics of the cappings of brood combs to determine if it would be possible for bees to detect abnormal brood within capped cells using visual cues. Cell cappings from old and new brood combs from each of three colonies of hygienic and non-hygienic bee lines were removed and tested. These previously selected hygienic colonies had a mean of 99.8% hygienic behavior, while the non-hygienic colonies had a mean of 2.3% hygienic behavior. The cappings were fixed in a support device that permitted light passage only through the cappings. Cell capping light transmittance for non-hygienic bee lines was 2.4 times higher than for hygienic bees. The larger pore number and size in cappings in non-hygienic colonies was confirmed by scanning electron microscopy. They concluded that visual perception for bees to detect "damaged" brood and stimulate hygienic behavior is unlikely. Pores in the cell cappings could affect the efficacy of olfactory detection; however, they found the pores to be fewer and smaller in the cappings from old brood combs in hygienic colonies.

Spivak et al. (2003) hypothesized that hygienic behavior is mediated by olfactory cues: bees may detect the odor of diseased, parasitized, or dead brood under a wax-capped cell, which stimulates them to uncap and remove the cell's contents. The genetic predisposition for a heightened detection of abnormal brood odors, may, therefore, facilitate the expression of hygienic behavior in a colony. Because the neuromodulator octopamine plays a pivotal role in olfactory-based behaviors of honey bees, Spivak et al. (2003) examined whether bees bred for hygienic and nonhygienic behavior differed with regard to their octopamine expression and physiology. They compared the staining intensity of octopamine-immunoreactive neurons in the deutocerebral region of the brain, medial to the antennal lobes, between hygienic and nonhygienic bees (based on genotype and phenotype). They also tested how the olfactory responses of the two lines, based on electroantennograms (EAG's), were affected by oral administration of octopamine and of epinastine, a highly specific octopamine antagonist. Bees expressing hygienic behavior (irrespective of genotype) possessed octopamine-immunoreactive neurons that exhibited more intense labeling than same aged bees not performing the behavior. In bees bred for nonhygienic behavior, octopamine significantly increased the EAG response to low concentrations of diseased brood odor. Conversely, in bees bred for hygienic behavior, epinastine significantly reduced the magnitude of the EAG response, a reduction not observed in nonhygienic bees. Both lines of evidence indicated that octopamine has the potential to facilitate the detection and response of honey bees to diseased brood.

Hygienic behavior of *Varroa* mite-tolerant Africanized and susceptible Carniolan colonies was evaluated in Brazil by sham-manipulating or artificially inoculating 4175 capped worker brood cells with *Varroa destructor* mites or ants, or their odor extracts (Aumeier and Rozenkranz 2001). Both bee types expressed the hygienic components 'uncapping', 'removal of introduced mite/ant' and 'removal of brood' to the same extent and pattern. The similar response to dead mites of different origins and solvent-extracted mites indicates a minor role of scent or of movement of mites within sealed brood cells as releasers of hygienic behavior. However, application of dichlormethane-extract of mites increased the hygienic response compared to pure solvent alone. Hygienic reactions to mite infested brood cells must, therefore, be elicited by other signals, possibly by the detection of specific reactions or odors of the infested larvae or pupae.

The stimuli triggering hygienic behavior towards *Varroa* mite infested brood are olfactory cues emanating from cells containing infested brood. After confirming the capacity of bees to detect and empty mite-infested cells, Nazzi et al. (2004) studied the volatile chemicals released by artificially infested worker brood cells by means of SPME-GC-MS. The identified chemicals were then bioassayed by comparing the bees' hygienic behavior towards treated cells into which 1 µg of each compound was injected and control cells which received the solvent alone. Z-(6)-pentadecene significantly increased the number of cells emptied by the bees.

Varroa sensitive hygiene (VSH) is a genetic-based behavioral resistance, in which *Varroa*-infested pupae are removed from capped brood by adult bees (Harbo and Harris 2005; Ibrahim and Spivak 2006). Removal of a pupa begins with detection of an abnormal condition by hygienic bees. Eventually, the cell cap is perforated by a bee to expose the affected host, and the host is then usually removed from the brood cell. Sometimes, *Varroa* infested pupae that are uncapped are recapped without the host pupa being injured (Boecking and Spivak 1999; Aumeier and Rosenkranz 2001; Aumeier et al. 2000; Boecking et al. 2000; Arathi et al. 2006; Villegas and Villa 2006). The foundress mite may escape an uncapped brood

> *"Varroa sensitive hygiene (VSH) is a genetic-based behavioral resistance, in which Varroa-infested pupae are removed from capped brood by adult bees."*

cell before it is recapped, but she usually remains within the cell (Boecking et al. 2000; Aumeier and Rosenkranz 2001). Brood exposed to VSH bees for one week often have high mean percentages (>30%) of recapped brood cells (Harris 2008; Villa et al. 2009) and some colonies may have >90% of all brood recapped. Most of these recapped cells are not infested by *Varroa*, but approximately 20% of recapped cells can contain a mite (Harris 2008). Harris et al. (2012) found the VSH bees seem to target pupae with fertile mites (by either removing or by uncapping and recapping) over those with infertile mites by a 3:1 ratio. The biased removal of fertile mites suggests that some stimuli triggering VSH behavior are related to the presence of offspring within the brood cell. These odors could originate directly from the offspring (feces or cuticular hydrocarbons) or from increased damage (feeding wounds or viral transmission) to a host pupae caused by a family of mites. BC

References

Arathi, H.S. and M. Spivak 2001. Influence of colony genotypic composition on the performance of hygienic behavior in the honeybee, *Apis mellifera* L. Anim. Behav. 62: 57-66.

Arathi, H.S., I. Burns and M. Spivak 2000. Ethology of hygienic behaviour in the honey bee *Apis mellifera* L. (Hymenoptera: Apidae): behavioural repertoire of hygienic bees. Ethology 106: 365-379.

Arathi, H.S., G. Ho and M. Spivak 2006. Inefficient task partitioning among nonhygienic honeybees, *Apis mellifera* L., and implications for disease transmission. Anim. Behav. 72: 431-438.

Aumeier, P. and P. Rosenkranz 2001. Scent or movement of *Varroa destructor* mites does not elicit hygienic behaviour by Africanized and Carniolan honey bees. Apidologie 32: 253-263.

Aumeier, P., P. Rosenkranz and L.S. Goncalves 2000. A comparison of the hygienic response of Africanized and European (*Apis mellifera carnica*) honey bees to mite infested brood in tropical Brazil. Gen. Mol. Biol. 23: 787-791.

Boecking, O. and W. Drescher 1992. The removal response of *Apis mellifera* L. colonies to brood in wax and plastic cells after artificial and natural infestation

with *Varroa jacobsoni* Oud. and to freeze-killed brood. Exp. Appl. Acarol. 16: 321-329.

Boecking, O. and M. Spivak 1999. Behavioral defenses of honey bees against *Varroa jacobsoni* Oud. Apidologie 30: 141-158.

Boecking, O., K. Bienefeld and W. Drescher 2000. Heritability of the *Varroa*-specific hygienic behaviour in honey bees (Hymenoptera: Apidae). J. Anim. Breed. Genet. 117: 417-424.

Gramacho, K.P. and M. Spivak 2003. Differences in olfactory sensitivity and behavioral responses among honey bees bred for hygienic behavior. Behav. Ecol. Sociobiol. 54: 472-479.

Gramacho, K.P. and L.S. Goncalves 2009. Sequential hygienic behavior in Carniolan honey bees (*Apis mellifera carnica*). Genet. Mol. Res. 8: 655-663.

Harbo, J.R. and J.W. Harris 2005. Suppressed mite reproduction explained by the behaviour of adult bees. J. Apic. Res. 44: 21-23.

Harris, J.W. 2008. Effect of brood type on *Varroa*-sensitive hygiene by worker honey bees (Hymenoptera: Apidae). Ann. Entomol. Soc. Am. 101: 1137-1144.

Harris, J.W., R.G. Danka and J.D. Villa 2012. Changes in infestation, cell cap condition, and reproductive status of *Varroa destructor* (Mesostigmata: Varroidae) in brood exposed to honey bees with *Varroa* sensitive hygiene. Ann. Entomol. Soc. Am. 105: 512-518.

Ibrahim, A. and M. Spivak 2006. The relationship between hygienic behavior and suppression of mite reproduction as honey bee (*Apis mellifera*) mechanisms of resistance to *Varroa destructor*. Apidologie 37: 31-40.

Lapidge, K.L., B.P. Oldroyd and M. Spivak 2002. Seven suggestive quantitative trait loci influence hygienic behavior of honeybees. Naturwissenschaften 89: 565-568.

Momot, J.P. and W.C. Rothenbuhler 1971. Behaviour genetics of nest cleaning in honeybees. VI. Interactions of age and genotype of bees, and nectar flow. J. Apic. Res. 10: 11-21.

Collison/Sheridan Continued (7)

Morais, M.M., T.M. Francoy, I.E. Borissevitch and L.S. Goncalves 2010. A scientific note about spectroscopic analysis of honey bee brood comb cappings in hygienic and non-hygienic honey bee colonies. Apidologie 41: 531-533.

Nazzi, F., G. Della Vedova and M. D'Agaro 2004. A semiochemical from brood cells infested by *Varroa destructor* triggers hygienic behaviour in *Apis mellifera*. Apidologie 35: 65-70.

Rothenbuhler, W.C. 1964. Behaviour genetics of nest cleaning in honeybees. IV. Responses of F_1 and backcross generations to disease-killed brood. Am. Zool. 4: 111-123.

Spivak, M. 1996. Honey bee hygienic behavior and defense against *Varroa jacobsoni*. Apidologie 27: 245-260.

Spivak, M., R. Masterman, R. Ross and K.A. Mesce 2003. Hygienic behavior in the honey bee (*Apis mellifera* L.) and the modulatory role of octopamine. J. Neurobiol. 55: 341-354.

Swanson, J.A.I., B. Torto, S.A. Kells, K.A. Mesce, J.H. Tumlinson and M. Spivak 2009. Odorants that induce hygienic behavior in honeybees: identification of volatile compounds in chalkbrood-infected honeybee larvae. J. Chem. Ecol. 35: 1108-1116.

Thompson, V.C. 1964. Behaviour genetics of nest cleaning in honey bees. III. Effect of age of bees of a resistant line on their response to disease-killed brood. J. Apic. Res. 3: 25-30.

Villa, J.D., R.G. Danka, and J.W. Harris 2009. Simplified methods of evaluating colonies for levels of varroa sensitive hygiene (VSH). J. Apic. Res. Bee World 48: 162-167.

Villegas, A.J. and J.D. Villa 2006. Uncapping of pupal cells by European bees in the United States as responses to *Varroa destructor* and *Galleria mellonella*. J. Apic. Res. 45: 203-206.

Woodrow, A.W. and E. C, Holst 1942. The mechanism of colony resistance to American foulbrood. J. Econ. Entomol. 35: 327-330.

Clarence Collison is an Emeritus Professor of Entomology and Department Head Emeritus of Entomology and Plant Pathology and Audrey Sheridan is a Research Technician at Mississippi State University, Mississippi State, MS.

Managed Pollinator CAP
Coordinated Agricultural Project

RNAi For Treating Honey Bee Diseases

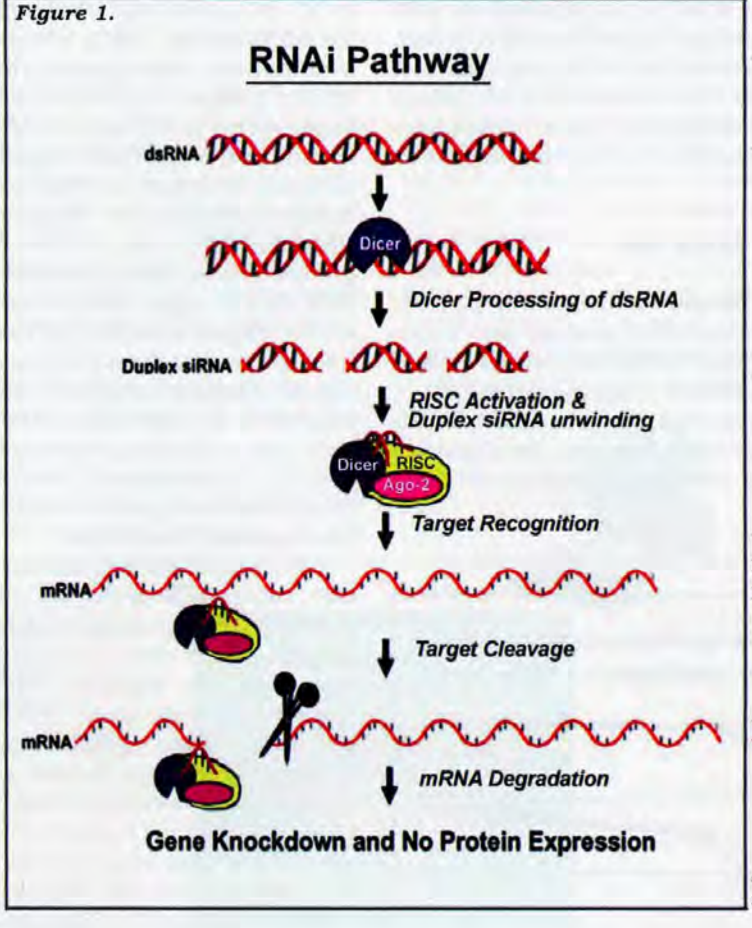
Judy **Chen,** Jay **Evans**

RNAi Looks Promising As A Tool For Combatting Honey Bee Pathogens & Paracites

1. Background

Many ground-breaking discoveries in science have occurred through serendipity. RNA interference (RNAi), a natural process to turn off gene activity in plants and animals is one of the many serendipitous discoveries that involved a mix of unexpectedness and insight that led to a valuable outcome. Back in the late 1980s, Dr. Rich Jorgenson, a molecular geneticist, and his colleague were trying to create a petunia with intensely purple colored flowers by inserting multiple copies of a purple color-producing gene into petunia plants. Surprisingly, the result turned out to be completely different from their expectation. Instead of achieving darker colored flowers, they got plants with white or patchy blossoms. At the time, no one quite understood why the addition of extra copies of an introduced gene silenced both themselves and the plant's own purple color producing genes. Later, Drs. Andrew Fire and Craig Mello pieced together the molecular machinery behind color alternations in petunias and identified an efficient mechanism of cells to regulate protein production at the RNA stage, a mechanism famously known as RNAi (Fire et al., 1998). The discovery of RNAi has been viewed as a major breakthrough in cell biology and Drs. Fire and Mello were awarded the Nobel Prize in Physiology or Medicine 2006 for their discovery of RNAi.

Figure 1.



2. RNAi Mechanism and Application

A gene is the functional unit of heredity in all living organisms. It consists of a specific section of DNA that holds the genetic information that each organism uses to pass genetic traits onto their offspring. The information held in this gene is converted into a protein that the organism can use in two steps. First, messenger RNA (nearly a mirror image of the gene) is produced after cues received by the organism's cells. This RNA is then used to direct the production of new proteins, the long stretches of amino acids that build bodies and actions.

RNAi is one tool used by cells to turn up or down the production of specific proteins. It is used both to weaken protein levels of the host itself and to knock down proteins from viruses and other agents that attack the host. As the Nobel prize winners discovered, the RNAi pathway is triggered by the presence of double-stranded RNA (dsRNA), an unusual event whereby RNA adheres to an exact mirror of itself. These dsRNA strands are recognized as being odd, and are consequently recognized by the appropriately named protein 'Dicer'. Dicer binds and cleaves long stretches of dsRNA into short fragments which are called short interfering RNA (siRNA).

Diced siRNA products are carried through the cell by a protein complex, finding their own matches in the RNA soup and degrading these matches. This degraded mRNA can no longer serve as a template for protein syn- ➪

Figure 2.

thesis and therefore a specific gene's activity is silenced (Figure 1).

The ability to target and switch off specific genes with high sequence specificity makes RNAi a powerful tool for studying gene function and a promising approach for treating a variety of diseases. Since RNAi can specifically inhibit the function of any chosen target genes, this technique can theoretically treat diseases that are caused by errant gene expression and protein function. In addition, it is known that RNAi has an appetite for RNA viruses along with other pathogens and parasites. In fact, the RNAi system might be maintained in large part as a defense against the many RNA viruses found in plants and animals. In order to reproduce, these viruses pass through a dsRNA stage, and that is when they appear on the Dicer's radar.

3. RNAi Application in Honey Bee Disease Treatment

Honey bees possess the core components of the RNAi pathway including Dicer and the enzymes and structural proteins that use 'diced' RNAs to hunt down and degrade matching RNA (review in Aronstein et al. 2011). As a result, RNAi looks promising as a tool for combating honey bee pathogens and parasites. Beeologics, a company focused on the discovery, development, and commercialization of RNAi therapeutics (recently acquired by Monsanto), has developed a product called Remebee, a dsRNA homologous to Israeli acute paralysis virus (IAPV) that was found to be associated with honey bee Colony Collapse Disorder (CCD) (Cox-Foster et al. 2007). The injection and feeding of Remembee has proven effective in reducing the abundance of IAPV in bees and promoting bee health under both laboratory (Maori et al., 2009) and large-scale natural beekeeping conditions (Hunter et al., 2010). Additionally, Beeologics scientists, along with USDA collaborators, have shown that RNAi can be directed at reducing the gut parasite, *Nosema ceranae* (Paldi et al., 2010).

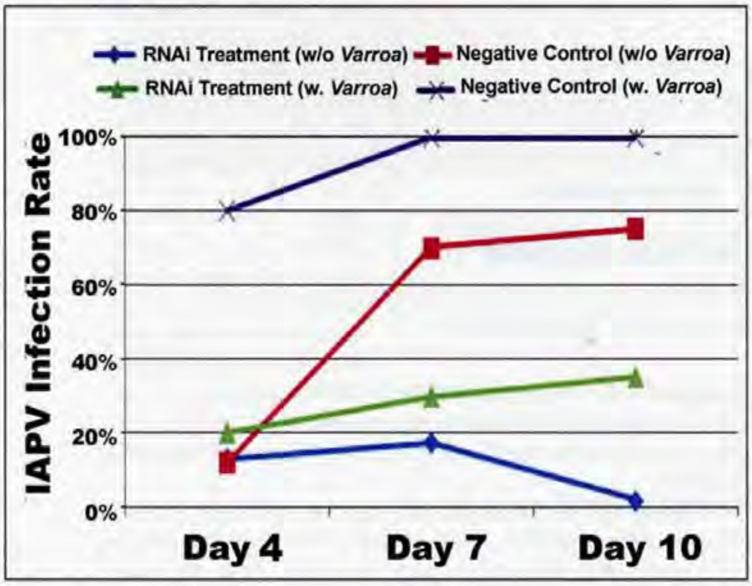
Recently, with CAP support, we conducted studies to further elucidate the antiviral effect of RNAi on the infection and replication of IAPV in honey bees. We targeted the IRES region of this virus, a key stretch needed to exploit the bees' own protein-making factory, the ribosome. To generate what we hoped was a more potent trigger for RNAi, we jumped past the dicing step by providing bees with siRNA that was ready to work as a bait for targeting viruses.

In our trials, the frames with emerging brood were removed from the colonies identified with IAPV infection by RT-PCR assay and newly emerged bees were collected the following day. Thirty newly emerged bees were placed into multiple rearing cages (Evans et al. 2009) as part of four groups. A 10 ml scintillation vial filled with 1:1 sugar syrup water mix was inverted over the top of the rearing cup to provision caged bees. *Varroa* mites were collected by sugar roll from a colony that was identified to have IAPV infection. Two groups were challenged with *Varroa* mites from an IAPV-rich colony, with one of these groups also receiving an siRNA cocktail directed at the IAPV IRES region (Treatment 1) and one receiving no siRNA (Negative control 1). Two groups were kept mite-free, with one of these receiving siRNA (Treatment 2) and one not (Negative Control-2). Each group consisted of four replicates. After setting up the experiment at day 1, the bees were collected at three-day intervals (day 4, day 7, and day 10) individually. We then measured virus levels using standard genetic techniques (Figure 2). The trial was repeated three times.

The results showed that the feeding of siRNA targeting IAPV could confer antiviral activity in bees (Figure 3). The IAPV infection rates in bees from Treatment-I and Treatment-II, which were fed with siRNA, were significantly lower than the Negative Controls without siRNA. The Negative Control-I group that was challenged by Varroa mite and received no siRNA reached 100% IAPV infection at day 10 post experimental setup. In the Treatment-II group, which was not exposed to *Varroa* mites, the siRNA treatment resulted in a very low or even undetected viral infectivity at day 10 post treatment.

Quantification of the IAPV titer in infected bees showed that bees in Treatment-II that received siRNA treatment and not exposed to *Varroa* mites had the lowest level of IAPV titer among four experimental groups. As a result, Treatment-II was chosen as a calibrator. The viral concentration of other groups was compared with calibrator and expressed as n-fold change. For bees from the Negative Control-I group challenged by *Varroa* mites and lacking siRNA treatment, the IAPV titer steadily increased over the whole experiment period and reached a maximum

Figure 3.



at day 10 post-treatment. The titer of IAPV in bees from Treatment-I was more than five-fold lower than in bees from Negative control-I (Figure 4). This result shows the feasibility of using siRNA to block or impair the translation of viral proteins to reduce virus replication, and reinforces the therapeutic potential of RNAi for treatment of honey bee diseases.

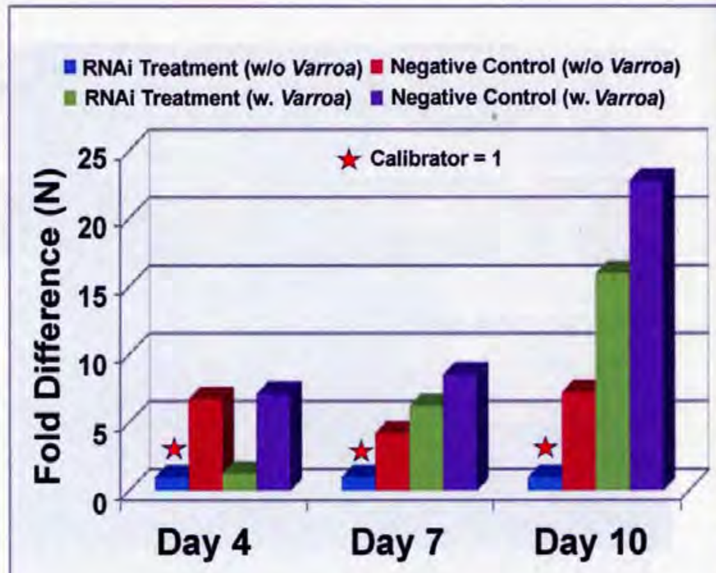


Figure 4.

4. Summary

Since its discovery over a decade ago, remarkable progress has been made in unraveling the molecular mechanisms associated with RNAi. Despite great potential for this remarkable process in disease control, many challenges remain, ranging from potential side-effects for the bee hosts to delivery challenges and even counter-counter-attacks by the viral targets. These unsolved problems must be overcome before RNAi is used routinely as a therapeutic agent for diseases. As the pace of new findings and discoveries of applications continues to gain momentum and genomic information of honey bees and critical honey bee pests and pathogens accumulate, we anticipate that RNAi will be an effective and non-toxic therapeutic alternative for the treatment of bee diseases in the future. BC

References

Aronstein, K., Oppert, B., Lorenzen, M.D. 2011. *RNAi in Agriculturally-Important Arthropods, in Book "RNA Processing" eds.* by Grabowski, P. pp. 157-180. InTech Publishers.

Cox-Foster, D.L., Conlan, S., Holmes, E., Palacios, G., Evans, J.D., Moran, N.A., Quan, P.L., Briese, T., Hornig, M., Geiser, D.M., Martinson, V., van Engelsdorp, D., Kalkstein, A.L., Drysdale, A., Hui, J., Zhai, J., Cui, L., Hutchison, S.K., Simons, J. F., Egholm, M., Pettis, J. S., Lipkin W. I. 2007. *A metagenomic survey of microbes in honey bee colony collapse disorder.* Science 318: 283-287.

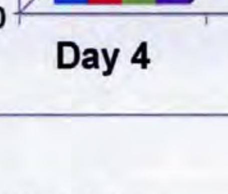
Evans, J.D., Chen, Y.P., Pettis, J., Williams, V. 2009. *Bee cups: Single-use cages for honey bee experiments.* J. Apicul. Res. 48: 300-302.

Fire, A., Xu, S. Q., Montgomery, M. K., Kostas, S. A., Driver, S. E., Mello, C. C. 1998. *Potent and specific genetic interference by double-stranded RNA in* Caenorhabditis elegans. Nature 391 (6669): 806–811.

Hunter, W., Ellis, J., vanEngelsdorp, D., Hayes, J., Westervelt, D., Glick, E., Williams, M., Sela, I., Maori, E., Pettis, J., Cox-Foster, D., Paldi, N. 2010. *Large-scale field application of RNAi technology reducing Israeli acute paralysis virus disease in honey bees* (Apis mellifera, *Hymenoptera: Apidae*). PLoS Pathogens 6 (12): e1001160.

Maori, E., Paldi, N., Shafir, S., Kalev, H., Tsur, E., Glick, E., Sela, I. 2009. *IAPV, a bee-affecting virus associated with Colony Collapse Disorder can be silenced by dsRNA ingestion.* Insect Molecular Biology . 18 (1): 55–60.

Paldi, N., Glick, E., Oliva, M., Zilberberg, Y., Aubin, L., Pettis, J. S., Chen, Y. P., Evans, J. D. 2010. *Effective gene silencing of a microsporidian parasite associated with honey bee* (Apis mellifera) *colony declines.* Appl Environ Microbiol 76: 5960–5964.



EPA BEE-N TO BAN SYSTEMIC PESTICIDES

Maryam **Henein**

Empty Hives Speak To EPA

About 100 activists, concerned citizens and beekeepers, including Congressman Dennis Kucinich (D-OH) and CCD spokesperson David Hackenberg huddled outside of the Environmental Protection Agency (EPA) headquarters on an overcast but mild mid-morning in late October to protest systemic pesticides that continue to slowly kill honey bees and humans. Many were adorned in black and yellow while others held signs that read "Save Our Hives."

On the street, a few yards away, David Hackenberg had parked his 40 ft. flatbed truck full of empty hives. At about noon, we hooked up a microphone and a small group took turns advocating the need to ban systemic pesticides.

"The EPA . . . continues to look the other way while Clothianidin and other systemic pesticides continue to harm our bees," said Jay Feldman Executive Director, Beyond Pesticides. "Bees have shown persistence in trying to hang in there and so will we. We need to impress upon the EPA that we are not going away."

One in three bites of food is reliant on honey bee pollination. As many of you may know by now, the unchecked use of dangerous systemic pesticides has resulted in alarming honey bee losses across America and the world. Colony Collapse Disorder was first reported in 2006 and despite six years of continued bee deaths, the EPA refuses to suspend their use. It's become normal for beekeepers to lose more than 30% of their honey bee colonies each year.

Clothianidin is especially dangerous because the U.S. is a corn nation. There are more than 88.2 million acres of maize growing in this country. Not only are 85 percent of those crops genetically modified, they are also treated with the systemic Clothianidin, meaning the poison gets taken up by the plant's vascular system and is expressed through pollen and nectar. And while corn is wind-pollinated, the bees do bring pollen back home when the corn tassels.

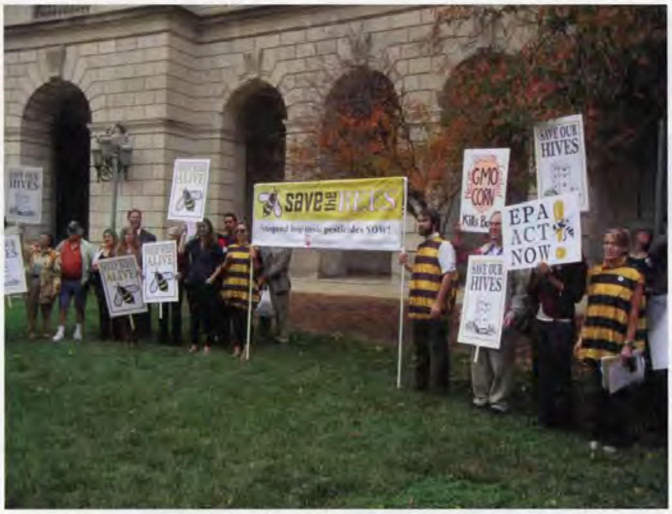
Furthermore, dust from the pesticide-coated seeds floats out over the countryside during planting. It lands on bees and other flowering plants and builds up over time in the soil.

The BeeLine

"We demand the EPA respond to the millions of Americans that have asked to remove this pesticide from our food system," stated Congressman Kucinich during the rally. He and his wife, Elizabeth keep a top bar hive in their garden. As vegans they do not eat the honey, but they appreciate the bee's role in pollinating their home garden. Elizabeth is also co-producing a film on GMOs. **www.GMOfilm.com**.

Following the rally, a small group including David Hackenberg, Jay Feldman of Beyond Pesticides and Peter

David Hackenberg



Jenkins, were invited to meet with Jim Jones. Not the rapper or cult leader but the Assistant Administrator for EPA's Office of Chemical Safety and Pollution Prevention (OCSPP).

"Despite all the studies out there, the Agency determined that they just don't agree with us on the science and that there is not sufficient information to conclude that pesticides play a significant role in 'bee difficulties'," said Feldman following the meeting. "I wish I had better news."

Consequently, the Center for Food Safety, Beyond Pesticides and the Sierra Club, along with affected citizens from around the country, filed a Sixty-Day Notice letter with EPA announcing their intent to jointly sue the agency for Endangered Species Act (ESA) violations. **http://www.centerforfoodsafety.org/2012/09/06/environmental-public-interest-groups-ready-for-legal-action-over-epa-approval-of-wildlife-endangering-chemicals/**

The planned lawsuit highlights EPA's continuing failure to ensure, through consultation with the U.S. Fish and Wildlife Service, that its numerous product approvals for the neonicotinoid insecticides clothianidin and thiamethoxam are not likely to jeopardize any Federally-listed threatened or endangered species.

In the nine years since the EPA conditionally registered Clothianidin for use on corn and canola, the agency has admitted to both the hazards of the insecticide and the need for compliance with ESA. The EPA fact sheet on Clothianidin reads

"Clothianidin is expected to present acute and/or chronic toxicity risk to endangered/threatened birds and mammals via possible ingestion of treated corn and canola seeds. Endangered/threatened non-target insects may be impacted via residue laden pollen and nectar. The potential use sites cover the entire U.S. because corn is grown in almost all U.S. states."

At the moment the EPA has until 2018 to review the safety of neonicotinoids for honey bees. BC

The Contribution Of Insect Pollinators To U.S. Agriculture

Nick **Calderone**

Introduction

Flowering plants (Angiosperms) play critical roles in many natural and agricultural ecosystems, providing food, fiber and shelter for wildlife and humankind alike. Pollination is an essential step in the reproductive process of the world's nearly 300,000 species of flowering plants because it is usually required for the production of seeds; but, just what is pollination and how does it differ from fertilization? **Pollination** is simply the transfer of pollen, bearing the male gamete, from the anther of a flower to the stigma of a flower (Fig. 1). After landing on a receptive stigma, a pollen grain germinates and a pollen tube develops, growing through the supporting style to the ovary. Genetic material in the pollen grain travels through the pollen tube to the ovary where it unites with an egg, the female gamete, in a process called **fertilization**. The fertilized egg develops into a seed, and that process may be accompanied by the development of fruit from surrounding tissue. For species that produce fruit, anywhere from one egg to several hundred eggs must be fertilized to ensure a high quality fruit because each egg requires a separate pollen grain for fertilization, and fruit will not develop in the area surrounding an unfertilized egg. Plants with incompletely pollinated flowers have fewer seeds and produce misshapen fruit with greatly reduced market value.

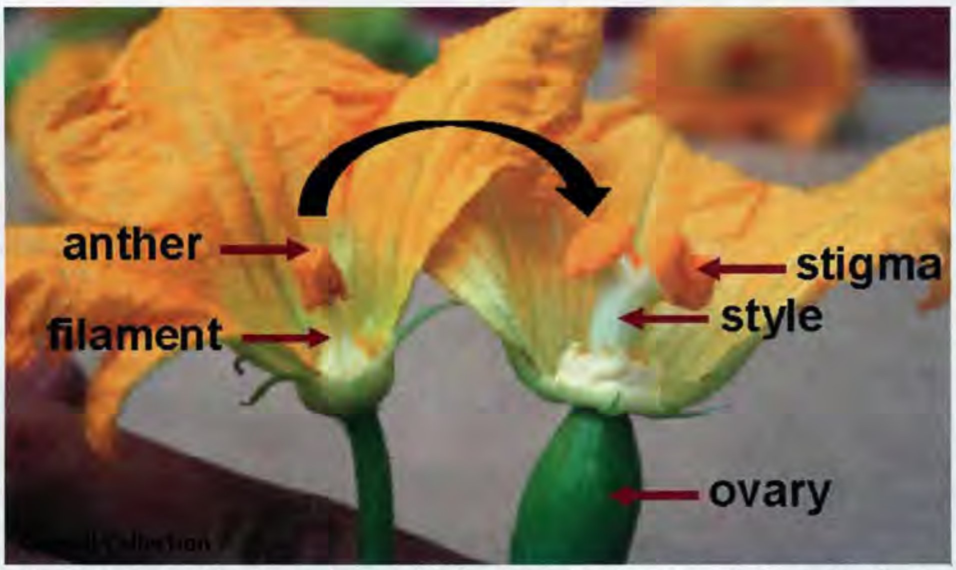


Figure 1. *Parts of the flower showing the filament and anther of a male flower (together referred to as the stamen) and the style and stigma of a female flower (together referred to as the pistil). Pollen lands on the stigma and a pollen tube grows through the style to the ovary.*

Animal pollinated crops include most of the fruits and vegetable you eat, or should be eating, on a daily basis to help maintain good health. In humans, high levels of fruit and vegetable consumption are associated with decreased risk of chronic disease. About 80% of the Angiosperms rely on animals, including bats, flies, butterflies, beetles and other insects for pollination. The majority of pollinators are insects, and the majority of those are bees (*Anthophila*), of which there are approximately 17,000 described species and as many as 30,000 species worldwide. With rare exception, bees collect pollen and nectar from flowers for food, transferring pollen in the process. North America is home to nearly 4,500 species of bees. Most are solitary, but there are 49 known species of the primitively social bumble bee in the U.S., 41 of which are also found in Canada; an additional 11 species are found in Mexico. The highly social western honey bee, *Apis mellifera*, was introduced to North America from Europe and Africa beginning in 1622. It is the only species of honey bee in North America; yet, for commercial agriculture, it has become the single most important pollinator.

Insect pollination contributes to agriculture in two ways. First, the production of many crops requires or benefits directly from pollination (directly dependent crops such as apples, almonds, cherries, oranges, squash, and vegetable and legume seeds: hereafter DD crops). Second, insect pollination is indirectly responsible for other crops that do not themselves require pollination but that are grown from seeds that do require pollination (indirectly dependent crops such as legume hay, sugar beets, asparagus, broccoli, carrots and onions: hereafter ID crops). Several studies over the years have reported on the value of insect pollination (see Insert 1 and Fig. 2). The variation in those estimates can be attributed to the different approaches taken by the various authors. Metcalf[1] reported the total gross value of a group of 30 insect pollinated crops deemed to depend 'almost exclusively' upon insects for production but did not differentiate among the contributions of honey bees, non-*Apis* bees and other insects. Levin[2] included the total gross value of crops that require or benefit directly from bee pollination (DD crops), the total value of crops that do not require pollination but that are grown from seeds that result from pollination (ID crops) plus 10% of the value of

Honey bees headed for pollination.

beef and dairy production resulting from the consumption of legume hay by cattle. Robinson, Nowogrodzki[3,4] and Morse and Morse and Calderone[5] present combined values for DD and ID crops but reduce the total gross values to reflect the estimated proportion due to honey bees; they do not include commodities further along the food chain. Southwick and Southwick[6] base their estimate of value on an analysis of supply and demand functions, defining value as "the surplus realized by consumers of these crops that would be lost if honey bees were depleted." Burgett, Rucker and Thurman[7] count only the value of pollination fees paid to beekeepers.

Here, I report the value of insect pollinators for both DD and ID crops for 2010. These data are an addendum to a larger study that examined trends in the contributions of insect pollinators to U.S. agriculture over the period from 1992 – 2009 that I will present in an upcoming article.

Methods

Data for production, cultivated area and the value of production for 2010 were obtained from the USDA National Agricultural Statistics Service (NASS). Cultivated acres were converted to hectares (1 hectare = 2.47 acres); production was converted to metric tonnes (1 metric tonne = 1.1 short tons)[1]; values are given in 2010 USD. Data for legume seed production and some other crops were not available, and this results in somewhat of an underestimate of the value of insect pollinators (see INSERT 2). I broke the data up into two major groups: DD crops and ID crops; and I further subdivided the two major groups into several subgroups of similar crops.

Crops depend to varying degrees on insects for pollination; and they vary with respect to their degree of dependence on honey bees and other insects for pollination. Dividing the value data between honey bees and non-*Apis* pollinators was based on published coefficients of dependency[3,4]. The portion attributed to non-*Apis* pollinators was calculated as the difference between the portion of total crop value attributed to all insect pollinators and the portion attributed to honey bees. In the case of ID crops, the assignment was based on the dependency coefficients for the production of the seeds used to produce those crops.

Results and Discussion

In 2010, the value of DD crops resulting from insect pollination amounted to $16.35 billion (Tables 1a and 1b) while the value of ID crops resulting from insect pollination was $12.65 billion (Table 2). Counting both DD and ID crops, insect pollination added more than $29 billion (2010 USD) to U.S. agricultural output in 2010. Both honey bees and other insects, primarily other bees, provided the majority of these services, although other insects played a role as well.

Increased production of DD crops due to honey bees was worth $12.4 billion (about 20.2% of the total value of DD crops) while the increased production of ID crops due to honey bees was $6.8 billion (about 33.5% of the total value of ID crops). Increased production of DD crops due to insects other than honey bees was worth $4.0 billion (about 6.5% of the total value of DD crops) while increased production of ID crops due to insects other than honey

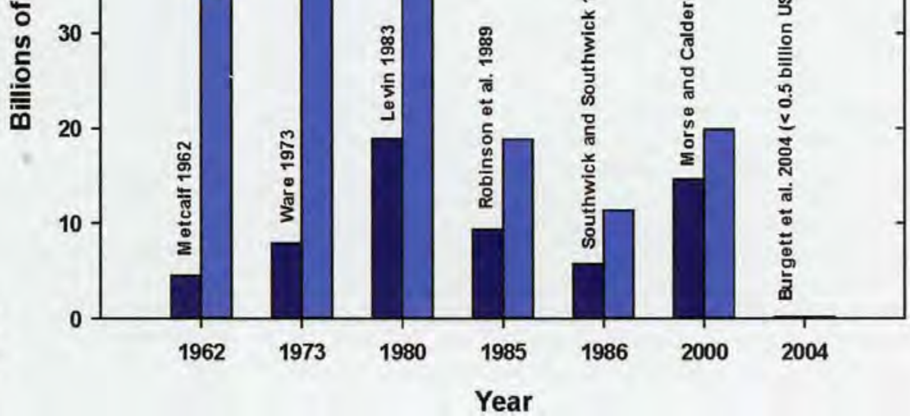


Figure 2. *Historical estimates of the value of honey bees to U.S. agriculture. See text for an explanation of what is included in each estimate.*

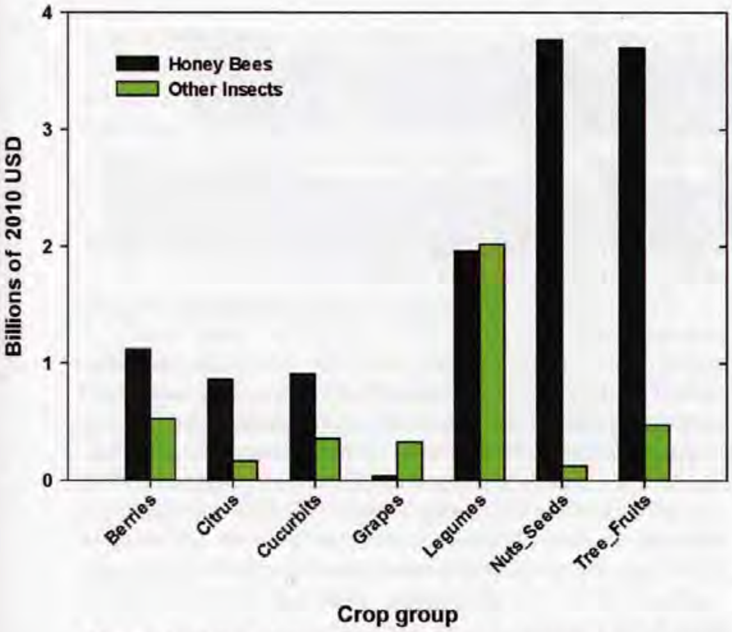


Figure 3. *Value of directly dependent crop groups due to honey bees and other insects.*

bees was worth $5.9 billion (about 28.9% of the total value of ID crops). The high value for the contribution of non-*Apis* pollinators to the value of ID crops is due to the role of the alfalfa leafcutter bee, *Megachile rotundata*, which is the primary pollinator of alfalfa seed used to grow alfalfa hay, a very high value crop. The aggregated data are broken down into a number of crop subgroups for both DD crops (Fig. 3) and ID crops (Fig. 4). In a future article, I will take a look at the contributions of individual crops to each of these smaller subgroups.

Two topics that influence efforts to calculate the contributions of insect pollinators to U.S. agriculture are: 1) the accuracy of the dependency coefficients for partitioning value among the various pollinators, and 2) the interpretation of value. With the exception of the coefficients for alfalfa seed and hay production, dependency coefficients used here come from Robinson, Nowogrodzki and Morse[3,4] who based estimates on a review of 275 studies conducted prior to 1989. To the degree that those estimates are sensitive to changes in management practices (e.g., selection of crop varieties; the use of pesticides, fertilizers and growth regulators; the size of fields or orchards) and local environmental factors (e.g., land-use patterns; the abundance and diversity of non-*Apis* pollinators), they may not reflect the current contributions of the various pollinator groups. In addition, the methodology of those studies was not usually designed to capture the contributions of non-*Apis* bees and other insects. Current research emphasizes the diversity and abundance of pollinator species combined with measures of blossom density, visits per blossom, pollen grains deposited per visit and yield. Such studies promise to increase the accuracy of our estimates of dependency coefficients in a variety of landscape situations and may well reveal a greater role for non-*Apis* pollinators.

The second topic involves the estimation of value. Most studies estimate the value of insect pollination as the increase in gross farmgate value over and above that expected in the absence of insect pollination. However, this method has certain limitations. It focuses on gross rather than net income; and it neglects to account for other inputs such as chemicals, fuel, equipment, labor, water and land. Dividing the value of a crop among the various inputs is more complicated than may first appear. Consider a hypothetical example. One may say that pollination accounts for 25% of the value of a crop, another may say that water accounts for 100% of the value of the same crop (no water – no crops), others that fertilizer accounts for 50%, and so on. You can see that the total claims made by the various inputs quickly exceed the actual value of the crop.

Further, this method differs from the way value is often used by economists because it does not account for the response of markets to changes in supply. If honey bee populations were reduced or eliminated, it is argued, markets would adjust through some combination of factors, including the use of alternative pollinators, changes in the price of goods, and other changes in grower and consumer behavior, until a new equilibrium is established. The actual value of honey bees would be the difference between the original farmgate revenues and the new farmgate revenues received after market adjustments had produced a new steady state. Take for example, the earlier estimate of $50 B by Levin[2] that included 10% of the production of beef and dairy resulting from the consumption of alfalfa hay. How much of this value would be lost if honey bees or leafcutter bees were not available? It is not an easy question to answer, but cattle ranchers would undoubtedly switch from alfalfa to a different feed. It may be more expensive, or less efficient, but any actual loss would be far less than the entire 10%. Therefore, a simple accounting approach provides only one perspective on value. It may be useful to think of value as used herein as an historical accounting of the additional gross revenues that have accrued to growers as a result of their having used honey bees, *caeteris paribus*.

A reduction in the availability of pollinators and pollinator dependent crops may have other consequences that are difficult to value. While a change in pollinator availability may lead to market adjustments involving changes in grower production and consumer consumption patterns, all such patterns are not equivalent. Assuming that current patterns without pollinator shortages reflect consumer preferences, changes in those patterns imposed by a loss of pollinators would necessarily reflect

Estimates Of The Value Of Insect Pollination To U.S. Agriculture

Because honey bees and other insects play a pivotal role in many agricultural cropping systems, several estimates of the value they contribute to US agriculture have been published (Fig. 1; billion = B): $4.5 B in 1957 (Metcalf), $7.9 B in 1972 (Ware)[8], $18.9 B in 1980 (Levin), $1.6 – 5.7 B in 1986 (Southwick and Southwick), $9.3 B in 1985 (Robinson, Nowogrodzki, Morse), $14.6 B in 1996-1998 (Morse and Calderone) and $150 million in 2004 (Burgett, Rucker and Thurman). Inflation adjusted equivalents (2009 USD) are $34.92 B (Metcalf), $41.21 B (Ware), $50.02 B (Levin), $18.85 B (Southwick and Southwick), $11.34 B (Robinson, Nowogrodzki, Morse), $19.84 B (Morse and Calderone) and $173.20 million (Burgett, Rucker and Thurman).

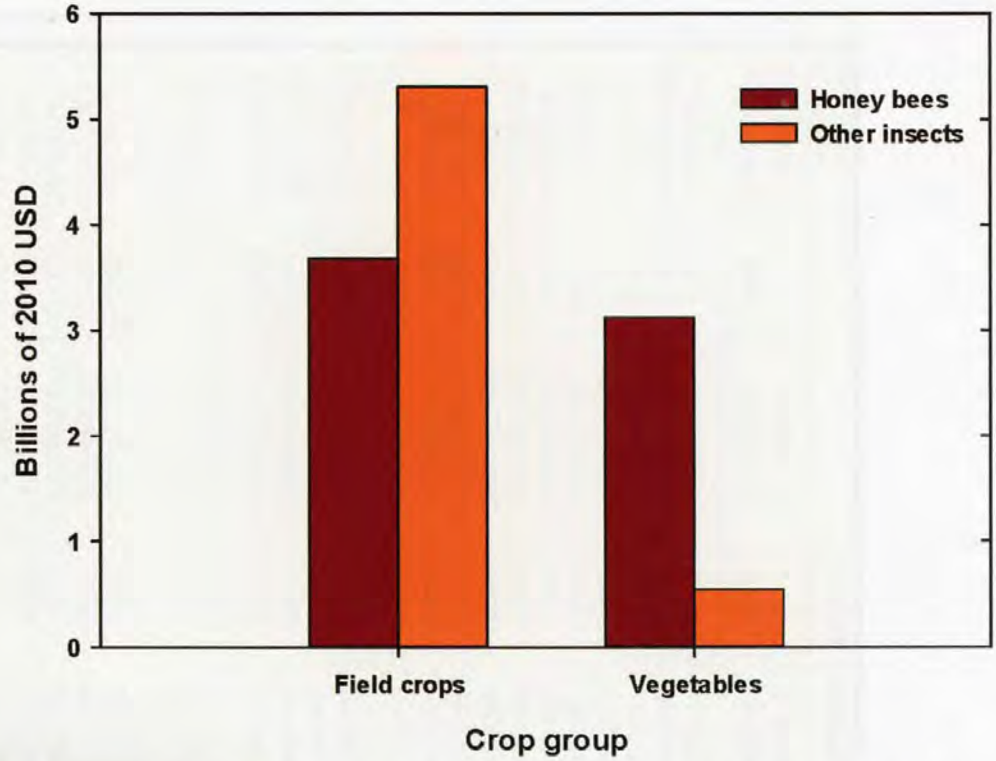


Figure 4. *Value of indirectly dependent crop groups due to honey bees and other insects.*

Bumble bees.

less desirable choices. Additionally, while the majority of calories are derived from crops that do not require animal pollination, the elimination of crops that do require animal pollination would result in a diet that is culturally impoverished and nutritionally inadequate due to a loss of micronutrients (see INSERT 3).

However one parses these issues, it is clear, that U.S. agriculture continues to have a significant need for insect pollinators; both honey bees and non-*Apis* pollinators. This bodes well for beekeepers who make a living providing pollination services for growers. In a future article, I will present data that show the trends in the production of animal-pollinated crops in the U.S. and that examines the effect of declining numbers of honey bee colonies on U.S. agriculture.

Sources Of Underestimates Of Current Estimates

Vegetable seeds: Data for vegetable seeds are no longer collected by NASS and are not included in any current estimates. Previous estimates attribute 100% of vegetable seed production to insect pollination, with 90% of that due to honey bee pollination and 10% to other insects.Morse and Calderone estimated that vegetable seed was worth an average of $61 million between 1996 and 1998. This could translate into an underestimate of $2.87 million (2010 USD) for DD crops for 2010, assuming no change in production.

Cotton lint: Cotton lint is produced from seed that requires insect pollination, making it a crop that benefits indirectly from pollination. However, lint production also benefits directly from having honey bees and other pollinators present during bloom. Therefore, value data are included for both direct and indirect contributions; however, to avoid duplication of data for production and cultivated hectares, those metrics are reported only as an indirect crop.

Tomatoes: Tomatoes are not included in the present study; however, fresh and processed tomatoes were valued at approximately $2.5 billion in 2009 (2.54 billion in 2010 USD) with some undetermined proportion due to non-*Apis* insect pollinators.

Bumblebees: Bumblebees are a major pollinator of many greenhouse crops, including tomatoes, peppers and some berries. They are also highly efficient pollinators of many field crops, including blueberries and cranberries (*Vaccinium* spp.). Bumblebees are available commercially, typically as nests of 150 or 300 workers or as 'quads' with 600 – 1,200 bees; however, national data on the economic contributions of wild and managed bumblebees are not available. This results in an underestimate of the value of insect pollination and the value of non-*Apis* pollinators in particular.

Table 1a. Statistics from 2010 for crops that require or benefit directly from insect pollination – Part I.									
Crop	**Production (1,000 tonnes)**	**Hectares (1,000s)**	**Total Value (1,000s $)**	**PIP**	**VIP (1,000s $)**	**PHB**	**VHBP (1,000s $)**	**POI**	**VOIP (1,000s $)**
Berries									
blackberry	20.50	3.04	33,291.00	0.80	26,632.80	0.90	23,969.52	0.10	2,663.28
blueberry [cultivated]	188.97	28.17	593,407.00	1.00	593,407.00	0.90	534,066.30	0.10	59,340.70
blueberry [wild]	37.65	9.31	50,600.00	1.00	50,600.00	0.90	45,540.00	0.10	5,060.00
Raspberry [black (OR)]	0.82	0.53	2,185.00	0.80	1,748.00	0.90	1,573.20	0.10	174.80
raspberry [red]	30.03	4.41	56,426.00	0.80	45,140.80	0.90	40,626.72	0.10	4,514.08
raspberry [all (CA)]	36.74	2.19	200,288.00	0.80	160,230.40	0.90	144,207.36	0.10	16,023.04
cranberry	308.99	15.58	316,486.00	1.00	316,486.00	0.90	284,837.40	0.10	31,648.60
strawberry	1,292.78	23.06	2,245,319.00	0.20	449,063.80	0.10	44,906.38	0.90	404,157.42
boysenberries	1.00	0.20	1,834.00	0.80	1,467.20	0.90	1,320.48	0.10	146.72
Citrus									
grapefruit	1,114.02	30.84	285,993.00	0.80	228,794.40	0.90	205,914.96	0.10	22,879.44
lemon	782.90	23.07	380,634.00	0.20	76,126.80	0.10	7,612.68	0.90	68,514.12
orange	7,439.82	260.13	1,934,982.00	0.30	580,494.60	0.90	522,445.14	0.10	58,049.46
tangelo	37.19	1.90	6,780.00	0.40	2,712.00	0.90	2,440.80	0.10	271.20
tangerine [and mandarins]	539.77	18.53	276,135.00	0.50	138,067.50	0.90	124,260.75	0.10	13,806.75
Cucurbits									
muskmelon [cantaloupe]	854.48	30.24	314,379.00	0.80	251,503.20	0.90	226,352.88	0.10	25,150.32
cucumber [fresh]	384.74	17.77	193,643.00	0.90	174,278.70	0.90	156,850.83	0.10	17,427.87
cucumber [pickled]	498.63	35.69	184,525.00	0.90	166,072.50	0.90	149,465.25	0.10	16,607.25
muskmelon [honeydew]	145.33	5.95	49,608.00	0.80	39,686.40	0.90	35,717.76	0.10	3,968.64
pumpkin	481.90	19.63	116,539.00	0.90	104,885.10	0.10	10,488.51	0.90	94,396.59
squash	296.74	17.60	203,592.00	0.90	183,232.80	0.10	18,323.28	0.90	164,909.52
watermelon	1,866.67	53.66	492,035.00	0.70	344,424.50	0.90	309,982.05	0.10	34,442.45
Grapes									
grape	6,726.05	383.52	3,626,760.00	0.10	362,676.00	0.10	36,267.60	0.90	326,408.40

*Data for 2010 from NASS; all values in 1000s of 2010 USD; PIP = proportion of production due to all insects; PHB = proportion of PIP due to honey bees; POI = proportion of PIP due to insects other than honey bees; VIP = value due to all insects; VHBP = value due to honey bees; VOIP = value due to insects other than honey bees

Table 1b. Statistics from 2010 for crops that require or benefit directly from insect pollination – Part II.

Crop	Production (1,000 tonnes)	Hectares (1,000s)	Total Value (1,000s $)	PIP	VIP (1,000s $)	PHB	VHBP (1,000s $)	POI	VOIP (1,000s $)
Legumes									
peanut	1,884.95	507.88	901,347.00	0.10	90,134.70	0.20	18,026.94	0.80	72,107.76
soybean	90,609.82	31,005.40	38,915,328.00	0.10	3,891,532.80	0.50	1,945,766.40	0.50	1,945,766.40
Nuts and seeds									
almond	1,282.58	299.47	2,838,500.00	1.00	2,838,500.00	1.00	2,838,500.00	0.00	.
Macadamia nuts	18.14	6.07	30,000.00	0.90	27,000.00	0.90	24,300.00	0.10	2,700.00
canola	1,111.73	579.11	486,865.00	0.50	243,432.50	0.90	219,089.25	0.10	24,343.25
cotton [seed]	5,616.38	.	1,003,861.00	0.20	200,772.20	0.80	160,617.76	0.20	40,154.44
rapeseed	1.89	0.89	975.00	1.00	975.00	0.90	877.50	0.10	97.50
sunflower	1,240.83	758.30	582,448.00	1.00	582,448.00	0.90	524,203.20	0.10	58,244.80
Tree fruits									
apple	4,219.13	140.00	2,220,817.00	1.00	2,220,817.00	0.90	1,998,735.30	0.10	222,081.70
apricot	59.33	4.92	47,486.00	0.70	33,240.20	0.80	26,592.16	0.20	6,648.04
avocado	135.44	24.25	322,108.00	1.00	322,108.00	0.90	289,897.20	0.10	32,210.80
cherry [sweet]	283.68	35.62	721,154.00	0.90	649,038.60	0.90	584,134.74	0.10	64,903.86
cherry [tart]	86.36	14.43	40,516.00	0.90	36,464.40	0.90	32,817.96	0.10	3,646.44
kiwifruit	29.66	1.70	24,961.00	0.90	22,464.90	0.90	20,218.41	0.10	2,246.49
nectarine	211.56	11.86	129,075.00	0.60	77,445.00	0.80	61,956.00	0.20	15,489.00
olive	176.90	13.35	113,360.00	0.10	11,336.00	0.10	1,133.60	0.90	10,202.40
peach	1,043.53	47.60	614,908.00	0.60	368,944.80	0.80	295,155.84	0.20	73,788.96
pear	738.09	23.07	381,695.00	0.70	267,186.50	0.90	240,467.85	0.10	26,718.65
plum	128.19	10.60	78,422.00	0.70	54,895.40	0.90	49,405.86	0.10	5,489.54
prune	343.37	24.69	149,860.00	0.70	104,902.00	0.90	94,411.80	0.10	10,490.20
prune and plum	10.98	1.24	4,915.00	0.70	3,440.50	0.90	3,096.45	0.10	344.05
TOTALS									
PART I + PART II	**132,318.25**	**34,495.46**	**$61,174,042.00**	-	**$16,344,809.00**	-	**$12,356,574.07**	-	**$3,988,234.93**

*Data for 2010 from NASS; all values in 1000s of 2010 USD; PIP = proportion of production due to all insects; PHB = proportion of PIP due to honey bees;
POI = proportion of PIP due to insects other than honey bees; VIP = value due to all insects; VHBP = value due to honey bees; VOIP = value due to insects other than honey bees

Table 2. Statistics from 2010 for crops grown from seeds that require or benefit directly from insect pollination.

Crop	Production (1,000 tonnes)	Hectares (1,000s)	Total Value (1,000s $)	PIP	VIP (1,000s $)	PHB	VHBP (1,000s $)	POI	VOIP (1,000s $)
FIELD CROPS									
alfalfa	61,600.57	8,075.91	7,519,469.00	1.00	7,519,469.00	0.33	2,507,286.13	0.67	5,012,182.87
cotton	3,987.51	4,332.85	7,317,704.00	0.20	1,463,540.80	0.80	1,170,832.64	0.20	292,708.16
VEGETABLES									
asparagus	36.24	11.33	90,777.00	1.00	90,777.00	0.90	81,699.30	0.10	9,077.70
broccoli	826.40	49.25	648,886.00	1.00	648,886.00	0.90	583,997.40	0.10	64,888.60
carrot	1,033.15	27.52	597,362.00	1.00	597,362.00	0.90	537,625.80	0.10	59,736.20
carrot	291.23	5.06	29,608.00	1.00	29,608.00	0.90	26,647.20	0.10	2,960.80
cauliflower	284.90	14.71	247,456.00	1.00	247,456.00	0.90	222,710.40	0.10	24,745.60
celery	920.11	11.53	398,854.00	1.00	398,854.00	0.80	319,083.20	0.20	79,770.80
onion	3,320.89	60.57	1,455,103.00	1.00	1,455,103.00	0.90	1,309,592.70	0.10	145,510.30
sugarbeet	28,980.02	467.70	1,968,389.00	0.10	196,838.90	0.20	39,367.78	0.80	157,471.12
TOTALS	**101,281.02**	**13,056.43**	**20,273,608.00**	.	**$12,647,894.70**	.	**$6,798,842.55**	.	**$5,849,052.15**

*Data for 2010 from NASS; all values in 1000s of 2010 USD; PIP = proportion of production due to al insects; PHB = proportion of PIP due to honey bees;
POI = proportion of PIP due to insects other than honey bees; VIP = value due to al insects; VHBP = value due to honey bees; VPOIP = value due to insects
other than honey bees

How Many Crops Do We Depend On for Our Food?

Despite all of the talk about pollination and the decline in pollinators, you may be surprised to know that most of the world's food supply and most of the world's calories are derived from crops that depend on wind or water for pollination or are propagated by vegetative means, that is, without pollination or fertilization. These staple crops, including rice, corn, wheat, barley, oats, millet, cassava, yams, sweet potatoes, coconuts and bananas, provide the bulk of the macronutrients in our diet: carbohydrates, protein and lipids. However, these crops are inadequate as sources of the many micronutrients needed for good health (e.g. vitamins, minerals, organic acids, phytochemicals including anti-oxidants). Hence, the animal-pollinated crops play a critical role in a healthy diet.

Acknowledgments

I thank Mark Jandricic for coding the crop database and for data entry. This article draws on the following article for most of its material: *Calderone NW (2012) Insect Pollinated Crops, Insect Pollinators and US Agriculture: Trend Analysis of Aggregate Data for the Period 1992–2009. PLoS ONE 7(5): e37235. doi:10.1371/journal.pone.0037235.* Funding for this project was provided, in part, by the Nation Honey Board. BC

References

1. Metcalf C, Flint W (1962) The value of insects to man. In: Metcalf C, Flint W, Metcalf R, editors. Destructive and useful insects. 4th ed. NY: MacGraw-Hill Book Co.
2. Levin MD (1983) Value of bee pollination to U.S. Agriculture [Apis mellifera]. Bull Entomol Soc Am 29 (4): 50-51.
3. Robinson WS, Nowogrodzki R, Morse RA (1989) The Value of Honey Bees as Pollinators of USA Crops. Part I of a Two-Part Series. American Bee Journal 129: 411-423.
4. Robinson WS, Nowogrodzki R, Morse RA (1989) The Value of Honey Bees as Pollinators of USA Crops. Part II of a Two-Part Series. American Bee Journal 129: 477-487.
5. Morse RA, Calderone NW (2000) The value of honey bees as pollinators of U.S. crops in 2000. Bee Culture 128: 15 pp insert.
6. Southwick EE, Southwick L, Jr. (1992) Estimating the economic value of honey bees (Hymenoptera: Apidae) as agricultural pollinators in the United States. Journal of Economic Entomology 85 (3): 621-633.
7. Burgett M, Rucker R, Thurman W (2004) Economics and honey bee pollination markets. American Bee Journal 144: 269-271.
8. Ware G (1973) Bees in agriculture: their problems and importance. Report on conference on "The indispensable honey bee" Feb 12-13: 28-38.

Pollen, Nectar & Propolis

Larry **Connor**

Seventh In A Series . . . Examine How These Materials Are Used In The Hive

What bee colonies gather. How they use these materials in the hive. How honey is collected, processed and stored. The chemistry of honey. Removing honey and pollen from the hive. Propolis stories new and old. Remove honey from a hive and extract it. Bottle honey. Storing honey.

Last month we discussed the home of the honey bee provided by humans, with emphasis in swarms, package bees and nucleus colonies. It is time to discuss the raw ingredients bees collect to help them survive: pollen, nectar, propolis and water.

Pre-teach: The source and role of these four materials.

In a discussion with your students, ask them what they know about nectar, pollen, propolis and water. Many people are familiar with honey, and a significant number know about pollen, either through the process of pollination, or the sale of the material in natural food stores. Relatively few people know the role propolis and water play in the welfare of the hive.

With the class, develop a chart that summarizes the following: the source of the material, the reason bees collect the material, and how the bees handle the material. Use the two references and the Internet to find reliable material.

Goldenrod pollen stored in the hive will serve the colony well during the winter as the bees need protein.

Material	Source of Material	Why bees need it	Materials handling
Pollen			
Nectar			
Propolis			
Water			

At the end of a class session, my version of this might look like this:

Material	Source of Material	Why bees need it	Materials handling
Pollen	anthers of flowers	Protein, vitamins	pollen basket packing into cells adding honey fermentation to bee bread
Nectar	nectaries, extra floral nectaries, any sweet source	Carbohydrate for energy, role in foraging and wintering	Special mouthparts, nectar sharing to ripen nectar, honey comb storage
Water	Any water source	Dilution of sugar, metabolism of food processing, cooling hive when hot	Like nectar, shared with other bees and deposited in empty cells
Propolis	Flower and leaf buds	Reduce drafts at entrance, cracks in hive. Seal nest chamber to control moisture, microbes	Use pollen collection equipment other bees help deposit the material.

One way to produce honey is to sell chunks of sealed honey. Beekeepers have various options. This beekeeper simply uses thin wax foundation and cuts out the sealed portions to put into containers for sale. The rest can be mashed and drained as liquid honey.

Honey chemistry

The water and sugar mixture most flowers produce in their nectaries contains sucrose, the same sugar many people use every day as a sweetener. The average flower produces nectar with about 40% sucrose and 60% water. But honey is usually about only 18% sugar and the rest water. There are two processes that bees use to change nectar into honey.

First, they must convert the sucrose in nectar to two simple sugars, glucose and fructose. To do this they add an enzyme called invertase. In the field, the forager collects nectar. As she does this she secretes invertase from her hypo-pharyngeal gland and adds it to the collected nectar in her honey stomach. This causes the sucrose in nectar to be reduced to two simple sugars, glucose and fructose. Water is needed to make this conversion.

Second, the bees reduce the moisture content of the nectar to below 19%. When a forager returns to the hive, she seeks a house bee (one that has not flown), and transfers the nectar to her. There are dozens if not hundreds of pairs of workers in a hive when the nectar is entering the colony. The field bee has carried the nectar in a special part of her body called the honey stomach. This not part of the actual digestive system, so it is not vomit. Instead, the bee transfers nectar from her honey stomach, and offers droplets of nectar to the waiting house bees. Once she has transferred the nectar she is able to return to the field. Otherwise she becomes one of the honey ripeners inside the hive.

These are usually younger bees that ripen honey. They rest quietly on the honey comb and expose a portion of transferred nectar to the warmer and drier air inside the hive. She repeats this process over a 20 minute period, so that she can place the nectar into empty cells in the hive. When the invertase-rich, moisture-reduced nectar is ready, she puts drops along the top of drawn but empty cells inside the honey chamber. This may be one reason why bees collect more honey when they have an abundance of empty drawn comb on the hive, because they have comb available for ripening. This honey continues to make the chemical conversion while in these cells. Exposed to the warm rising dry air of the hive, the moisture continues to evaporate.

Finally the worker bees move the honey to cells where the new honey from other foragers is being stored. A group of bees move this honey and use fresh beeswax to seal the cell at the top of the cell when it is full. A small space of air is often left between the honey and the sealing wax, giving the honeycomb a white appearance, but sometimes the wax is placed directly on the honey, giving the wax a wet appearance. Honey continues to ripen in the cells even when sealed with wax.

Pollen collection

Not many beekeepers collect pollen. It requires a pollen trap per hive and a good knowledge of the source of the pollen the bees are collecting, usually based on spending time in the field watching foraging bees, and matching the differently colored pollen pellets to the pellets collected in the pollen trap.

Pollen must be collected in a pesticide free area to make sure there are no chemical residues in the pollen pellets. This means that beekeepers near fruit and vegetable crops, corn, soybeans, cotton, and other pollen sources should not collect pollen while these plants are in bloom. Of course keeping bees near these crops is not a good idea generally since the pesticides aren't good for te bees, either. Many excellent pollen sources include mountain pollen, wet-lands pollen, and wildflowers growing in reserves where no pesticides are used.

Once collected, pollen pellets are knocked off the hind legs of the foragers as they return from the field and pass through a grid designed to do this. The pollen must be collected frequently by the beekeeper to prevent mold and pollen mites from ruining the pollen. Many beekeepers spread the pollen into trays to air dry for a few hours, screen the pollen to remove hive debris, and then pour the pollen into food approved containers and store in a freezer. This preserves the protein in the pollen. Dry pollen loses a great deal of its nutrient value in just a few weeks.

Small scale beekeepers should sell pollen in containers kept in a cooler at the farm market or other sales location. They should ask to put pollen in the freezer at a natural food store.

Human-made bee bread

A few beekeepers try to duplicate the work of the honey bee by adding honey to pollen to create an artificial bee bread. Try to make some of this by trial and error and do a taste test. Is this a product you think has market potential? A few beekeepers add small amounts of propolis soaked in alcohol to add an even more interesting product for the market.

Class, apiary and field activities

1. Observe samples of these four materials, and review the stage each is stored inside the hive. The nectar has been converted to honey and stored in the honey comb. The pollen has been converted to bee bread and is also stored in the honey comb, often under a layer of honey. The propolis is on the frames and wooden parts of the hive, and may be used to reduce the size of the entrance during Winter. There is little stored water in most colonies, as the water is in the bees' bodies or perhaps traces stored in empty cells or on top bars on a hot day. Bees to not keep water in the hive during most of the year. Water is an issue during the Winter when the water from honey metabolism condenses on cold surfaces inside the hive.
2. If the class has an apiary, or you are able to visit an apiary, inspect a hive and look for these materials, take samples of honey, pollen and propolis for examination in the classroom or laboratory.
3. Look at various methods of honey production (natural comb vs. foundation) and harvesting. Include a demonstration of honey extracting and compare it with the process of crushing combs to extract the honey.
4. Bottle honey from the apiary. Study the containers available for honey sale. Review the cost of the bee equipment, the bees, the labor of keeping the hives, and discuss what a fair price is for honey. Research what is needed to label honey, and restrictions on selling honey to the public without using a food approved honey extracting and bottling facility. If possible sell the honey to other students and family.
5. Look at honey that has been stored for a period of time. Is there crystallization? Is there fermentation? Review these natural processes.
6. Look at pollen collection and processing (cleaning). Discuss the importance of keeping human-collected pollen frozen to maintain the nutritional materials inside. Compare this with the fermentation process bees use by letting natural microbes ferment the pollen into bee bread.
7. Have each student design (and if able, setup) a bee watering device, perhaps a dripping hose or other outlet that flows into a rock garden or small pond filled with aquatic plants. Discuss the need for less than pure water by bees—in their search for minerals and trace nutrients.
8. Classroom teachers with access to microbiology equipment may want to compare a agar media with and without propolis added. Observe the growth of simple bacteria on plates with and without propolis.
9. Humans affect bees significantly. Look at each of the four materials and discuss how each of them can play a role that may or may not help the colony:
   a. Sweet liquids may be collected as nectar. Search the Internet for stories about cherry honey (from maraschino cherry syrup spilled on pavement),

neon honey (from a candy company) and black honey, collected around amusement parks from discarded soft drinks.

b. Many powdery materials are collected by bees, especially when there is little natural pollen available. Discuss the collection of sawdust, finely milled animal food (feed lots, bird feeders), and other situations.

c. Bees are attracted to the water of swimming pools, bird baths, and pet dishes. Discuss how you might eliminate or at least reduce this attraction.

d. Propolis is a resin, and there are human resins used in construction. Bees will collect window caulking from houses and potentially bring unnatural contaminates into the colony. Look for evidence of human-sourced materials in you samples of propolis.

Final discussion and Report

Ask students to write a short report on the way bees collect materials from their environment and use them to fullest advantage. Have them include the risk of bee hives in agricultural areas, in urban areas.

Or ask them to discuss the properties of honey and pollen in the marketplace, special needs for safe marketing, storage and maintenance. What are the responsibilities and risk of a beekeeper in selling either honey or pollen to others? BC

References

Caron, Dewey M., *The honey harvest and Honey and Other hive products,* Honey Bee Biology and Beekeeping, Wicwas Press, Kalamazoo, MI

Connor, Lawrence John, *Bee-sentials: A Field Guide*, Wicwas Press, Kalamazoo, MI

Vocabulary

Pollen, nectar, water, propolis, bee bread, nectar conversion, pollen packing, hive cooling, pollen gathering, nectar gathering, nectar ripener, food storage, honey chemistry, sucrose, glucose, fructose, anti-microbial, extracting, foundation, natural comb, pollen traps, pollen storage, fermentation of honey, crystallization of honey, enzyme, invertase, hypo-pharyngeal glands

Check out **www.honeybeespeak.com**. This offers a matching service for folks who speak about bees and beekeeping, and the groups who seek their services.

January is time for the Serious Sideliner Symposium, held as part of the American Beekeeping Federation Convention in Hersey, PA. The SSS is held on Thursday and Friday of the convention. If you are a small scale, sideline, or semi-commercial beekeeper, come and join us for the two-day event.

Two new Wicwas Press titles are Beekeeping Equipment Essentials, by Ed Simon, who has written for Bee Culture, and Bee-sentials: A Field Guide, by the author of this article.

HOW I DO IT –

Assemble Wooden Frames

James E. **Tew**

I sense that every year more and more plastic frames are sold. I use them, but wood frames are still the traditional favorite. They take time to assemble, but this task is a tradition of classic beekeeping. They smell of new wood and when first assembled look as nice as they ever will. I don't want to assemble thousands but I enjoy putting a few dozen together.

The public and especially reporters frequently refer to them as "racks. They are the wooden structures in which honey bees build comb thereby making a piece of comb rigid enough to handle and extract without fear of it breaking. Sounds simple enough. I mean how complicated could it be to put four pieces of wood together? In fact, it would not be very difficult if there were only one style of frame requiring one way of assembly. You know that is not the case. Frames come in different sizes and styles – all requiring their own little quirks of assembly.

Early frames were simple rectangular casings. The very earliest frames were nothing more than top bars with wavy pieces of comb attached which would break off very easily. It was a short step to add a stub on each end (later named end bars) and then finally, a bottom bar to add rigidity to the whole contraption. From that point, every conceivable shape and style seemingly has been tried. Of that total number, only a few have survived and are available from bee supply consortiums today. Up until about 30 years ago when plastic frames made their debut, one thing all frames had in common was that they were made of wood. Plastic frames are used extensively now, especially in the commercial industry, but they have not yet replaced wood in traditional popularity. Though I have seen foundation and artificial comb made from aluminum, I don't recall ever having seen frames made from any type of metal. Aluminum comb was a failure because wintering bees could not keep it warm. From its exposed edges, aluminum comb drew coldness into the cluster area. No metal frames have been tried of which I am aware. If any readers should know of such an experiment, please let me know the particulars.

FRAME COMPONENTS

The Top Bar

The top bar can be either thick (¾") or thin (3/8"). All manufactured top bars are 18-7/8" to 19" long and are 1-1/16" wide. Though still usable, the variation in length is just enough to cause a bit of confusion if equipment from different manufacturers is mixed. Thin top bars are only used for comb honey production and may be slotted or solid and are part of a specialty frame so not commonly seen. Thick top bars, with a wedge for attaching foundation, are the frames most commonly seen. Occasionally, a grooved thick top bar may turn up. These are used in conjunction with a grooved bottom bar and are intended to support either plastic or plastic-centered foundation. Also, hookless, crimp-wired foundation can be used with a grooved frame. Plastic foundation or foundation inserts are readily available, too.

The Bottom Bar

Bottom bars can be either split, two-pieced, grooved, or solid. Two pieced bottom bars are probably the most common, but I can't say that it's any better than the other styles. All require the same amount of fastening. Be sure to get the appropriate foundation for the type of bottom bar that is to be used.

The End Bar

Except for length and cuts required to accept the bottom bar, the end bar is dimensionally standard. Nearly all end bars are 3/8" thick and are scalloped half their length on both edges to allow bee movement between frames.

Thin top bars compared to regular top bars.

ASSEMBLING A FRAME

Okay. What are we talking about here? Are we talking about putting 10 frames together or 500? If only a few frames need assembling, clear off a spot in the garage and have at it. On the other hand, if a large number of frames will need assembling, or if this will be an on-going process, arrange for a designated spot, get empty supers together to organize assembled frames, have a comfortable stool, and have all the necessary parts within easy reach. A radio to help time pass is really a nice addition. Anything beyond 10 frames can become mind-numbing.

For many years, bee supply manufacturers made end bars that had one side beveled, and the other side flat. Though end bars are not commonly made any more with the chamfered edges, it would not be unusual to come across some end bars needing assembly or repair. Here is my rule of thumb. Put your left thumb either in or on the wedge in the top bar. Put your right thumb on the chamfered bevel on the end bar and then force the end bar onto the top bar. The cuts in the top bar intended to receive the end bar are obvious. Rotate the top bar and again, with you right thumb on the chamfered bevel, put the other end bar on the top bar. In this manner, end bar edge bevels will be on opposite sides of the top bar. The purpose of the bevel was to reduce contact between end bar edges. A bevel was supposed to be positioned next to a flat edge, so only a minimum of contact was made, and propolis wouldn't be a problem.

Glue

It helps greatly if the end bars are glued to the top bars using wood glue. Though it has not been discussed yet, gluing bottom bars to the end bars is also a great idea and doesn't take but a minute. Another point for consideration is that we are only putting this frame together one time. So gluing or cross nailing is fine with me. If a frame is put together correctly the first time and is used properly, it will last indefinitely. Many times beekeepers don't want to construct a frame in such a way that it cannot be repaired in future years. I suspect that the usable life of most frames is about seven years. I would rather just replace the injured frame than try to cobble up a repair job. Now back to the assembly job . . .

With both end bars stuck to the top bar, glue oozing out, drive two 1¼" nails (18 gauge) through the top bar into the end bar. Proper nails are normally included in the deal when buying frames, but not always. Occasionally, some species of pine may be used that is difficult to drive nails through. It will add more time to the assembly process, but clip the head off one of the frame nails and use it as a drill bit to bore pilot holes. Pilot holes also help people who are not schooled in advanced hammering. Use a light hammer with something like a six ounce head. Tack hammers are too light while common nail hammers having 12, 16 or 20 oz heads are too heavy. After hammering two nails through the top bar into each end bar, flip the frame over, dab glue in the end bar slots and install the bottom bar – again probably a two piece bottom bar. Using four one-inch nails, secure the bottom bars to the end bars. Now here's a tricky – but worthwhile – part. If you haven't already done so, break out the wedge. Stand the frame on end and drive a 1¼" nail through the end bar into the ¾" part of the top bar. Then flip the frame around and drive one into the opposite end of the top bar. Several things can go wrong here and they all involve the nail coming out in the wrong place. If the nail is not properly aligned, it will break through on either side of the top bar. Another problem occurs when the nail strikes the nail that was driven through the top bar again causing the side nail to split out in the wrong place. I don't know a good way around this problem. However, if all nails go where they should, the cross-nailing and gluing makes a stout joint. At this point, everything should be glued, nailed and cross-nailed. Before the glue has an opportunity to set, rack (or torque) the frame into square. I would guess that about one third of frames assembled correctly are still out of square. Assuming nothing goes wrong, it will take about two to three minutes to assemble one frame. If hundreds or even thousands of frames are to be assembled, this job can become stupefying. At this point, many beekeepers consider pneumatic air guns to speed things along.

Various styles of bottom bars.

Pneumatic Equipment - Both the Good and Bad

Pneumatic staplers and pinners are reported to be four to five times faster than hand nailing and due to various adhesive materials coating the staples or pins, so pneumatic fasteners should provide considerably more holding power. In reality, when assembling frames I have personally found air staplers and pinners to be about 2½ times as fast as hand nailing. An added benefit is that I don't tire as quickly when using a stapler so I can put frames together longer.

For frames, beekeepers generally use a staple having a crown of 3/16" - ¼" and a leg length of 1-1/8" - 1¼". The staples are made from 18 gauge wire. Probably a bit more exciting, but still necessary, a staple should be driven through the end bar into the top bar as was described above during the hand nailing procedure. Electric staplers do not have legs long enough for frame assembly so they are not an option.

Though much faster, stapling

frames can approach sloppiness. Be prepared for the occasional wild staple leg to explode out of the top bar. Such staples are nigh impossible to pull back out. A pair of nippers can be used to clip the exposed leg and then tap flat with the hammer.

Except for an occasional errant staple leg, the pneumatic stapler sounds like the correct path to take toward assembly efficiency, but as one would expect, there is a catch. There must be a forced air supply in order for the stapler to operate. An air compressor capable of producing around 100-120 pounds per square inch will provide enough air for one stapler. Such a compressor costs about $200-$300. The stapler will cost about $90-$300 depending on features. The biggest difference between the economical staplers and the more pricey ones is oil. Cheaper machines require oiling while the more expensive machines do not require lubrication.

There it is. For most beekeepers, it's too expensive to buy air equipment for frame assembly only. There has to be another justification for the air equipment. Spray painting, pressure washing, and tire maintenance are three other common uses for an otherwise expensive piece of air compression equipment.

A painful mistake

Frame assembly, either by hand or using pneumatics, gets to be monotonous. The same things are done over and over and over again. Several years ago, with the radio going, and me pin nailing frames by rote – tired and bored brainless, I casually completed yet another frame and tossed it toward my pile of frames. I recall being taken aback that the frame seemed stuck to my thumb. Instantaneously, I tossed the frame again thinking that it had a bit of pine pitch on it and was sticking to my hand. This was a curious situation. As though lightening struck me, I realized that one of the pins had come out of the top bar and had neatly run just beneath the skin of my left thumb. As I realized that I had essentially nailed my thumb to the frame, the pain hit. To this point, only a fraction of a second had passed, but it seemed like an hour before I could pull that staple from my thumb. Suddenly, I was not bored nor was I tired, nor was I short of words. It hurt.

I love mine, but you have to decide what's best for you

Pneumatic staplers are great for assembling bee equipment, but it's costly and can occasionally hurt you. But then again, so can a hammer. One way or the other, wood frames have to be assembled.

A video series that shows some of this

In the near future, a video series that John Grafton and I have produced will be available on the Ohio State Beekeepers Association page. The series will show basic aspects of beekeeping – including wood frame assembly. Watch that web page for the announcement of this series. BC

Dr. James E. Tew, State Specialist, Beekeeping, The Alabama Cooperative Extension System, Auburn University, ***Tewbee2@gmail.com***; ***http://www.onetew.com***; *One Tew Bee* RSS Feed (***www.onetew.com/feed/***); ***http://www.facebook.com/tewbee2***; ***Twitter @onetewbee***

Scottish Beekeepers' Association 100th Anniversary

Beekeeping Personalities

Una **Robertson**

A Founding Father, The Unsung Hero, A Rock Collector, The Appliance Dealer, A College Lecturer And A Commercial Beekeeper – The Foundation Of 100 Years Of Growth.

The year 2012 has witnessed the Centenary of The Scottish Beekeepers' Association. This landmark in our history was marked, mid-September, by a weekend of celebration. On such an occasion thoughts inevitably turn to the past and to the innumerable people who have freely given their services across the years to ensure the future of beekeeping in Scotland. To pick out just a handful of personalities from a cast of so many is difficult. How to distinguish between them since each and every one played their part in creating and maintaining the Association that we see today?

Given such a challenge it will not be too surprising that the spotlight has fallen on some who were involved in the Association's early days, as they created the foundations on which others have built and their framework has stood the test of time.

G.W.Avery was considered by his contemporaries to be the S.B.A.'s 'Founding Father.'

His interest in beekeeping started in childhood when a maiden lady lent him books on the subject. He successfully transferred some of his father's skep bees into moveable frame hives and introduced an Italian queen into one of them. He spent much of his life as a farmer in various English locations, eventually moving to Cumberland where he set up a large apiary. From 1900 onwards he took an active interest in the formation of the county's Beekeeping Association and became its 'Touring Expert,' offering advice and assistance to local beekeepers. When the Association's Secretary retired due to ill health Avery filled the post. Foulbrood was widespread in the area but under his guidance the number of infected stocks examined reduced from 28% to 3%. Membership increased rapidly and the Association became the largest and most successful in the U.K.

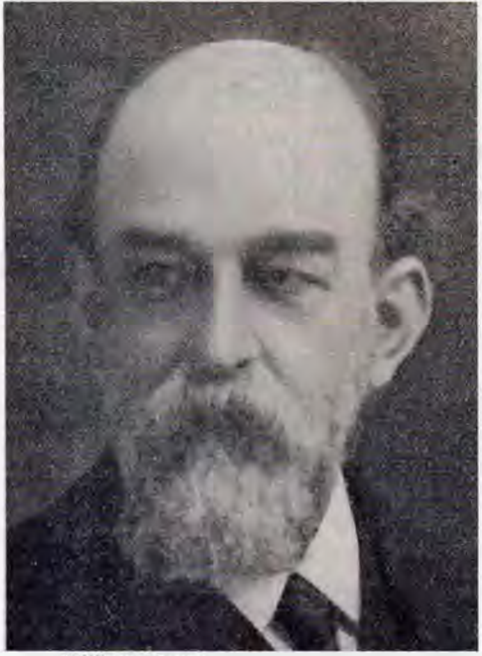
In 1911 he left Cumberland for Edinburgh, to be the first Lecturer in Beekeeping at the College of Agriculture there; this was a position newly-created in response to the devastation being caused by the so-called 'Isle of Wight' disease [IoW]. Almost immediately he began working towards setting up the national association and became its first Secretary although pressure of work at the College, where he set up a museum and an apiary for research and breeding purposes, caused him to resign soon afterwards. Despite this he continued to support the S.B.A. by lecturing on many occasions, holding demonstrations at the apiary and providing innumerable articles for The Scottish Beekeeper.

When advising beginners, Avery considered the best beekeeping plants to be white clover and heather, seeing it was rare for both sources to fail in the same season. He was a staunch advocate of the native black bee; considered that beekeeping had become too complicated and too expensive in recent years which had deterred those thinking of taking it up; that legislation was necessary in the fight against disease; and that education was important but so, to an even greater extent, was unity among beekeepers.

G.W. Avery

William Munro was described as the S.B.A.'s 'unsung hero'. The first two years were decidedly difficult as, despite the initial enthusiasm, only a small number of beekeepers had joined and Midlothian was the only County Association. William Munro and his colleague Charles Nicol put forward a revised Constitution. A series of meetings was held where this document was submitted, debated, revised still further and, in its amended form, sent out to all the beekeeping associations in Scotland for their consideration. At the final meeting in February 1915 it was decided to restructure the SBA on the basis of federation instead of the original 'affiliation'. Membership soared thereafter: within 18 months numbers had quadrupled and stood close to 1,000 and three new County Associations had been initiated. By March 1919 membership had doubled to over 2,000 with 23 federated Associations.

William Munro also formulated the system of examinations for Beemaster, Expert Bee Master and Honey Judge introduced at this time. These were set up with regard to the fact that many beekeepers of that generation had left school at an early age and, although extremely competent beekeepers, would never think of trying a written exam. The Beemaster exam was conceived as



William Munro

J.W. Moir

being wholly oral and practical. The test would be searching enough, but would involve no answering of questions on paper.

Realizing that, in the future, when examiners would be numerous and examinations would take place throughout Scotland it would be important to maintain a uniform standard he also devised a form on which the examiner made a detailed report, indicating the scope of the test and the marks awarded for knowledge of facts and operations covered. His wording was adopted as it stood and remained in use for a number of years.

John Moir, an original member, an early Vice-Chairman of the Executive Council and Treasurer is best remembered nowadays for laying the foundations of the S.B.A.'s celebrated collection of beekeeping literature. He had come to beekeeping by way of farming in East Africa where his crops needed bees for pollination purposes.

In 1878 he and his brother heeded the call of David Livingstone, became Joint Managers of what became known as the Africa Lakes Company and set sail for East Africa. Their objectives were to establish new routes to the interior as a means of providing alternatives to the use of slaves as transport; to build depots and trade honestly with the local people; create employment for them, assist in exploration and support the missionaries already there.

They arrived at the port of Quilimane and set to work rivetting up the shell of the small steamship called 'The Lady Nyasa' which had been shipped out in a vast number of crates. This craft was to be their main means of transport as they worked their way via Blantyre and Lake Nyasa, along the Zambezi towards Tete and Lake Tanganyika.

It was a challenging time for the two men as their activities stirred up much opposition, leading to a two-year war against the slavers and their allies; both Moir brothers were seriously wounded but eventually their opponents were defeated.

Once things had settled, John Moir began farming in the Shire Highlands, introducing new food plants and crops such as rubber, cotton and coffee – supplies of the latter coming from Edinburgh's Botanic Garden. The local people called him 'Mandela' which referred to the twinkling of light on his spectacles but the word came to be used over a wide area, symbolizing fair dealing and honest treatment.

In 1900 John Moir was invalided home to recuperate in Edinburgh where he spent his time in charitable work and in beekeeping – until 1912 and his involvement in the affairs of the S.B.A, most particularly in relation to the library that now bears his name.

Robert Steele was another original S.B.A. member, Chairman of the Council in 1916, Markets Convener and a College Lecturer. His interest in beekeeping had been stimulated as a child in 1865 when, aged 11, an elderly aunt gave him a skep of bees. He made his own skeps until he heard about wooden hives with combs that lifted out and started making them instead, not only for himself but for neighbors and then for beekeepers further afield. He is generally credited with being the first person in Scotland to set up a business supplying the needs of beekeepers; at the time there was no ready-made foundation, no honey extractor, no sections and appliances were rudimentary. He outgrew the space in his father's workshop and moved the business to a village nearby where the firm stayed for almost 20 years. After his main workshop burnt down in 1899, extensive new premises were built at Wormit, Fife. A few years later he sold up and travelled widely in Australia and New Zealand for health reasons. On his return to Scotland he bought back the business, together with Mr Brodie of New Zealand, and thereafter the firm traded as Steele & Brodie, the name by which it was known to generations of beekeepers. Their catalogues presented many innovations including the earliest extractors and their own 'Wormit hives'. Robert Steele left the firm for 10 years or so after joining G.W. Avery as a Lecturer at the Edinburgh & East of Scotland College of Agriculture and a further period of travel, but he returned to it in 1922 as Managing Director. Sadly, the firm closed its doors in 1998 after 123 years of service to Scotland's beekeepers.

Like his colleague, Robert Steele was a firm believer in the efficacy of native black bees as honey gatherers

Robert Steele

while giving the minimum amount of trouble. Although he had had Italian queens since the 1870s and continued to keep them he considered them poor at producing comb honey.

Dr John Anderson attended the SBA's inaugural meeting in 1912 having travelled from Stornoway, where he was Science Master at the Nicolson Institute. In 1915 he was appointed Lecturer in Beekeeping at the North of Scotland College of Agriculture, at Craibstone near Aberdeen. From the researches he and his students had carried out at the Institute he believed that the official 'Cambridge' report of 1912 into 'IoW' was wrong in stating the cause to be *Nosema apis* and that further research was required. He collaborated with Dr. Rennie, Lecturer in Parasitology at Aberdeen University, and in 1916 they published a joint paper that disposed of the official theory and led the way to further investigations. Dr. Rennie's proposed research project was successful in securing funding whereas his own plan to set up a breeding programme for native bees on an isolated island failed. It was Rennie's work that eventually pinpointed the previously unknown tracheal mite Acarapis woodi (Rennie) as the cause of 'IoW'.

John Anderson was elected President of the S.B.A. in 1919 and became The Scottish Beekeeper's second Editor in 1926 despite the heavy work schedule at the College and his other activities. His interests included research into endocrinology but he gained his Ph.D. from Aberdeen in 1929 for a thesis on 'Contributions to the Natural History of the Hive Bee.' He was Chairman of the Aberdeen District Beekeepers' Association with its 1600 members, Honorary President of the Glasgow & District Beekeepers' Association and a popular lecturer and judge at Honey Shows throughout the country. He was also a Fellow of the [International] Apis Club and served as its President.

While in Stornoway John Anderson invented the Nicolson Observatory Hive; he then developed the 15 frame Glen Hive that was 50% larger than the standard type and his influence ensured it was widely adopted. He was the first person to recognize and to write on addled brood, showing it was inherent in the queen. He was a man of strong opinions and delighted in provoking a debate. Unlike Avery, he argued against the introduction of legislation to combat disease and became a member of the Beekeepers' Defence League, established to fight any such proposals. Unlike Avery again, he considered that commercial bee farming would be perfectly feasible in Scotland as the country had its own native bees, its climate was generally suitable and the availability of flora was perfectly adequate.

To this day Dr. Anderson's name is remembered. After his sudden death in 1939 a fund was set up and contributions were invited. £100 was given to Dr. Anderson's family and the remaining £150 was invested and the income provides for the purchase of the Dr. John Anderson Award, the S.B.A.'s highest award, given for exceptional service in the furtherance of beekeeping in Scotland and beyond.

W.W. 'Willie' Smith is the sixth and final 'personality' to come under the spotlight. He arrived on the beekeeping scene rather later than the others but as his name is perpetuated among the beekeepers of Scotland he cannot be omitted. Willie Smith was a professional beekeeper, earning his living from his bees, and he created the hive that now carries his name.

After he returned from the First World War he began his beekeeping by borrowing a hive from a local beekeeper, making several copies of it and buying four stocks of native black bees at £5 each – an enormous sum at the time. His stocks were devastated by Acarine and by A.F.B; he persevered despite such set-backs, experimenting with various management systems and with assorted hives and appliances. He adapted some Langstroth hives to take 11 British Standard frames; they were single-walled, with a top bee space and supers that held either frames or sections or a mixture of both. His model was relatively cheap and easy to make, manipulation was straightforward and the parts were interchangeable. This simplified his beekeeping practices and in the 1930s he became a professional beekeeper, ultimately running some 500 stocks single-handedly. Living close to historic Traquair House, near Innerleithan, he asked permission to use an image of the mansion's famous gates on his honey labels and it is said that consignments of 'Traquair honey' were regularly sent to London to be enjoyed by the Royal Family.

Willie Smith was a popular lecturer throughout the UK, always encouraging the young and keeping nothing back when speaking of the way he managed his bees. By his work he demonstrated that commercial beekeeping was not only possible in Scotland but also profitable and worthwhile. Dr. Anderson would have been pleased to see his theory vindicated.

Six 'personalities' from a cast of literally thousands: a tiny percentage of the many beekeepers active over the century. The focus has fallen on 'the Founding Father', the 'Unsung Hero'; the Book Collector'; the Appliance Dealer; the College Lecturer; and the 'Professional Beekeeper'. However, this ignores so many others who could equally have come under the spotlight. The S.B.A.'s first 'Lady President' for example, elected in 1927; or Mrs. M.M.Hooper who contributed a monthly column for beginners in The Scottish Beekeeper for an amazing 25 years; there is T.B.Bailey's outstanding service as Secretary over 16 years or Robert Skilling's editorship of the magazine for 17 years. Yet they, together with so many others, by their dedication ensured not only the survival of the national association but developed it into what it has become today. BC

Una Robertson is the Conveyor of the John W. Moir Library.

BE POLLINATOR FRIENDLY

Ross **Conrad**

Manage your yard and garden to be pollinator friendly.

Honey bees and other pollinators require three essential components in their habitat: somewhere to nest, a supply of safe water, and enough blossoming plants from which to gather nectar and pollen. Native plants are undoubtedly the best source of food for native pollinators, because the plants and their pollinators have coevolved. The European honey bee, originating from the old world is not as efficient a pollinator for many native plants since it coevelved with old-world plants, many of which are considered invasive in the U.S. today. The honey bee colony makes up for this lack of efficiency in part by endowing its foragers with remarkable fidelity to a single species of flower and by producing tens of thousands of foragers in a single hive.

Unfortunately, throughout America's many landscapes, flowers have been pushed to the margins surviving along roadsides and field edges, as well as in wild areas and cultivated gardens. Providing patches of flowers is one thing we can do to improve the environment for pollinators. Not only does the creation of foraging habitat help the bees, but also the butterflies, beetles, flies, and other insects that pollinate these plants, and results in beautiful, appealing landscapes. In this article, I am going to try to avoid being bee-centric and address some of the basic needs of the honey bee, as well as many of the native pollinators.

Three things we can do are:

- Avoid using insecticides, herbicides, and fungicides
- Consider alternative techniques, timing, and scale of mowing activities
- Provide a range of native flowering plants that bloom all throughout the growing season

Avoid Chemicals

I don't think I have to go into great detail on this topic as it is pretty self-explanatory. Toxic chemicals that are designed to kill insects are not going to be healthy for pollinating insects and the body of evidence showing that toxic compounds are detrimental to bees and pollinators continues to stack up like cordwood. Not only have tiny amounts of pesticides been shown to have sublethal impacts on bees, but chemicals designed to kill weeds or fungi pathogens that are normally safe, can become toxic when they combine with other chemicals in the pollinator's environment. When we kill weeds with herbicides we are reducing the amount of natural forage available to pollinators at the same time.

Thankfully, there are numerous nontoxic alternatives to controlling insect, weed, and fungi pests. Not only are there numerous books that explain such techniques in detail, but organic and sustainable farming and gardening organizations throughout the country are often happy to offer advice and point you in the direction of helpful resources that can help you solve issues without having to resort to toxic chemicals, or by recommending the least toxic option.

Mow Less and With Greater Awareness

Mowing cannot only cause direct insect mortality, especially for immature stages that can't avoid a mower, but it can also drastically reduce forage by eliminating highly desirable flowers. To maximize pollinator benefits, no single area should be mowed more than once or twice a year with a field and brush mower or a brush hog. In fields where the grass grows tall, a single late spring mow after the grasses are a foot or two tall, creates the opportunity for the sun to reach the slower growing and shorter flowering plants allowing them to bloom, while at the same time removing the tall vegetation that obstructs easy access by pollinators. A final mow in Autumn or early Winter once the flowers have died back and many plants become dormant will help keep your fields open and prevent the forest from taking over once again.

This is perhaps the best excuse to get out of regular mowing chores that I have ever heard! In addition, mowing a mosaic of areas over several years, is more desirable than mowing an entire field or site all at once. Rather than mow entire areas where access is required, paths can be mowed through fields. By managing your field, lawn, or yard, in a patchwork of areas, you maximize the develop-

ment stages of the blossoming plants on your site, while keeping disturbances to habitat and nesting areas to a minimum. Besides, think of all the time and money you will save on fuel and mower maintenance.

Providing An Abundance Of Forage

To benefit bees and other pollinators the most, an effort should be made to provide a wide range of plants that will offer a succession of flowers throughout the growing season. The regular availability of nectar and pollen bearing blossoms is perhaps the most important (and aside from mowing less, the most fun) aspect of providing for the pollinator community. Along with a range of plants, a range of flower colors is desirable, especially blue, purple, violet, white and yellow. Having several different plant species that are always flowering in Spring, Summer, and Autumn will provide nutritional support for pollinators throughout as much of the year as possible. With a variety of plants, you help support a wide range of pollinators that fly at different times of the season, and make the area more attractive and enjoyable for you as well.

Plantings should be thought of in terms of patches or areas. Clustering flowering plants into clumps of a single species will be much more attractive to pollinators than single plants scattered here and there. When possible and if space allows, plantings should be at least four feet in diameter. This is one time where bigger is definitely better.

Try to use local, native, and heirloom plants as much as possible. Research has shown that compared to exotic species, native plants can be as much as four times more attractive to pollinators. Also it is a good idea to provide a diversity of flower shapes. Pollinators come in a variety of sizes, with different tongue lengths, and the more wide-ranging the blossom shapes, the greater the number of pollinators that will benefit.

Below is a list of native plants found in the Northeast, along with various "exotic" garden plants that can add variety and supplement the native plants. This list is far from exhaustive but should give you some ideas of the many possibilities for providing nectar and/or pollen sources to pollinators. You may also want to use a flower, shrub, or tree guide or ask your local nursery for species indigenous to your area.

Early-Season Flowering Plants

Alder – (*Alnus incana*)
Tall Bush Blueberry – (*V. corymbosum*)
Low Bush Blueberry – (*V. pennsylvanicum*)
Dandelions – (*Taraxicum officinale*)
Eastern Bluestar – (*Amsonia tabernaemontana*)
Hazelnut – (*Corylus americana*)
Wild Blue Lupine – (*Lupinus perennis*)
Maples – (*Acer*)
Balm of Gilead – (*P. balsamifera*) – Balsam Poplar
Narrow-leaved Cottonwood – (*p. angustifolia*)
White Poplar – (*P. tremuloides*) – Quaking Aspen
Raspberry – (*Rubus idaeus*) – variety - *aculeatissimus*
Serviceberry – (*Amelanchier alnifolia*) – Juneberry, Shadberry
Spiderwort – (*Tradescantia*)

Strawberries – (*Fragaria virginiana*)
Pussy Willow – (*S. discolor*)
Weeping Willow – (*S. babylonica*)
White Willow – (*S. alba*)

Mid-Season Flowering Plants

Alfalfa – (*Medicago sativa*)
Basswood – (*Tilia americana*) – American Linden
Bergamont – (*Monarda didyma*) – Bee Balm, Horsemint
Wild Bergamot – (*Monarda fistulosa*)
Black Locust – (*Robinia pseudoacacia*)
Blackberry – (*Rubus allegheniensis*)
Butterflyweed – (*Asclepias tuberose*)
Alsike Clover (*Trifolium hybridum*)
Brush Clover (*Lespedeza capitata*)
Sweet Clover (*Melilotus spp.*)
White Clover (*Trifolium repens*)
Coriander – (*Coriandrum sativum*)
Elderberry – (*Sambucus canadensis*)
Hawthorne – (*Crataegus*)
Hollyhock – (*Alcea rosea*)
Lobelia – (*Lobelia erinus*)
Marigold – (*Gaillardia pulchella*)
Milkweed - (*Asciepias syriaca*)
Swamp Milkweed – (*Asclepias incarnate*)
Mint – (*Mentha*)
Peppermint – (*M. piperita*)
Spearmint – (*M. spicata*)
New Jersey Tea – (*Ceanothus americanus*)
Ox Eye Sunflower – (*Heliopsis helianthoides*)
Showy Tick Trefoil – (*Desmodium canadense*)
St.-John's Wort – (*Hypericum formosum*)
Common Vetch (*V. sativa*)
Four Seeded Vetch (*V. tetrasperma*) – Lentil Vetch
Hairy Vetch (*V. villosa*) – Purple Vetch
Tufted Vetch (*V. cracca*) – Bird Vetch, Cow Vetch
Woodbine – (*Psedera quinquefolia*)

Late-Season Flowering Plants

Heath Aster – (*Aster pilosus*)
New England Aster – (*Aster novae-angliae*)
New York Aster – (*Aster novi-belgii*)
Smooth Blue Aster – (*Aster laevis*)
Boneset – (*Eupatorium*) – Joe-Pye Weed
Catnip – (*Nepeta cataria*)
Rough Goldenrod (*S. rugosa*)
Showy Goldenrod – (*S. speciosa*)
Great Blue Lobelia (*Lobelia siphilitica*)
Sneezeweed – (*Helenium autumnale*)

Multi-Season Flowering Plants

Anemones (*Anemone*) – Spring, Summer, or Autumn depending on species
Borage – (*Borago officinalis*) – Summer/Autumn
Calendula – (*Clendula officinalis*) – Late Spring/ Summer/Autumn
Cocklebur – (*Xanthium canadense*) - Summer/ Autumn
Meadowsweet (*Spiraea Ulmaria*) -Late Spring/early Summer, late Summer
Narrow-lvd Mountain Mint (*Pycnanthemum tenuifolium*) – Mid/late Summer, Autumn
Sunflowers (*Helianthus*) – Early-Mid Summer/Autumn depending on variety
Narrow-Leaf Sunflower – (*H. angustifolius*) – Late Summer/Autumn
Ten-petaled Sunflower – (*H. decapetalus*) – Late Summer/Autumn
White Turtlehead (*Chelone glabra*)– Mid-Late Summer/Autumn
Yarrow (*Achillea spp.*) - Summer and sometimes Autumn BC

Ross Conrad is the author of Natural Beekeeping: Organic Approaches to Modern Apiculture. Look for the revised and expanded edition of *Natural Beekeeping* due out in April 2013.

DOWNTOWN

You know how the reason why you took up beekeeping ends up dictating a thousand choices on down the line . . . the sorts of things that you never saw coming when you listened to your first teacher? It's actually astonishing and delightful, though sometimes you can find yourself unexpectedly at odds with other folks who probably only mean the best, too.

Are you are keeping honey bees in order to help pollinators, to complete an urban homestead, to produce a key ingredient of a personal nutritional program, to connect your family with nature, to start a revolution, to stake out your corner of the urban coolscape? This *does not even begin* to capture all the reasons people keep bees downtown. These things not only change the way we handle our bees, they handle the way we work with other beekeepers!

While we all look similarly eccentric to the world outside, downtown differences actually drive a lot of actions that can put us in disagreement. Though beekeepers that have each other's backs have honey bees that stand a better chance of surviving all the random events that pop up every season, and we do better when we compare notes, we might have a bit of a problem here.

One old saying is "Two beekeepers, three opinions." To my mind, this is optimistic. I have forceful disagreements with myself from time to time. While I would like to present myself as a proponent of peace in our time, I'm probably too opinionated for that, too. But we have got to find a way to work this out if downtown beekeeping is going to thrive and look like an ordinary and reliable thing to have in your neighborhood.

A theme has developed, coast to coast, in almost every major city, that there are divergent and even antagonistic groups of beekeepers in each area that have a hard time collaborating or even speaking with each other. I wish I could claim to be a proponent of peace in our time, but I'm just as guilty.

You will find, sooner rather than later, that your path is diverging from other members of the beekeeping community, because of what is important to you. Examples? Some folks start with community, with an "each-one-teach-one" gradual approach to getting particularly responsible and deeply educated beekeepers out there to build a network and slowly grow acceptance. Their focus is on people, on changing attitudes and building connections.

A Hive Divided

OK, this is me. Personally, in these fearful times I am looking for a way to insidiously inspire joy and wonder before knee-jerk phobias have a chance to kick in. This might yield only a dozen or two new hives a year in this city.

Others respond more immediately to the crisis in honey bee populations, or the urgency of righting environmental problems, and want as many colonies out there as possible. They point out that most beekeepers in the history of the world learned by doing, and the bees have their own way of winning friends and allies if you can only get them into peoples' hands. These folks lead with the distribution of bees, and can bring in ten times as many colonies per year. Neighbors should just have to deal with it, to "get with the program."

There are others in the middle, folks who deliver solid education or regular maintenance with each colony, or those who mean well and learn a lot up front but fail to look after their bees when life gets busy, children arrive, or they need to quickly move out of town. Probably most urban beekeepers just want to keep bees, to get to know another beekeeper or two and have access to special help in an emergency, but not to be consumed by an overarching agenda. It's a city, there's variety.

In cases like this, it may be that no one is undeniably in the right, but we have got to figure out a way to live together. If the greening of downtown is going to work, if *this time* we can actually bring our own vegetable gardens and bees and tree canopies into the city and have them stay for the lifespan of more than one trend, we need an ecology that can include us all.

Perhaps a sharing of concerns can lead to a sharing of missions? In the city where I work and live, we do not have a law that either protects or sets out the responsibilities of beekeepers. Instead, we have a weird concoction that seems to have been written by an ignoramus in *Alice in Wonderland*. Right now, most agencies consider the law potentially unenforceable, and don't want to touch it (though sometimes they do, when they feel they can get away with bullying someone). We are, however, only one

judge's opinion away from a really bad precedent. Our city officials respond to nothing as quickly as they do public safety failures, and a stinging incident can seem like one of those even if no one gets seriously hurt.

I also worry about feral colonies, not so much swarms (because they are gentle and temporary, though they freak folks out) but the ones that set up in a wall inside expensive real estate. The occupants always claim an allergy, they usually point to the welfare of kids, and they get steamed as anything over expense and potential damage to their primary investment. Way to make enemies, if you ask me.

One of the things I have noticed around here, however, is that unmanaged beehives don't last very long, and that the new beekeepers who are truly smitten seem to end up seeking additional education on their own. Rather than doing a targeted education program to a small selected group of pre-qualified activists, it would probably be a good idea to continually speak to everyone who takes up either approach, and continue to offer education in as many forms as possible. Asking everyone who received some one-on-one help to offer the same to someone else down the line seems like a sustainable model, and publicizing lists of mentors, educational opportunities, meetups, and local experts to people with all kinds of approaches is more sane than standing on opposite sides and criticizing each other.

In the city, with its variety of personalities, economic realities, habitat variations, and priorities, there does not seem to be a clear cut way to expand beekeeping without some friction, and – frankly – without some chance that folks who don't care enough will drop an unmanaged hive into a risky place. Or that folks who think they know better will block opportunities for others with a different inspiration.

If we all got along, we would probably be in a better place to address unfortunate incidents when they happen. We would look, to the outside world and to each other, like Solution Providers. After all, pointing fingers is not going to help, and nature will always throw a few curve balls to even the most meticulous beekeeper. Showing up in a veil with a plan? Now THAT makes friends.

Remember, to folks who don't know us, we all look the same. Maybe we can give each other that break. Even if the leaders of your club or your meetup or your community garden can't see eye to eye with the other kids, get out there among those folks. City beekeepers can go to as many meetings, to attend as many different information sessions, to volunteer in as many contexts as possible to build an information base to improve the welfare of your bees and your perspective on your goals.

You are always better off knowing more, rather than fewer, local beekeepers. Make sure that you meet some Top Bar Hive people if you are a Langstroth beekeeper, and don't discount the environmental value of Langs if you are in TBH. Work alongside someone with a really different approach, or in a different neighborhood, every once in a while. New beekeepers have blown my mind as regularly as the old guard!

If your local organization does not facilitate opportunities for folks to do this (something more specific than a message board), would it be hard to develop one? Do other clubs in town or nearby receive notices when you meet? Is it possible to arrange shared events, like community harvests or equipment building sessions, where folks can work together and meet one-to-one rather than sitting in chairs listening to a speaker?

And here's an anecdote from the suburbs. During my second year of beekeeping, there were two presentations in two neighboring counties, on consecutive nights, from two extremely accomplished beekeepers. Interestingly, they both used the same title, "Top Ten Beekeeping Practices." Both guys were truly impressive, between them over seven decades of beekeeping experience, and almost 500 hives.

They disagreed head to head on six of the 10 items. You know, I don't think they get along, either. BC

Toni Burnham keeps bees all over her city.

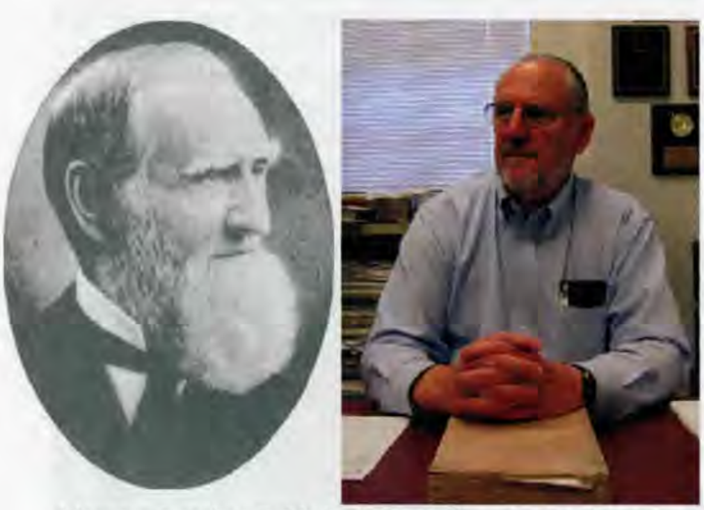
Happy Birthday To The USDA And Land Grant Colleges

M.E.A. **McNeil**

Two step-siblings were born just a few months apart in the midst of the Civil War the U.S. Department of Agriculture and the land-grant colleges. They were signed into being by President Abraham Lincoln in 1862. Each stroke of his pen opened the possibility of higher education for those in every social class and the availability of practical scientific information to a nation.

Together, among an enormity of other purposes, the two provide the sites for most domestic bee researc. "There is no place where there isn't a crossover," said Marla Spivak, University of Minnesota entomology professor. To learn how that came to be is to follow their intertwining stories, with the bees braided in – remembering that, to begin with, nearly all beekeepers were farmers.

Both the Department of Agriculture and the land grants were fathered by the federal government and mothered by different inspirations of the Enlightenment – a period that celebrated human rights, education, and scientific inquiry. Although the two are separate entities, brought about by divergent imperatives (and legal origins and aims), they grew up like step-kin – nurturing, feuding and maturing into cooperative partners. Like most siblings, they have distinct natures: consider that the USDA is celebrating its 150th birthday and the land-grants their sesquicentennial.



A legacy: Jonathan Baldwin Turner (left), a leader of the movement that launched the Morrill Act, creating the land-grant colleges, and his great-great grandson Prof. Reginald Barrett, a wildlife biologist at The University of California at Berkeley, one of the early land-grant institutions. (photo of Barrett by McNeil)

Every state has at least one land-grant institution, with almost all having left the original "college" designation to become universities. Most are named for their home state, so it is not commonly known that others are not, such as Purdue, Rutgers and Cornell. As to the reach of the USDA, it is ubiquitous. It includes multiple environmental, farm service, housing, nutritional, funding and food safety roles. The bee research labs are under the Agricultural Research Service.

How the two came about informs their characters. Their histories have separate beginnings, but it was not long before they began to intersect – as they do up a tree-lined walkway at the University of California at Berkeley. There, at the Department of Environmental Science, Prof. Reginald Barrett can be found. His book-lined office holds memorabilia from his career as a wildlife biologist at this land-grand university as well as accounts of his family legacy. He is the great-great-grandson of Jonathan Baldwin Turner, the leader of a movement in the 1850's that culminated in the Morrill Act, the legislation that made land-grant institutions in every state a reality.

As a child, Barrett listened to his two grandfathers debate opposing world views. From a young age he was allowed to walk across the UC campus to look through the microscope in the lab of his paternal grandfather, who was a professor of plant pathology in the Agricultural Experiment Station. That grandfather, who married Turner's granddaughter, came from a poor farming family descended from an indentured servant; he was educated through the grace of a scholarship at Cornell, an early land-grant university. He'd used his acumen to solve problems in the citrus groves at the UC Riverside Experiment Station, and half of his university salary came from the USDA. His stand in the elders' face-off was in favor of *meritocracy*. In opposition was Barrett's other grandfather, who came from an upper-class banking family and subscribed to the belief that a scientist needs to be wealthy enough to support his research and should not take public money. He favored an *aristocracy*.

Turner and the Land Grants

Higher education, in Jonathan Turner's time, was limited to the sons of the privileged, as he was. They attended colleges that were private and sectarian. Turner was sent to Yale, which was then a parochial school, for a classical education. Upon graduation in 1833, he was ordained a Congregationalist minister and became a

Norman Jay Coleman, 6th and last Commissioner of Agriculture, April 1885- February 1889.

Exterior view of the old Department of Agriculture Building.

missionary to the wilds of Illinois. As a professor at the new Illinois College, he soon found himself confronted with the moral issue of who could attend. He considered American democracy a valuable experiment and maintained that unless the public was educated they could not make rational decisions to vote. All people, he concluded, regardless of class "want, and they ought to have, the same facilities for understanding the science and the art of their life business . . . which the professional classes have long enjoyed." In this, he included slaves.

He published a weekly journal with articles on abolition, inventions, agriculture and education, in which he pressed for public schools. Forced out of his teaching post for his views, Turner chose his battle: he became an advocate for a publically funded system of higher education to serve what was then called the "industrial" class.

"He was absolutely convinced that our Constitution was the way to go," said Barrett, "But he was very worried that unless the average person was educated and understood how to make decisions when it came to politics, it wasn't going to work." Not only that, the American Revolution was not such a distant memory; he understood that revolution festers when power is concentrated in the hands of the few, when people have nothing to lose.

To muster support for his vision of a national system of universities, he rode from farm to farm on horseback, held meetings, organized conferences, found volunteers to print and distribute his tracts. "There is wisdom enough in the state, and in the union, to plan and conduct it, there are students enough to patronize it, there is useless land and wealth enough to endow it."

He formed liaisons with agricultural groups, promoted a professorship of the "green earth," and established experimental fields for horticulture on his farm. He met with Senate candidate Lincoln as well as the incumbent Senator Stephen Douglas.

As much a part of our lives as the land-grant colleges are now, it is hard to perceive how revolutionary the idea was and how fierce the opposition. Turner's life was threatened and, in 1853, his barn was burned to the ground.

"He just kept pushing this idea that everyone who was willing and able should get a college education, and it was worth it to society to pay for it, because they would get it back in the long run," said Barrett. "He wasn't supporting agriculture per se; he felt that people needed education to function fully in a democracy. It was agricultural only because they were farmers." And farmers made up the majority of the population in the last half of the 19th century.

The goal was not unique to Turner. Thomas Jefferson wrote in 1786, "Let us in education dream of an aristocracy of achievement rising out of a democracy of opportunity" – an ideal shared by nearly every one of the founding fathers. One of the first laws passed by Congress provided land in every township for public schools. But higher education, available to the few, was on a classical model, with rare practical disciplines.

Soon after the American Revolution, farm journals began to call for the establishment of agricultural schools, since the dissemination of most information got no farther than meetings of well-to-do gentleman farmers. Although most attempts at such schools in the first half of the 19th century failed, the mid-century saw an awakening of interest in general education. State legislatures stepped forward, and the Agricultural College of the State of Michigan, later Michigan State University, was chartered in 1855, receiving 14,000 acres of state land. Farmers' High School of Pennsylvania, later Pennsylvania State University, was established ten days later.

These state efforts inspired a growing movement to make higher education available throughout the nation by involvement of the federal government. But the early

The 1867 U.S. Department of Agriculture staff – L to R Superintendent Seed Department Major H.A. Meyers; Superintendent of Gardens William Saunders; Chief of Correspondence Col. E.M. Whitaker; Chief Clerk Major G.B. Newton; Agriculture Commissioner Isaac Newton; Private Secretary W.E. Gardner; Statistician J.R. Dodge; Chemist Thomas Antisell, M.D.; Superintendent Experimental Farm Isaac Newton Jr.; and Entomologist Townsend Glover. Photo courtesy National Archives and Records Administration.

A centennial stamp issued to celebrate Michigan State and Penn State as the first and second land-grant colleges, started a few months apart in 1855.

agricultural colleges had little scientifically based information to teach and turned students to the practical upkeep of college demonstration farms.

It was Turner who combined three ideas: universal access to higher education, research and instruction in agriculture, and appropriations through sale of public lands. The Industrial League of the State of Illinois was formed, which gave a powerful national voice for Turner's proposal. Horace Greeley, the New York Tribune pro-abolition journalist, called the movement "Illinois thunder".

Successive bills to create the land-grant colleges were introduced by Vermont Senator Justin Morrill. The first, in 1857, died in the hostile public lands committee and the second, in 1859, was vetoed by President Buchanan.

That year, Abraham Lincoln, a candidate for president, addressed a fair put on by the Wisconsin State Agricultural Society. Such fairs were the major means of spreading agrarian information in the period of 1815-70. Lincoln was born on land too hardscrabble to cultivate, and he grew up on a farm so marginal that he had to be hired out. Nonetheless, that speech was his only extended commentary on agriculture:

"It is assumed that labor and education are incompatible; and any practical combination of them impossible. According to that theory, a blind horse upon the treadmill is a perfect illustration of what a laborer should be . . . the education of laborers is not only useless but pernicious and dangerous. In fact it is, in some sort, deemed a misfortune that laborers should have heads at all.

Free labor argues . . . every head should be cultivated and improved by whatever will add to its capacity for performing its charge. In one word, free labor insists on universal education. No other human occupation opens so wide a field for the profitable and agreeable combination of labor with cultivated thought as agriculture. Every blade of grass is a study; and to produce two, where there was but one, is both a profit and pleasure. And not grass alone; but soils, seeds, and seasons. Standing crops, diseases of crops, and what will prevent or cure them. Trees, shrubs, fruits, plants, and flowers – the thousand things of which these are specimens – each a world of study within itself. No community whose every member possesses this art can ever be the victim of oppression of any kind of its forms."

It was as president that Lincoln acted on these sentiments. On July 2, 1862, the rump 37th Congress, its dissenting Southern Congressmen having withdrawn, sent the Morrill Act to the president. The Civil War was raging, and on that day General McClellan retreated at the end of a week-long battle with heavy casualties on both sides. That Wednesday in Washington, Lincoln wrote letters to military commanders, held meetings on the progress of the war and the status of fugitive slaves and called for 300,000 more recruits. And he signed the Morrill Act, which is widely regarded as the most important piece of educational legislation ever passed the United States.

Not only did it recognize that all citizens are entitled to higher education, but it recognized that the practical aspects of life are worthy of higher study. Benefits from the act were based on representation in Congress – 30,000 acres of public land for each United States senator and representative. Within five years, each state was required to support at least one college "to promote the liberal and practical education of the industrial classes."

A confluence of situations made the legislation possible. "Education is not mentioned in the Constitution," points out Christopher Loss, an expert in the politics of American higher education who teaches history at Vanderbilt University. "There was an ongoing debate on the role of the central government in affairs not mentioned in the Constitution." Buchanan had vetoed the Morrill Act in the belief that states should develop universities on their own, as some had. "Slavery was the big, big issue. The passage of the Morrill act boils down to the role of federal government in education." The confluence of circumstance that made it possible was: sentiment toward education as a democratic and moral right; a movement toward practical education; grants of land in war time to build government loyalty. The slave states were offered an opportunity to create land-grant universities under the Union.

Many state universities came directly from the legislation, with Kansas State University the first, followed by Illinois and Nebraska. Existing colleges earned land-grant status in Iowa, Pennsylvania, Wisconsin and New Jersey (where the oldest, Rutgers, was founded in 1766). The act eventually led to the creation of 74 colleges nationwide.

Credit for the legislation has accrued mainly to Morrill, whose statesmanship deserves recognition for ushering its passage; most land-grant institutions have a Morrill Hall.

Justin Smith Morrill

The Birth of the USDA

The 18th century European Enlightenment spurred not only the American Revolution but a new view of science as a key to the mysteries of nature's laws. In America, according to Vanderbilt's Loss, "There was also a quasi-mystical dimension, the sacredness of the land, a sense of manifest destiny – conquer the land, tame it for untold possible growth as resources to nurture the growth of the nation. Farmers had no goal but a bountiful harvest."

When Washington wrote in 1796 about the benefits of "collecting and diffusing information" in agriculture, 90% of the population lived on farms – many of which kept bee hives. But both his recommendation to create a National Board of Agriculture, and his successor John Adams' urging for legislation to promote agriculture were unsuccessful.

In 1819 the U.S. Secretary of the Treasury sent a letter to all consulates asking for the collection of useful seeds and plants. At that time, even though there was desire for new, improved varieties, such a quest was a gentleman's game: no money was appropriated, and most scientific exchange took place in what were called learned societies. Scientific advance came mainly from Europe, and Americans seeking it traveled to study there. The various subdisciplines of agricultural inquiry started in Germany, Scotland and England. The establishment in 1843 of the private Rothamsted experiment station in England was an instructive development for Americans. Today it houses an important bee research station.

Meanwhile, a diverse collection of plants and seeds had piled up at the U.S. Patent Office. With no system or expertise for storing them, many were lost. Interest in science surged during the Jacksonian period; coincidentally, in 1837, Henry Ellsworth, a Yale-educated attorney with an interest in agriculture, became Commissioner of Patents, a position within the Department of State. At his own expense, he redistributed the seeds and plants through members of Congress and agricultural societies. Later granted a name, the Agricultural Division, and a $1000 stipend from Congress, Ellsworth also began publishing letters from private individuals reporting on their experiments and observations. Such reports also comprised most bee science at the time, shared in local and state bee meetings and published in the later-century bee magazines.

In 1849, the Patent Office was transferred to the newly created Department of the Interior, but the agriculture division was still confined to data collection. Agitation mounted for the creation of a Department of Agriculture.

In 1861, in his first annual message to Congress, Lincoln asked for an "agricultural and statistical bureau" to serve "the largest interest in the nation". He had a little fun, finding it "fortunate that this great interest is so independent in its nature as to not have demanded and extorted more from the Government". The Department of Agriculture was elevated to Cabinet status in 1889 with a Commissioner, Isaac Newton, who had served in the role for 28 years. His new budget allowed him to hire an entomologist, a chemist, a statistician and a horticulturist. The Congressional act was so broadly conceived that it has remained the basic authority for the USDA to the present time. Some warned that the colleges and the USDA were open to becoming instruments of national policy, subject to the pressures of Congress and lobbyists.

From The Association of Public and Land-Grant Universities – The original mission of these institutions, as set forth in the first Morrill Act, was to teach agriculture, military tactics, and the mechanic arts as well as classical studies so that members of the working classes could obtain a liberal, practical education. Over the years, land-grant status has implied several types of federal support.

The first Morrill Act provided grants in the form of federal lands to each state for the establishment of a public institution to fulfill the act's provisions. At different times money was appropriated through legislation such as the second Morrill Act and the Bankhead-Jones Act, although the funding provisions of these acts are no longer in effect. Today, the Nelson Amendment to the Morrill Act provides a permanent annual appropriation of $50,000 per state and territory. A key component of the land-grant system is the agricultural experiment station program created by the Hatch Act of 1887. The hatch Act authorized direct payment of federal grant funds to each state to establish an agricultural experiment station in connection with the land-grant instutition there.

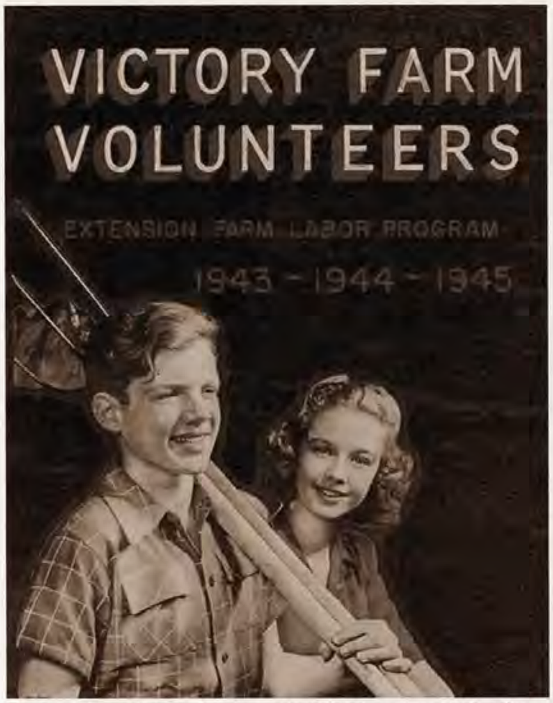
Dodging a Bullet

Although all 37 states accepted the Morrill Act land grants, the early colleges not only did not flourish but were described by historian Wayne Rasmussen as "dismal". Professors had primitive facilities, low salaries and heavy workloads (a fact likely to elicit some present-day guffaws). Enrollment grew slowly and student attrition was high. State support was weak if forthcoming at all. Land was plentiful for farming, and there was little incentive or interest in scientific technologies. Farm journals charged that students were leaving their farms. Pennsylvania Governor Robert Pattison said, "The farming communities of the state are absolutely indifferent about the existence of the college and do not believe it of any use."

Harvard President Charles Eliot recalled the "humiliating spectacle" in Congress of "half-dozen men, representing a few institutions of education, many of them half-born, vying for a share in the public gifts . . . a demoralizing use of public money."

The House of Representatives launched a hostile inquiry in 1874, condemning the colleges for their inability to attract agricultural students. The colleges' unexpected

Establishing act – the Department's basic mission "to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of the word."



Victory Gardens – During World Wars I and II, Victory Gardens were a vital source of food production as well as a remarkable illustration of American patriotism. Today the Victory Garden concept is making a comeback as Americans again embrace the idea of gardening and home-grown food as a way to maintain a healthy diet and environment. The National Agriculturel Library contains a wealth of information on Victory Gardens as well as on gardening and healthy eating in general.

vindication was the result of their concerted responses: The Penn State President, George Atherton, said, "I wish to call attention to the fallacy implied in speaking of these institutions as 'agricultural' simply, and then proposing to test the results by asking how many 'farmers' they turn out." The wording of the law, they pointed out, did not permit them to be so restricted. It required them to provide a liberal as well as a practical education.

The colleges made another important point in those deliberations: Branches of learning related to agriculture "have not been neglected or subordinated. In fact these institutions are coming to fill the place of the agricultural experiment stations of Europe which are supported by the various governments." As an example, the German agricultural experiment stations had grown from a single station in 1852 to more than 70 in 1875.

Early Research Stations

Rising distress in American agriculture in the 1870s resulted from economic depression, depleted soil, drought, and pests. Farms were abandoned, and those still in production were in need of help. The knowledge developed by the colleges was disseminated through campus agricultural courses and scholarly papers. Farm journals resourced their articles on these papers as well as material published by the USDA. But farmers distrusted what they called "book farming". In an old joke, a young land-grant graduate, set to paint hive boxes for an old beekeeper, took issue with the task, explaining that he had a college education. The beekeeper replied, "I'm sorry for that; I'll show you how to hold the brush."

Interestingly, during the 50 years between 1820 and 1870 industrial conditions in the United States were

AN EVOLUTION

"The U.S. Department of Agriculture (USDA) plays a large role in the administration of federal land-grant funds and the coordination of agricultural land-grant activities at the national level. The USDA's Cooperative State Research Service (CSRS), for example, administers both Hatch Act and Morrill-Nelson funds. A portion of the Hatch Act funding supports regional research, enabling scientists to collaborate and coordinate activities and thus avoid duplication of research efforts. The Extension Service of the USDA administers Smith-Lever funding, cooperating with state governments (which also provide funding for extension programs) to set priorities and facilitate the sharing of information within the entire Cooperative Extension System.

Because the 1890 land-grants do not receive Hatch Act or Smith-Lever funds, special programs have been created to help finance agricultural research and extension at these institutions. The Evans-Allen program supports agricultural research with funds equal to at least 15 percent of Hatch Act appropriations. Another program funds extension activities at the 1890 land-grants with an emphasis on reaching socially and economically disadvantaged people."

The National Institute of Food and Agriculture (NIFA) is an agency within the U.S. Department of Agriculture (USDA), part of the executive branch of the Federal Government. Congress created NIFA through the Food, Conservation, and Energy Act of 2008. NIFA replaced the former Cooperative State Research, Education, and Extension Service (CSREES), which had been in existence since 1994.

NIFA's mission is to lead food and agricultural sciences to create a better future for the Nation and the world by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations. NIFA doesn't perform actual research, education, and extension but rather helps fund it at the state and local level and provides program leadership in these areas. The broad expectation is that NIFA will enhance the stature and impact of food, agricultural, and natural resource sciences and ultimately grow support for agricultural research, education, and extension.

NIFA's two key mechanisms for accomplishing its mission of "advancing knowledge" are:

- National program leadership. NIFA helps states identify and meet research, extension, and education priorities in areas of public concern that affect agricultural producers, small business owners, youth and families, and others.
- Federal assistance. NIFA provides annual formula grants to land-grant universities and competitively granted funds to researchers in land-grant and other universities.

NIFA collaborates or has formal working partnerships with many institutions and individuals. Key partners are the institutions of higher learning making up the Land-Grant University System. However, NIFA also partners with other federal agencies, within and beyond USDA; non-profit associations; professional societies; commodity groups and grower associations; multistate research committees; private industry; citizen groups; foundations; regional centers; the military; task forces; and other groups.

Mrs. Ploma M. Adams stands beside the plaque denoting her farm as the first one to initiate a conservation plant in the U.S. on February 4, 1938.

Eleanor Roosevelt visiting the Beltsville USDA-ARS bee lab in 1939. Photo: Special Collections, National Agricultural Library: USDA Bureau of Entomology Album.

completely reorganized. The percentage of people engaged in agriculture dropped from 83 to less than 48, while the percentage of those engaged in manufacturing, trades, and transportation increased from 17 to more than 31.

Still, twenty-six states took up the task of getting agricultural information out in the 1880s, putting on seminars one to eight weeks long, called farmers' institutes. A coalition of interests – farmers, state organizations, agriculture boards and state legislatures – encouraged the establishment of research stations. The first were started in Connecticut and California in 1875. An emerging class of agricultural scientists met informally each year, 1880-85, and began to organize among disciplinary lines. By 1887, 14 states had stations, eight of which were connected to land-grant colleges. The question of who should control the research agenda remained, and there emerged an intense disagreement among investigators as to the form and function of agricultural research.

To garner support for government funding, a convention of colleges and experiment stations met in 1885. In 1887, the Hatch Act provided for the federal funding of agricultural experiment stations and decided their venue: land-grant colleges in each state. Later that year, The Association of American Agricultural Colleges and Experiment Stations was formed as well an Office of Experiment Stations within the USDA – both with the same goal, which put them on a collision course.

The First Bee Lab

Most early Department of Agriculture scientists, through the period of Reconstruction, were from Europe, and it proved difficult to keep them. In addition, there were so many jobs coopted by Congressional patronage that few resulting hires had appropriate skills – causing the new agricultural commissioner, Norman Coleman to say, "I came to the department with about the same reluctance that a criminal goes to jail." The spoils system was ended by the Pendleton Act of 1883, which required applicants for government jobs to pass competitive exams. The USDA was among the first agencies to abide by that act.

New graduates of the land-grant colleges, trained in disciplines such as biological chemistry and plant physiology, became USDA scientists, and they brought with them a dedication to research. The scientists, not ideologically aligned to a party, became a voice for scientific policymaking, which gave the USDA a unique place in the government at the turn of the century. They traveled to professional meetings and collaborated in research and inspections. They gained a role in determining farm legislation.

Other voices made themselves heard as well: Beekeeping organizations, formed after the Civil War to share expertise, put years of pressure on Congress to prohibit pervasive honey adulteration with sugar, bringing about the Pure Food Act of 1906.

The first Bee Research Laboratory was established in 1891 at the Smithsonian Institution by the Agriculture Department while it was under the Bureau of Entomology. From the beginning, the major focus of the lab was identification and control of honey bee diseases. One of its first services was the Bee Disease Diagnostic Lab which offered free analysis of samples– as it does to this day. American foulbrood was rampant at the time, and, by the early 20th century vigilance heightened, with some states enacting laws requiring apiary inspection. Although the function of the lab's diagnostic service was not research, the specimens from concerned inspectors and beekeepers from across the country were valuable. Hachiro Shimanuki, who headed the ARS Bee Research Laboratory in Beltsville, MD from 1966-2000, said it "made researchers aware of prevalent problems and gave them material to study".

It was at that lab in 1907 that the causal organism of American foulbrood was discovered by G.F. White to be *Paenibacillis larvae* (then called *Bacillus larvae*). White also found the cause of black brood, a bee disease renamed European foulbrood by his colleague E.F. Phillips.

A stream of other notable accomplishments came out of the lab: In 1910, the USDA published a beautifully detailed book, *The Anatomy of the Honey Bee* by R.E. Snodgrass, an "agent and expert". It was followed in 1915 by James A. Nelson's *Embryology of the Honey Bee*; his extraordinary drawings, made from the microscope, show the development of the egg from 74 to 76 hours, until the embryo breaks the chorion and becomes a larva. Up to the import prohibition in 1922, Frank Benton introduced bees from all over the world. His name may be familiar as the inventor of the Benton queen cage, still in wide use. In 1928, C.E. Burnside showed that bee paralysis was caused by a virus.

Another bee lab was established in 1928 in Baton Rouge, LA., with a focus on bee breeding. Three years later, the USDA-ARS located a single plant scientist in Weslaco, Texas, and the site expanded to include another bee lab. That lab is being closed, although all of the scientists and their research are being relocated to the other ARS bee labs, which has been the fate of two other such labs more than 20 years ago – one in Madison, WI and the other in Laramie, WY. In the late 40's, the Bee Biology and Systematics Laboratory, a lab that now works with non-Apis bees, was started at Utah State University, followed, in 1966, by the Carl Hayden Bee Research Center in Tucson, AZ.

Turf Tiff

A period of sibling rivalry between the USDA and the land-grants ensued in the early 20th century. One cause was overlapping mandates to produce and disseminate agricultural research. Both responded to the need for greater contact with farmers by forming extension divisions. They not only took on the same task, they differed over how best to do it.

At the turn of the century, about a third of the population remained on farms. The Progressive Movement of the period was concerned with a wide range of reforms, including education. Theodore Roosevelt, its political leader, appointed a County Life Commission in 1908 that recommended that each land grant have a "department of college extension – to reach every person on the land in its state, with both information and inspiration." Suggestions for carrying it out were mostly didactic.

Faculty at land-grant colleges put on a whirl of farmer institute meetings and small group short courses; they published papers; mailed missives; organized correspondence classes; created model farms, study clubs and even educational trains – with at best uneven success. A committee of the Association of American Agricultural Colleges and Experiment Stations (AACES) reported that "the present scope of dissemination work among farmers is entirely inadequate . . . As a plain matter of fact, we are not today, either directly or indirectly, reaching the great masses of the tillers of the soil with educational processes that may be regarded as even fairly efficient." Even so, it was recommended that their methods, "systematic or formal teaching", were best. Farmers simply had little time or inclination to read college bulletins or go to school.

At the same time, the USDA, in the person of Seaman Knapp, was pursuing a different method. Knapp had been a professor of agriculture at the Iowa Agricultural College. When an independent project to develop rice plantings in Louisiana stalled, he struck on the idea of paying a farmer in each township to demonstrate how to do it. "We learned then the philosophy and power of demonstration," he said. When he joined the Department of Agriculture in 1898, he used monies set aside for boll weevil eradication in the South to set up a network of agents doing hands-on instruction.

For staff, he eschewed the land-grant faculty, whom he considered to be too theoretical, in favor of local farmers. "We aim to get the best farmers . . . We find that these men are more influential than if they knew ten times as much about science, as they know the best science in the world – and that is the science of winning out, of making a good crop and making money on the farm."

"The boll weevil was the biggest single problem in farming cotton. Since its entry into the United States from Mexico in 1892, the insect known as *Anthonomus grandis* Boheman, spread throughout the South, forcing radical economic and social changes in areas that had been almost completely dependent on cotton production. Many experts consider the boll weevil second only to the Civil War as an agent of change in the South. Over the years, estimates of yield losses and control costs due to the boll weevil total more than $22 billion. And 100 years later the USDA program has just about wiped boll weevil out in the U.S."

Agents' pay was meager and the days were long. One recalled traveling "on horseback usually leaving home on Monday morning and returning about the end of the week."

Knapp instructed his agents to "avoid discussing politics or churches. Never put on airs. Be a plain man, with an abundance of good practical sense". His work was actively opposed, perhaps because his program defied Southern hierarchical social structures and his farm clubs included groups for Negro children. Still, his demonstration agents flourished. Historian Roy Scott describes it as "an example of bureaucratic autonomy conditioned upon reputation".

Mississippi Agricultural College president John Hardy admitted that the program "is even better than Institute work, for [agents] are in touch with the actual farmers 365 days in the year." But most other land-grants were not so sanguine about the situation. Many were skeptical of its success, ridiculed its method, and, most of all, suspicious of a purely federal project. University of Illinois Dean Eugene Davenport saw "a gigantic scheme" that would subjugate the land grants to the USDA.

Knapp exacerbated the food fight, calling "the College people immensely narrow and faultfinding" and the president of the South Carolina Agricultural College to be "largely the inspirer of... small potato ideas".

Even if he could not dispel tensions, the best of the competing ideologies were unified under William Spillman of the USDA, who had been a professor of agriculture and director of the experiment station at Washington State College. He guided instruction away from formal methods and established a government program with decentralized state experiment stations. Northern

The pilot of this specially equipped plane flies at a specified altitude over a prescribed path above the area set aside for the testing of a DDT mixture at the Beltsville airfield in March 1947. Photo courtesy of National Archives and Records Administration.

Flying from 100 to 300 feet above grasshopper-infested rangelands in Johnson County, WY the C-47 (DC-3) spreads bait at the rate of 300 pounds a minute in June 1949. Its two three-man crews make it possible to cover 20,000 acres in a 14-hour day, with each acre receiving five to 10 pounds of bait. Photo courtesy of National Archives and Records Administration.

colleges were nearly unanimous in denouncing the program, pointing out that it could lead to government control, with some accusing Spillman of empire building out of personal ambition. Spillman recognized the value of the demonstration method as he organized county agents in the North and West, but he drew on the expertise of the colleges. He hired graduates of the land-grants with farming backgrounds who had at least three years of post-graduate practical agricultural experience. He placed them permanently in 234 counties to work with local farmers. Eventually, according to historian Daniel Carpenter, he "ignited an enduring fascination among Northerners for combining county extension with the scientific study of farm management." This fusion is Spillman's lasting achievement that can be seen today in the work of extension apiarists.

The Emergence of Cooperative Extension

Legally, the research stations remained departments of the colleges, but a stream of federal funding diminished their control. With the Adams Act of 1906, the stations became directly funded by and accountable to the USDA, which supported the county agent model, with information disseminated through local agents. The colleges, as well as farmers' groups, continued to support their 19th century model, with agents visiting farm shows and county fairs and putting on farmers' institutes – once held all 48 states but declining to only nine by 1927.

Knapp eventually stopped sending brickbats from the USDA to the land-grants. It was just as well, as the college president he'd called a potato-head, David F. Houston, became the Secretary of Agriculture who eventually brought the two institutions together. In 1913, Houston met with the university group to arrange a compromise. He recognized that the colleges, with their proximity to farmers and scientific knowledge, were the logical agencies to manage extension programs. At the same time, it was clear that it could not happen without federal support. Houston proposed that extension should be a cooperative enterprise with the federal government, administered by the colleges. It was agreed that projects financed by federal funds would be mutually agreed upon by the college involved and the USDA.

On a warm May day in Washington in 1914, President Woodrow Wilson signed the Smith-Lever Act, establishing Cooperative Extension Service within USDA. The local papers reported on the weather the next day but nothing about the legislation that would effectively bring the university to the people. "Cooperative" was the key word, and it required concessions: the colleges would receive new funding and run extension in exchange for adopting the USDA's county agent-led demonstration method; The USDA agreed that future agents would not be local farmers but graduates of the land-grants. The arrangement encouraged station scientists to conduct research, publish in scientific journals, and enhance academic recognition for the colleges.

Smith-Lever was distinguished from earlier grant-in-aid acts by requiring federal funding to be matched locally from public and private sources – not the least important of which was the American Farm Bureau Federation, which became a contributor and influence. This multifaceted base strengthened the participation of farmers, who had proven less than comfortable with a government program. It merged the land grants' research and extension functions and channeled both through the county agent.

Further acts over the next 50 years brought federal support to about a third, with the rest from state, county and private sources."

Between State and Society

A new definition of the "education" to be offered by extension agents, described in their mandate to include "useful and practical information", came with American involvement in the Great War. To rally farmers to the war effort, the government used farm extension agents, nearly tripling their numbers between 1914 and 1918. County agents were given 15 speaking points to urge increased production as "America's obligation". They solicited for Liberty Bonds and Red Cross drives; conducted salvage drives and helped the War Department secure draft animals and feed. Work under E.F. Phillips at the Bee Research Lab played a part in increasing commercial honey production by 400%.

The number of extension specialists in the new program grew steadily until, by the 1920s, there were enough for every county in the U.S. This extraordinary growth was maintained with local administration: fewer than 1% worked in the extension service headquarters in Washington, DC. CES prepared bulletins and provided information to the county offices but county agents were paid and responsible to the state.

The country fell into a deep agricultural depression following the war, and the president of the American Farm Bureau Federation warned Congress that "Unless something is done for the American farmer, we will have a revolution in the countryside . . ." The crisis originated, ironically, from too much production, not too little. Technological advances, such as nitrogen fertilizers, had created chronic overproduction, resulting in the drop of prices to below costs. By 1933, Franklin Roosevelt inherited a farm economy that had been in steady decline for well over a decade. Among other problems, drought caused overused land to give up its topsoil: on a single afternoon in the Texas Panhandle, in what came to be known as the Dust Bowl, the volume of earth that swirled into the wind was twice what was excavated for the Panama Canal.

A quarter of the population still farmed, although foreclosures were rampant as it was for everyone in the great depression and the dust bowl. One of the elements of Roosevelt's New Deal was a voluntary farm support system based on the concept of "the ever normal grainary": Simply put, the government would buy farm surplus to stabilize market prices, with stored goods to be distributed in times of need. The Agricultural Adjustment Administration would pay farmers for agreeing to reduce output. The extension service was pressed to gain the participation of "some of the nation's most skeptical citizens," according to Loss. So it was that the land-grants and their extension agents developed into mediators of the relationship of state to society, situated as they were, in between. The challenge of extension was to preserve its integrity as an educational institution while carrying out these government programs.

The Farm Transformed

The turning point in the structure of the American farm came at the end of World War II. Some five million remaining farms typically raised diverse crops, including livestock and honey bees for pollination and honey. Migratory pollination had developed with transportation: Early photos show hives transported with horse and wagon, then Ford model Ts and railroad cars. Farmland still had wild borders providing habitat for native pollinators and beneficial insects. New technology, developed by private research and USDA scientists, was introduced to increase productivity on declining acreage. After the war, DDT, the first of the modern synthetic insecticides, came into wide agricultural use. It was followed by other pesticides like heptachlor that, like DDT, persist in the environment for decades. These new practices, together with high operating costs and low commodity prices, brought about the consolidation of farms, mono-cropping and the abandonment of hedgerows. Industrial efficiency was gained at the price of benefits that are only more recently understood.

Beekeepers began losing bees in major kills from pesticides. In the 1950's, scientific concern began to tighten governmental restrictions. Remembering another anniversary, it is 50 years since the 1962 publication of *The Silent Spring* by biologist Rachel Carson; it inspired state extension specialists to urge moderation in the use of chemicals. They created a pesticide education and safety program to create awareness. Researchers from many disciplines developed an IPM approach to reduce the level of pesticide use.

The government recognized the need to protect beekeepers in order to maintain the national food supply. A pesticide bee-kill indemnity program was created. The first federal price supports for honey, accomplished through loans to honey producers and honey marketing cooperatives, came with the Agriculture Act of 1949. The 1985 farm bill incorporated a provision for price supports known as the buyback provision, a honey loan payback program. The act also appropriated research funds to discover chemical applications for beekeeping.

The USDA published seminal research on the composition of honey and the first honey standards in 1975, the work of Jack White, a government sugar chemist. Another USDA book, *Insect Pollination of Cultivated Crops* by S.E. MacGregor, is considered a classic. In 1986 *The Scanning Electron Microscope Atlas of the Honey Bee* by Eric Erickson at the Tucson lab was published at Iowa State.

The Super Bee

The ideal bee has long been the grail of beekeepers. The replacement of the nasty *Apis mellifera mellifera* with Italians in the mid-19th century was like tulip-mania. The government bee lab was in the quest: A news clipping from the National Agricultural Library marked 1937-40 reports, "They have just begun to bring forth their super-bee," defined as one that "piles hives high with honey. When better bees are built, Beltsville will build them."

Importation of foreign bees had come to an abrupt end when the 1922 Honey Bee Act was passed by Congress as a proactive measure to stop the spread of the tracheal mite. At that time, American foulbrood was wreaking havoc on bee colonies in the US; Walter Rothenbuhler at Ohio State was committed to developing disease-resistant bees. In 1944, the University of Missouri Agricultural Experiment Station announced the first practical method of controlling American foulbrood with the aid of sulfathiazole, an antibiotic developed during WW II.

Dr. Shimanuki, now retired Beltsville Lab Leader said he started studying bees during the time of Rachel Carson and wanted to work with biological control of diseases. He worked with Dr. Rothenbuhler in grad school to develop AFB-resistant bees, a continuation of the research of O.W. Park from Iowa. "The development of resistant bees requires breeding programs," he said. "It was cheaper [for beekeepers] to use sulfa drugs and antibiotics, and that minimized the importance of resistance. People didn't want to pay extra for bees too expensive to breed and sell."

Researchers branched out to breed various traits in bees, and Rothenbuhler's work from Iowa and Ohio State was set aside – until Tucson researchers encouraged Spivak to take it up again when she moved from the USDA to the university. The resultant Minnesota Hygienic line of bees demonstrated a genetic trait now acknowledged as an important defense. USDA researchers at Baton Rouge, John Harbo and Jeffery Harris, developed a line of bees with a trait later called *Varroa* sensitive hygiene, VSH. In the hunt for advantageous behavioral traits, the lab also imported both the Yugo and Russian strains. "Finding natural resistance has been our goal since the mite moved into the global population of honey bees" said Harbo. Breeding and germplasm importation are a focus at Washington State by Steve Sheppard and Sue Cobey, who rebred the Carniolan bee. Both USDA and university bee researchers have made significant contributions to the understanding of bee behavior.

"If you solve a problem then you get another question," said Shimanuki. "It's never a forever solution. We come up with temporary means. The bees are going to survive long after we do."

Band of Brothers or Big Brother?

A new memorandum of understanding in 1988 reaffirmed that "All cooperative agents shall be joint representatives of the land-grant institution and the USDA" except in special circumstances. They "will mutually develop a single comprehensive extension program for the state." Does this mean that extension is, in large part, a governmental policy agency, as it has been called on to be in the past? Who determines the research agenda?

"The scientists have a good fraternity. They are above it all," said Shiminuki. Their efforts have been mustered for a different kind of war: The precipitous decline of the bees over the last six years has aligned university, USDA-ARS and extension toward addressing the crisis – not only bee researchers and apiarists, but geneticists, biochemists, palynologists, toxologists, statisticians from both institutions and beyond.

"You could draw a family tree of beekeeping," said Shimanuki. True, a few leaves were rustled by individual temperaments: In the early 40s USDA researchers Frank Todd and George Vansell, doing seminal work on pollen at UC Davis, were dismissed from the campus by a turf-defending department head. But such kerfuffles have mostly become quaint anecdotes, and Davis extension apiarist Eric Mussen sees the site as a good fit for a future USDA lab.

A Bureau of Printing and Engraving employee examines a run of food stamps for the U.S. Department of Agriculture for errors in May 1974. Photo courtesy National Archives and Records Administration.

True cooperative cross-pollination began early on. "Cooperation – it's always been there," said Shimanuki. Federal labs originally functioned within the land-grants, with the University of Wisconsin an example. Some USDA researchers taught classes at near-by land grants such as those from Baton Rouge at Louisiana State and those still in adjunct positions at Utah State. The exception was the University of Maryland, which always had its own beekeeping professor. Extension agents and USDA-ARS scientists came from the land grants, with some later returning to the universities as professors. A notable example is Phillips, who came from the University of Pennsylvania as a young land-grant graduate to the USDA. He became a leader in scientific support for the beekeeping industry, ultimately teaching at Cornell, where the Phillips Collection, his valuable bee library, is kept.

"The history of the research is very much cooperation," said Shimanuki. "Most accomplishments are team efforts, it's hard to say who should get credit. Much of the work is application of the techniques of others."

Spivak said, "I am just looking for expertise and collaboration. I could care less where they are." With the number of bee researchers in the country comprising no more than a good sized dinner party, publications are co-authored, data and grad students are exchanged. She points out, though, that there are differences: "At the USDA labs they don't have to teach and interact; they tend to focus down. The university people have broader scale perspective of what's going on in biology because they have to teach."

Generally, the USDA addresses shorter-term practical problems and the university longer-term problems, according to Marion Ellis, professor and extension apiarist at the University of Nebraska. "The USDA is more affected by what's happening politically because their funding is approved by Congress, which is sometimes more and less generous. Also each lab has a mission, what they are directed to address. At the land-grant universities there is less political pressure, but they are affected by what they can get funded."

Funding, according to Mussen, affects the amount of risk a researcher can reasonably take. "At the USDA, high-risk practical research can be done without jeopardizing funding: You get an idea of what might help,

The USDA-ARS attempted to stop the spread of Africanized bees toward the U.S. Here, in 1988, they prepare to hang paper mache bait traps laced with a chemical attractant or pheromone to attract migrating swarms. Photo courtesy USDA

and if it doesn't work you come up with another idea. In our case [at the university], the idea has to work, based on what you really think will work" because too many misses, no matter how informative, will turn away grant support. The university "thinks of itself as doing more basic research, and that's probably true. The USDA has many refereed papers, and it does a very good job at down-to-earth research. I could never look down my nose at USDA research."

"The labs have distinct IDs," according to Jeff Pettis, research leader at Beltsville. "With the closing of Weslaco, we have: Baton Rouge, genetics and breeding; Beltsville, pests and diseases and the Disease Diagnostic Lab; Tucson, pollination, nutrition and Africanized bees."

"Collaboration? If it is advantageous it happens," said Ellis. A stunning example is the teamwork with the USDA and a network of 16 universities under the $4 million Coordinated Agricultural Project (CAP) grant which comes from NIFA. Some 28 studies have come out of it on, for some examples, mites, nosema, genetics, breeding, management, microsporidia, non-Apis bees, agricultural chemicals including treated seeds and interactions of varroacides.

Who determined those research goals for CAP? According to Spivak, researchers in an open coalition that met at bee conferences named their own areas of concern. Marion Ellis said, "The beauty of the CAP grant was that all the people who wanted to work on identified concerns were working in a collaborative manner. I thought it was a beautiful model for doing research. There is no barrier to working together. It is shifting; it is more the way granting agencies are looking, and I think it is a healthy change."

Cooperation has increased with the urgency of the bee crisis. Mussen said, "Honey bee researchers consider themselves peers working in different areas. University and USDA researchers all go to the same meetings; there is not a sense of competition, the two groups work together well. There has been conflict in the past, but there's not much now. They have been forced to get together because of the big grants."

One CAP paper, for example, involves work by researchers at the University of Maine, the University of Nebraska, Penn State, Washington State, the University of Minnesota, The University of California at Riverside and the USDA-ARS. A $5 million grant has gone to Dennis vanEnglesdorp's Bee Informed Project from NIFA, a massively collaborative project to track the health of bees nationally. The sequencing of the honey bee genome in 2006 provided a model for international cooperation.

As the USDA-ARS bee labs plan research agenda for the coming year, scientists will meet at Beltsville with land-grant colleagues and other stakeholders to coordinate their goals, according to Jeff Pettis. Some current projects are: determine gene function relating to disease resistance; develop molecular techniques to diagnose and characterize pests and pathogens; investigate nutrition to improve winter survivability and queen durability; develop methods for in vitro preservation of honey bee germplasm.

Equality

Before we erupt in a happy birthday chorus, consider how the cake has been sliced. A second Morrill Act, in 1890, was passed to include the South, where there was de jure segregation; it allowed the creation of separate land-grant colleges for blacks – identified as "1890 schools". De facto segregation in the North was addressed with a separate college in Delaware. Funds, with few exceptions, bypassed the 1890 schools. The USDA finally addressed the disparity 100 years later.

Not everyone benefited equally from extension either. In a typical example, Florida created a separate program for blacks, and, in 1920, when they comprised a third of the rural population there, 5% of extension funds were spent for work among that group.

Although historically door-yard bees were often kept by women, entomology was traditionally a man's pursuit. There were rare exceptions, such as Anna Comstock, who learned beekeeping at the land-grant Cornell and became an extension professor in 1898 – until male colleagues had her demoted – and Margaret Washington, who taught beekeeping to black women at Tuskeegee, one of the 1890 land-grant colleges.

Progress was uneven at best for women scientists at the colleges, although it was better than at the USDA labs, until the affirmative action laws of the 1960s. Change was supported by innumerable small enlightened acts, such as Marion Ellis' struggle to bring on a female entomology professor as a role model; it shifted the undergraduate demographic in his Nebraska department from mostly male. Now, both the universities and the bee labs have many skilled female contributors, although many presently there have braved prejudices that young women of today only hear of.

Another undervalued group has been the bees. To put the beneficence of the $9 million in recent grants to the CAP and BIP projects in perspective, it amounts to less than half an hour of the Iraq war.

Quo Vadis?

"You can tell a whole history of the United States by the history of universities, especially land grants," said Loss, who calls them a uniquely seminal contribution to education in the world.

The impact of land-grant universities continues to be profound. At the University of California, for example, 40% of undergraduates are the first in their families to go to

Eric Mussen has become the only full-time extension apiarist west of the Rocky Mountains. He opened his UC Davis archives for research for this article. McNeil photo

college, and 39% are able to attend because of federal Pell Grants. Their resultant innovation and expertise returns some $14 in economic output for every $1 of taxpayer investment, according to an independent study in 2011.

Even so, "Today the old consensus around higher education as a public good has withered away," said Loss. Spivak, as a typical example, has seen her allotment from the university agricultural experiment station decline by 70%.

Mussen is the only full time extension apiarist west of the Rocky Mountains. Most such positions, where they survive across the country, are rolled into professorships with responsibilities for extension, research and teaching. Support for grad students at Davis has declined from funding three academic quarters to one. The other two come through teaching assistantships and grants. The problem no longer lies in the specter of the extension agent proselytizing for a war and peddling bonds; Mussen says he has had to resort to panhandling for operating expenses. "When grants dry up who's got the money? Big business."

Barrett describes the two branches at land grants, the professors and cooperative extension, as "a very effective and powerful system". His own appointment is half-time teaching and half experimental station. As for his great-grandfather's vision, "Up to 1940 the university functioned as Turner would have envisioned it. He wanted everyone to start fresh without outside, powerful influences. During World War II and after, there was financial influence of agribusiness on the university system.

"I don't have money for a graduate student anymore. I can take you on only if you're self-funded. In contrast, my grandfather at the ag station was funded for two postdocs and three fully funded PhD students. We have become entrepreneurs -- any way I can get money, short of robbing a bank, like schmooze at clubs. I used to carry six graduate students; my last two grad students are self-funded. I have to buy my own paper and pencils and phone. We are on our knees here. We are hired guns these days and we are waiting for anyone to come along to fund anything. Berkeley is rapidly becoming a private university. If we're having trouble, God help the rest of them. You can't continue this way. We are running on one cylinder instead of four."

So, while the UC Berkeley Campanile carillon rang out as blueberry juice, cranberry juice and white lemonade were poured in a patriotic toast to the founding of the

Dr. Judy Chen, Beltsville Bee Lab, samples a bee for virus.

The bee-infesting Varroa mite causes considerable economic losses for beekeepers and agriculture. Cytologist Bill Wergin (left) and entomologist Jeff Pettis examine a highly magnified photo of a honey bee infested with Varroa. *Pettis leads the research team at Beltsville.* Photo by Scott Bauer. USDA-ARS

land-grants, Barrett was looking for cause to celebrate. "I probably won't be replaced when I retire," he said. He sees his grandfathers' debate shifting. "A rich guy named Goertz funded my chair. We are moving toward an American aristocracy. Turner felt you need to counterbalance to educate. Most people don't know who controls the resources in this country. It would kill Turner to see all those people who don't vote."

Loss sees the same danger. He is himself a graduate of a land-grant college, as were his parents. He came from a family of farmers, and his great-uncle was an extension agent honored in the Rutgers hall of fame. "The Morrill Act still matters, despite the many educators, administrators, and policy makers who mistakenly think of higher education as a private enterprise, unmoored from the public it was created to serve. The Morrill Act symbolizes the public trust that has given life to our nation's entire educational system for the past 150 years – and it reminds us all of the public commitment that will be necessary for the system to thrive for 150 more."

University of Minnesota Museum curator Kevin Lavery, offers this hope . . .

"We're not only connected in new ways in the Information Age, but I think we're also doing research in a very different way than we did in the past, to develop solutions in partnership that are not only solutions from a scientific angle, but also from a cultural and human angle. I think we're seeing a different kind of model occur."

Lincoln's original vision was that "Such community will be alike independent of crowned-kings, money-kings, and land-kings. Let us hope, rather, that by the best cultivation of the physical world, beneath and around us; and the intellectual and moral world within us, we shall secure an individual, social, and political prosperity and happiness whose course shall be onward and upward, and which, while the earth endures, shall not pass away.

Knowing what we know now, let's wish again like it was 1862. BC

Additional information was distilled from innumberable USDA sources with the help of Kim Kaplan, USDA Media.

The relevance of an article on this subject was recognized by Kim Flottum. Particular thanks to Eric Mussen and Joe Graham for their support, as well as to those who contributed interviews.

M.E.A. McNeil is a journalist and Master Beekeeper who writes often on bee-related subjects. She can be contacted at: mea@onthefarm.com.

Sources

1. *The ABC and XYZ of Bee Culture,* ed, H. Shimanaki, Kim Flottum, Ann Harman, Root Publications, 2007.
2. Baker, Gladys et al, *Century of Service: the First 100 Years of the United States Department of Agriculture,* US Department of Agriculture Centennial Committee, 1963.
3. Barrett, Reginald, Goetz Professor of Wildlife Management, Department of Environmental Science, Policy & Management, University of California at Berkeley, interview September 12, 2012 at UCB.
4. Block, Gene, Chancellor University of California at Los Angeles and Chairman of the Association of Public and Land-Grant Universities, "Celebrating the 150th Aniversary of the Morrill Act", UCLA Newsroom, July 2, 2012.
5. Brown, Donald R., " Jonathan Baldwin Turner and the Land-Grant Idea", a lecture to the Illinois State Historical Society in Champaign Urbana on October 15, 1961, **dig.lib.niu.edu/ISHS/ishs-1962winter/ishs-1962winter-370.pdf.**
6. Carpenter, Daniel P., *The Forging of Bureaucratic Autonomy: Reputations, Networks and Policy Innovations in Executive Agencies, 1862-1928,* Princeton University Press, 2001.
7. Carrier, Mary Turner, *The Life of Jonathan Baldwin Turner,* University of Illinois Press, 1961.
8. Dewhurst, Kurt, "Morrill Act Opened Doors for 19th Century Americans" WKAR radio interview with Kevin Lavery, April 26, 2012.
9. Ellis, Marion, Professor and Extension Apiculture Specialist, University of Nebraska, interview September 17, 2012.
10. Finacom, Steven, "150th Anniversary for Civil War-era Law that Helped Bring UC into Being", Capital Projects, June 29, 2012.
11. Freeling, Nicole, "Honoring Our Land-Grant History", UC Newsroom, July 7, 2012, **www.universityofcalifornia.edu/news/article/27951**.
12. *The Hive and the Honey Bee,* ed., Joe Graham, Dadant and Sons, Hamilton, IL, 1993.
13. Horn, Tammy, *Bees in America,* Univ Press of KY, 2005.
14. Imhoff, Daniel, *Foodfight,* Watershed Media, 2007
15. Loss, Christopher P., *Between Citizens and the State: The Politics of American Higher Education in the 20th Century,* Princeton University Press, 2012
16. Loss, Christopher P., Assistant Professor of Public Policy and Higher Education, Vanderbilt University, interview September 14, 2012
17. Martin, E.C. et. al, *Beekeeping in the United States,* USDA Agriculture Handbook Number 335. 1980
18. Morgenstern, Michael, "Why the Morrill Land-Grant Colleges Act Still Matters", The Chronicle of Higher Education, July 16, 2012.
19. Mussen, Eric, University of California at Davis Extension Apiarist, interview September 14, 2012.
20. Putnam, Paul A., *Anecdotal History of the Beltsville Agricultural Center,* P. Putnam, Springfield, VT, 2000.
21. Rasmussen, Wayne D., *Taking the University to the People; seventy-five Years of Cooperative Extension,* Iowa State University Press, 1989.
22. Scott, Roy V., *The Reluctant Farmer; The Rise of Agricultural Extension to 1914,* University of Illinois Press, 1970.
23. Shimanuki, Hachiro, Research Leader, USDA-ARS bee lab, Beltsville, MD 1966-2000, interview October 10, 2012.
24. Smith, I. Barton, "The Bee Disease Diagnostic Service – 100 Years and Growing at the USDA Bee Research Laboratory, Beltsville, Maryland, The American Bee Journal, August 2011, 767-72.
25. The Times Herald, "Md. Beekeepers Convene at Hagerstown", January 13, 1940, archived news clipping, USDA-ARS Beltsville archives.
26. Toome, Alfred, "Superbee with Long Tongue Piles Hives High with Honey", newspaper clipping, circa 1937-40, USDA-ARS Beltsville archives.
27. Spivak, Marla, Distinguished McKnight Professor, Extension Entomologist, University of Minnesota, interview September 17, 2012.
28. Turner, J.B., *Industrial Universities for the People,* Morgan Journal Book and Job Office, 1858.
29. White, Janet L., "Honoring 150 Years of Accessible Higher Education, California Agriculture, April-June 2012.
30. Williams, Roger L. *The Origins of Federal Support for Higher Education,* The Pennsylvania State University Press, 1991.

Happy Birthday USDA!

VISIT THE BEE LABS!

Ann **Harman**

During the 19th century our country made great strides in becoming an organized nation. After the Revolutionary War an entire governing system had to be established. Although cities were flourishing, adventurous people were moving westward. Population was increasing. Small-scale farming was an important part of everyone's life. However transport of perishable goods, agricultural products, was limited. Rail transport did exist but it was not until 1869 when the Golden Spike was driven into the railroad tracks at Promontory, Utah, that the country was truly linked from east to west.

In spite of the advances in technology during the Industrial Revolution, the United States was still an agricultural nation. The government had made efforts to help agriculture but the Department of Agriculture was not established until 1862 by President Abraham Lincoln. In 1889 President Grover Cleveland was able to give the Department of Agriculture the Cabinet status it has today. Although research was an important part of the newly-formed Department, the Agricultural Research Service (ARS) was not a separate agency in the Department until 1952. The ARS has undergone internal reorganizations since then. Today research on honey bees and other bees is one of the many projects of the ARS because the pollination of crops is of utmost importance.

At one time six research laboratories existed, each with their own focus: Beltsville, MD, for bee diseases; Laramie, WY, as an isolated disease and treatment testing lab; Baton Rouge, LA, for honey bee genetics; Tucson, AZ, pollination and pesticides; Madison, WI, for management for honey production; Logan, UT, for pollination using both honey bees and other bees. Both the Madison, WI, lab and the Laramie, WY, lab were closed from the shrinking of the overall bee research funds. Today one additional lab operates in Weslaco, TX, as part of the Kika de la Garza Subtropical Agricultural Research Center. The focus there is management of parasites, pests and diseases of honey bees – healthy bees for pollination. The focus of the Logan, UT, lab now is on bees other than honey bees although some research has carry-over to honey bees.

The ARS also maintains the National Agricultural Library (NAL) in two locations: The Abraham Lincoln building in Beltsville, MD, and the DC Reference Center in Washington, DC. The NAL maintains the Beekeeping Bibliography, a compilation of 30,000 pieces of information on honey bees. This vast collection, now in the library's database contains summaries, abstracts and citations to books, pamphlets and periodicals for the period of 1905 to 1973.

The oldest research laboratory is titled Bee Research Laboratory but is known around the world as the Beltsville Bee Lab. It is located in the Henry A. Wallace Beltsville Agricultural Research Center, Beltsville, MD, the world's largest agricultural research complex. The Beltsville Bee Lab began its work in 1891. However it incurred a short break in 1896-1897. This lab is the only one in a temperate climate more representative of much of the United States. Only seven scientists have headed the lab since its start. Its current leader is Dr. Jeff Pettis. The Beltsville Bee Lab is, in a way, in two parts. One part is its diagnostic services for bee diseases. Samples taken from honey bee colonies, bees and brood, are sent to the lab for diagnosis. The other part is the research for controls of pests and diseases.

In 1966 Dr. Hachiro Shimanuki was transferred to the lab and at that time was the only research scientist there. However, over the years more were added and today the staff has scientists working with bee genetics, viruses, bacterial diseases and pests and their controls. Dr. Shimanuki retired in 2000. He described his time at Beltsville as the most "tumultuous" years of beekeeping. Chalkbrood arrived in the late 60s followed by tracheal

U.S. National Agricultural Library.

Jeff Pettis, Beltsville Bee Lab Leader.

Tom Rinderer, Research Leader at the Baton Rouge Bee Lab.

Gloria Degrandi-Hoffman is Research Leader at the Tucson lab.

mites in 1984, *Varroa* 1987, Africanized bees in 1991 and small hive beetle in 1996. In addition this lab discovered resistance to oxytetracycline used to control the American foulbrood bacteria.

In 1996 Dr. Anita Collins moved to the Beltsville lab and begin the work on cryopreservation of honey bee sperm. The Beltsville lab also obtains approval from FDA of chemical controls for pests and diseases of honey bees. The screen bottom board for *Varroa* control was developed at this lab and is now widely sold by beekeeping equipment suppliers. The low-humidity strategy for control of small hive beetle in honey houses was also developed here. One can consider those 120 years as extremely beneficial to bees and beekeepers everywhere.

We now move to Louisiana to the Baton Rouge Bee Laboratory, established in 1928. Today it is known as The Honey Bee Breeding, Genetics and Physiology Laboratory with Dr. Thomas Rinderer as Research Leader. During the early years much attention was paid to package bees and queens but even in the 1940s breeding for disease resistance was being conducted.

The Baton Rouge lab has an island off the coast that is the nation's only honey bee quarantine station. Here the bees brought from Russia lived for several years while their health and tolerance for varroa was investigated. Any future imports of bees will live at the quarantine station until their release to the beekeepers is appropriate. The island also serves as an isolated mating area necessary for breeding research.

As the Africanized bee was working its way north from South America scientists from the Baton Rouge lab worked seasonally in Venezuela for 10 years to assess behavioral defense, alarm communication and other traits of the Africanized bee.

At present seven scientists work at the Baton Rouge lab. One important project is to help beekeepers integrate the *Varroa* Sensitive Hygiene (VSH) trait into their bee stock. The Russian bees are still being studied and bred for their tolerance to *Varroa*.

The Baton Rouge lab partners with beekeepers to test honey bees in real apiary situations. The cooperators can provide many more colonies than the bee lab could maintain. The bees can be tested in different climates to demonstrate their success. As many as 500 colonies are in the partnering program each year.

The Russian Honey Bee Breeders Association had its start in 2007 with the purpose of maintaining and improving the various lines of Russian honey bees. The RHBA follows the breeding program of the Baton Rouge Lab.

Moving on, we arrive at Weslaco, TX, at the Kika de la Garza Subtropical Research Center. It had its beginning with just one scientist in 1931. Today 30 scientists are employed there working on many agricultural topics, not just on honey bees. At present six honey bee scientists work there. Pollination and Integrated Pest Management for honey bee colonies are the primary topics of their research. The scientists work with bee colonies that are pollinating crops such as almonds. Bee health, including disease, pests and parasites, for the pollinating colonies involves searching for sustainable solutions to their problems.

In the late 1980s the Weslaco lab was monitoring the advancing Africanized honey bee in Mexico, along the Gulf of Mexico and along the Texas border. On October 15, 1991, the Africanized bee was found in a trap along the Rio Grande River. This colony marked the official arrival of the AHB in the United States.

Continuing westward we come to the Carl Hayden Bee Research Center in Tucson, AZ. Arizona has been populated with the Africanized honey bee for a number of years. Therefore one of the research objectives has been how to manage European honey bees within Africanized bee territory. About eight scientists work there today. Dr. Gloria Degrandi-Hoffman is Research Leader.

The Tucson lab has concentrated on nutrition as a key to healthier colonies, so important for commercial pollination. Scientists have looked at high fructose corn syrup (HFCS) used as bee feed and helped develop pollen substitutes. *Varroa* mite problems are also a topic with researchers looking at brood pheromones as possible attractants. Also investigations of the mortality of *Varroa* with extracts from hop plants led to a new control for the mites.

Still in the west, but farther north we come to the Bee Biology and Systematics Laboratory at Logan, UT, founded in the late 1940s for research on alfalfa seed production. This is the only lab in the U.S. devoted to

Rosalind James, Research Leader at the Bee Biology and Systematics Lab in Logan, UT.

studying the many native bees other than honey bees. However some of their research can have impact for the health of honey bees. These non-Apis bees are important pollinators and some could be considered "managed" for pollination of certain crops such as alfalfa.

This lab has about seven scientists including the Research Leader, Dr. Rosalind James. The researchers are investigating diseases and their control, behavior of the various bees, crops that need pollination and the particular bees needed, and bumble bee conservation and management. In addition an evolutionary biologist focuses on bee taxonomy as well as being curator of the world-class Bee Museum. Here information on the various bees and their host plants form a database. Bee conservation and habitat conservation are important parts of research at the Logan lab.

The needs of growers for their crop pollination are important in the research being done at Logan. Some crops are not pollinated effectively by honey bees but still require insect pollination. Therefore research with native bees can match a particular bee with a target crop. Native bees, just like honey bees, are subject to diseases and pests. Scientists at the Logan lab are developing controls for these problems as well as improving management for better health of the bees.

The bee labs do cooperate with universities in their areas. It is interesting to note that more molecular biologists and geneticists are now part of some of the bee labs retinue of scientists. Modern scientific technology is now an important part of bee research.

Over the years the bee scientists have received recognition with national honors and awards for their work. The all-important task of crop pollination by honey bees and other bees is carefully looked after by a dedicated group of scientists and their technicians. The bees are benefitting from such research topics as improved genetics, diseases being diagnosed, treatments being scrutinized, bee nutrition being examined. Every beekeeper, and indeed every person, needs to thank these five bee labs and the scientists, technicians and support staff for their work. BC

Ann Harman keeps bees in Flint Hill, VA and teaches beekeeping all over the world.

MORRILL IN ACTION

UGA

The University Of Georgia

Jennifer **Berry**

Franklin College.

When choosing a college, most students have an array of different reasons for wanting to attend this one over that one. For instance, a recent graduate who wants to study the fine art of ballet probably would not apply to MIT, and one wanting to become an atmospheric scientist would stay away from Juilliard.

When I was exploring graduate programs, I narrowed my search for a particular school pretty fast. First, I had to have a decent Entomology Department. Second, I refused to live in a big city again since I had just left Hollywood, CA. And, third, I didn't want to move to a state where I had already lived. These may have been pretty lame reasons, but I was older and knew a little more about what I wanted to do and where I wanted to live. Whether or not the school had a good football team was the least of my concerns. Once I narrowed the list, only two schools remained; this presented a difficult decision. Then, a professor friend of mine told me where he had received his PhD and how much he loved not only the school but the town and the people, as well. I was sold. So, I packed my bags, cats and dogs, loaded the truck, and headed to Athens, Georgia – home of the University of Georgia (UGA).

UGA is big news here in Georgia, not only because of the Bulldogs, a nationally-ranked football team (yes, even after their recent, horrific loss to South Carolina), but because UGA is, well, the University of "GEORGIA." UGA, with nearly 10,000 faculty and staff across the state, is one of the largest employers in Georgia. UGA owns 39,395 acres of property, consisting of six campuses across 30 counties, as well as numerous farms and research facilities. The annual budget to run the university this year is $1.32 billion, 29% of which is provided by the State of Georgia. The money provided by the state has been a recurring political issue since the economy went south. When the State of Georgia can't pay its bills, and, by corollary, the budget is out of balance, education always seems to be the first item on the chopping block. According to Georgia's constitution, the budget must be balanced. This is a good thing for the state in the long run. However, it is hard on those in education who have lost their jobs or gone without cost of living increases for over five years.

UGA houses numerous colleges offering 79 programs, including the colleges of Agricultural and Environmental Sciences (to which our lab belongs), Arts and Sciences, Business, Ecology, Education, Environment and Design, Family and Consumer Sciences, Forest Resources, Graduate School, Journalism and Mass Communication, Law, Pharmacy, Public Health, Public and International Affairs, Social Work, Veterinary Medicine, the GHSU/UGA Medical Partnership, and Engineering. This abundance is necessary to afford the 26, 571 undergraduate and 8,194 graduate/professional students plenty of choices. That's a grand total of 34,765 students! And, I thought things were big only in Texas.

The students at UGA are also involved in extra curricular activities. UGA recognizes over 600 registered student organizations, which include 32 social fraternities and 26 social sororities.

An overwhelming number of high school students, particularly in Georgia, want to attend UGA – one of the largest schools in the South East. Lamentably, there are only so many openings each year, and acceptance into UGA has become extremely competitive. For example, last year, the average GPA score for the 4,685 entering freshmen was 3.8. That's a pretty high standard for a state school. And, among these new, bright-eyed students, 97 percent of the in-state freshmen have earned the HOPE Scholarship, which is funded entirely from revenue generated from the lottery. It is available to Georgia residents whose academic achievements are above par. The program basically pays for a student's educational costs while attending a HOPE eligible college in Georgia.

UGA also has quite a history. First, it's the country's first chartered public university. It was established on January 27, 1785 by the Georgia General Assembly and it is the oldest public institution of higher education in the United States. The University's first president was Abraham Baldwin. He held the radical position that higher education was "a public good, not a private privilege, and should not be exclusive to those of wealth."

But, it wasn't until 1799 when the university actually began. During a meeting of the Senatus Academicus (a joint assembly of the Board of Visitors and the Board of Trustees, both presided over by the Georgia Senate), 633 acres of land was set aside in order for the university to be built. The land was located along the banks of the Oconee River, in the heart of Athens, Georgia. Two years later the first class was held in a clearing which is now the historic section of UGA's North Campus. The first class graduated on May 31, 1804. It wasn't until 1806 that the first brick building was constructed on campus. It was named Franklin College in honor of Benjamin Franklin. It is still in use today, housing administrative offices and classrooms. The Board of Trustees, which replaced the *Senatus Academicus* in 1859, has been in service ever since. While great hopes were raised when Abraham Lincoln signed the Morrill Act in July, 1862, portending federal support for state institutions of higher learning, there was a slight obstacle that got in the way for Georgia: War!

One of the University of Georgia beeyards.

On January 18, 1861 Georgia seceded from the union and, by February 5th, was the fifth state to join the Confederacy (Confederate States of America). On April 12th, 1861, Civil War hostilities began when the Confederate forces attacked Fort Sumter – a U.S. military installation in South Carolina. It marked the beginning of the "War Between the States" with battles raging for years, primarily in the south, and resulting in the deadliest war ever in American history with over 750,000 soldier and civilian casualties. It finally came to an end on April 16, 1865, which was four months after Sherman's famous "march to the sea" and the capture of Savannah.

Before the long march ended, Sherman had seized and burned most of Atlanta to the ground. Remember that famous scene in *Gone With the Wind* when Rhett so gallantly saves Scarlett, Melanie and Prissy? He whisked them away through the streets while railroad cars exploded and criminals tried to take their horse and buggy. Well, that was the old Atlanta.

Once he was satisfied that Atlanta would not stand again for some time, Sherman stripped his army of all non-essentials and proceeded to march southeast through Georgia. The result was that parts of Georgia lay completely in ruins. Farms were raided and destroyed. Tens of thousands of livestock were slaughtered or seized. Homes were burned. Millions of pounds of corn and fodder were confiscated. Hundreds of miles of railroad, bridges, and telegraph lines were demolished. Cotton gins and mills were burned to the ground. And, the psychological damage as a result of Sherman's destructive swath affected Georgians from the mountains to the southern border for years to come. Thousands of civilians were either killed or arrested as traitors, including women and children.

Georgia was the last of the Confederate States to reenter the Union in June 15, 1870. Its infrastructure and economy were in shambles. As a result, Georgia remained poor and didn't recover until well into the 20th century. However, there was a small glimmer of hope when the State Assembly gave $300 to the injured soldiers who served in the war. And, there was another flicker of light that would soon shine as well.

During the war, Abraham Lincoln signed the Morrill Act of 1862 which granted federal land to the states for the establishment and funding of educational institutions. It also provided for the education of people from all social classes in agriculture, mechanical and other applied fields.

Understandably, the states that had seceded from the Union were not eligible for the benefits of the Morrill Act right away. UGA had to close its doors for a little over two years during the war. Soon afterwards, the enrollment peaked at 78 students. Eventually, the Morrill Act helped with the creation of the UGA College of Agriculture and Mechanical Art, opening May 1, 1872.

Michael Adams, current president of UGA, wrote, "the

Morrill Act, too, sees higher education as a public good, a means not only to educate young people but to be of broader benefit to all the people of the state. We take this charge seriously at the University of Georgia. The spirit and the letter of the Morrill Act are alive and well at UGA, and I am proud of the good work that we are doing."

Like the president wrote, UGA is not here just to educate, but also to help connect UGA's resources and expertise to the needs of the people and communities throughout the state. UGA's Cooperative Extension and Outreach Programs are good examples of UGA's commitment to solving some of Georgia's most daunting challenges. Extension agents and specialists across the state provide vital information to producers and consumers of Georgia's agricultural products. All citizens in Georgia including homeowners, farmers, and business people benefit from these programs. For example, there is expert advice and information available about poultry, horses, beef and dairy cattle, swine, sheep, goats and aquaculture. There are resources and best management practices for field crops such as canola, cotton, grains, peanuts, soybeans, tobacco, as well as for forestry. There are guidelines for growing apples, beans, blackberries, blueberries, citrus, corn, grapes, greens, onions, peaches, pecans, potatoes, squash, strawberries, and tomatoes. There's information available about pests and diseases on all the above. And, finally, there are "how to" programs on organic agriculture, running your own business, sustainable agriculture and urban agriculture.

Please join me in wishing a Happy Birthday to the Morrill Act of 1862 and in offering many thanks to Jonathan Baldwin Turner, Justin Smith Morrill and those who had such a bright vision for the future! BC

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

GLEANINGS

DECEMBER, 2012 • ALL THE NEWS THAT FITS

GENETIC SHUFFLE

Worker bees have become a highly skilled and specialized work force because the genes that determine their behavior are shuffled frequently, helping natural selection to build a better bee.

Research from York University in Toronto, Canada, sheds light on how worker bees – who are sterile – evolved charismatic and cooperative behaviors such as nursing young bees, collecting food for the colony, defending it against intruders, and dancing to communicate the location of profitable flowers to nest mates.

The researchers report in the journal Proceedings of the National Academy of Sciences that when they examined the honey bee genome, they discovered the genes associated with worker behavior were found in areas of the genome that have the highest rate of recombination.

Recombination represents a shuffling of the genetic deck: recombination in the ovaries of a queen shuffles the chromosomes she inherited from her parents.

As a result, the queen's female offspring are likely to inherit mosaic chromosomes with different combinations of mutations, says Biology Professor Amro Zayed, whose lab conducted the research.

Recombination allows natural selection to act on specific mutations without regard to neighboring mutations.

"If I'm a good rower in a dragon boat with 49 poor rowers, I am going to lose all of my races," Zayed says. "But if teams were shuffled after every race, I'll likely have a better chance of winning. I may even get to be in a boat with 49 good rowers just like myself.

"The same thing happens with mutations on a chromosome. Recombination makes the evolutionary fate of mutations independent of their surrounding neighbors, which enhances the process of natural selection."

Lead author Clement Kent says the research team believes it has solved one of the mysteries of the honey bee's genome.

"The honey bee has the highest rates of recombination in animals – 10 times higher than humans," he says. "Our study shows that this high degree of genetic shuffling has turned on the evolutionary faucet in parts of the bee genome responsible for orchestrating worker behavior.

"This can allow natural selection to increase the fitness of honey bee colonies, which live or die based on how well their workers 'behave'."

The research was funded by the Natural Sciences & Engineering Research Council of Canada and Province of Ontario. – *Alan Harman*

HAWAII $30,000

The Univ of HI was given $30,000 to develop more efficient methods for controlling small hive beetle.

Governor Neil Abercrombie signed into law a measure appropriating the money for the research to be carried out in consultation with the Department of Agriculture on HI Island, maui, Oahu and Kauai.

This will include work being performed at university's 110-acre Panaewa farm on Hilo.

Abercrombie says bee-pollinated crops contribute about $106 million to the local economy.

"The University of HI is leading research that will help to protect many of HI's own native pollinators, including seven species of yellow-faced bees that are candidates for the endangered species list," he says.

The university has been offering an introductory course on beekeeping on Hilo for more than 20 years, and now also offers an advanced course that allows students to build upon their acquired skills with independent projects that include research and creative activities.

Alan Harman

HALF AS SMART?

It sounds a bit like something from Frankenstein, but scientists at the Universities of Sheffield and Sussex in the UK have begun an ambitious project to produce the first accurate computer model of a honey bee brain.

Project leader James Marshall, leading the £1-million ($1.6-million) Engineering and Physical Sciences Research Council-funded project in Sheffield, says the model will be used to advance the understanding of artificial intelligence (AI) and how animals think.

The team will build models of the systems in the brain that govern a honey bee's vision and sense of smell. They then plan to create the first flying robot capable of sensing and acting as autonomously as a bee, rather than just carrying out a pre-programmed set of instructions.

If successful, this project, called Green Brain, will meet one of the major challenges of modern science – building a robot brain that can perform complex tasks as well as the brain of an animal.

Tasks the robot will be expected to perform include finding the source of particular odors or gases in the same way that a bee can identify particular flowers.

If successful, the artificial brain could ultimately be used for search and rescue missions, or even mechanical pollination of crops.

"The development of an artificial brain is one of the greatest challenges in artificial intelligence," Marshall says. "So far, researchers have typically studied brains such as those of rats, monkeys, and humans, but actually 'simpler' organisms such as social insects have surprisingly advanced cognitive abilities."

The research is also expected to provide a greater understanding of the honey bee itself.

Green Brain's modeling could also help scientists understand why honey bee numbers are dwindling and also contribute to the development of artificial pollinators, such as those being researched by the National Science Foundation-funded Robobees project, led by Harvard University.

Alan Harman

ABF IN HERSHEY, PA

Don't miss the information available at the ABF meeting in January, including:

- Signals of Starvation: Effects of Nutrition on Pheromone Communication in Honey Bee Colonies presented by Dr. Mark Carroll, Carl Hayden Bee Research Center
- Research on Methods to Control Pests of Honey Bees at CMAVE-USDA-ARS presented by Dr. Peter Teal, Center for Medical, Agricultural and Veterinary Entomology, USDA-ARS
- Pesticide Impacts and Interactions for Migratory Beekeepers presented by Dr. James Frazier, Penn State
- Panel Discussion on Small Scale Bottling Regulations facilitated by Charles Lorence
- Panel Discussion on Urban Beekeeping facilitated by Jim Bobb
- Bee Disease Identification presented by Randy Oliver
- Serious Sideliner Symposium facilitated by Dr. Larry Connor

Find out more at **www.nabeekeepingconference.com**.

2012 Year End Index

Titles

Obituaries

New Products

Display Advertisers

A bear's after the sheep, but he hasn't gotten into my bees – yet!

The good-natured rancher pulled up with two poker-faced Mexican sheep wranglers with lariats, two friendly border collie/blue heeler-mix dogs, and a big ol' stock trailer. The idea was to bring in a couple of his loaner sheep, which spent the Summer and Fall grazing in my orchard, until I got careless, and they got out. The bear's on their tail, and those four (now only two!) sheep have gone plumb loco.

At night they play hide-and-seek with the bruin. Mornings and evenings they graze. Mid-day they shade up. Above the ditch, this is Zane Grey country. Boulders, pinion, juniper, sagebrush, dry arroyos and cliffs. Mountain lions when you least expect them.

"I saw the sheep just down the road on the hogback," I said, as I leaped into the bed of the rancher's pickup. He knows my politics. "I don't know if you'll want to ride back there," he laughed, pointing to all the campaign stickers plastered on his back window.

"Just as long as nobody takes my picture," I said.

"I can only imagine how you'd feel," he quipped.

We climbed over hill and dale. I can't keep up with Juan and Rodrigo. To catch ornery half-wild sheep, first you have to find them. Then the dogs grab onto the sheep and slow them down until the wranglers can rope them. This is what they tell me. We've had two sheep roundups, and it hasn't happened yet.

I've got a month off until I go back to work on the ski hill, but what with the lost sheep, honey extracting, my gal Marilyn getting a new hip, and an October tax deadline, I got behind with the bees.

Indian Summer slips away. Now, in mid-October, I'm trying to catch up. At one yard I put on pollen supplement patties to beef up my Winter bee populations, but some of the queens had already stopped laying.

The next day at the home yard, I started off doing the same thing, but I did some *Varroa* mite tests, too. Whoa, Nelly! Bad news!

A month ago I tested all of my hives, except for a few that tested zero mites in August, and the plan was to knock down the worst hives with thymol and hit the hives that need it with an alternate treatment when the queens stop laying this Fall or early Winter. (If only oxalic acid were legal!) Most colonies yielded zero to three mites in a 300-bee sugar-shake sample in September. A few, six or eight or 16. So what? We live with mites, right? I had a plan.

So hives that tested five or more mites in September got twin 25-gram Apiguard treatments a fortnight apart. The first treatment was September 18. Twenty-five grams is half the label dosage, but that's how I've been doing it, and until now it's worked. Twenty-five grams, between the supers. Those mites should be dead. But that's not what 20 re-tests showed. The treated colonies tested at counts that trended about the same – or a little higher – than they were a month ago. One hive count jumped from nine to 29!

Untreated hive mite numbers were up, too. Two hives that previously tested at zero mites now tested at five and six. What's going on here? Is this a reflection of mites getting forced into the open as brood diminishes along with bee numbers? Is my testing at fault? I thought I was getting pretty good.

Curiously, the hive with the highest September mite number – 16 – tested clean yesterday. This was what I expected with Apiguard – dramatic mite reductions following two applications.

These bees got moved down to the valley from their isolated Colorado high country yards in early September, most of them. I can't rule out their having robbed some local hives infested with *Varroa*, after the move. Maybe I'm selecting for mite resistance to thymol with an over-reliance on Apiguard. I don't normally treat every hive every year, so I thought I was being judicious. Maybe not!

Bees around here fatten up on fall rabbit brush pollen, but since the frost two weeks ago, pollen gathering has about quit. A week ago I put out dry pollen supplement feeders in both of my overwintering yards, but maybe that wasn't a great idea. Communal feeding would seem to favor mite introductions into hives with few or no mites, and it stimulates brood rearing, which normally is a good thing. But now, with mites fooling me yet again, I want to treat sooner, rather than later. All of a sudden I'd rather see my queens shut down, instead of ramp up! I want those mites out in the open, not in sealed brood, so I can give 'em the hotfoot.

I need longer days and more energy to deal with my bees. But my life keeps spinning around those wayward sheep! Every time I give up and decide to write the rancher a check, somebody calls with a sighting, and away we go! It's hard to let go when those little darlings are grazing on the neighbor's front lawn.

I even have people who want to help. The rancher says call anytime. A gal who competes in international sheep herding trials with her border collies is dying to give my sheep a try. She changed her schedule so she could come down today, but today the sheep have vanished. Of course.

Ed **Colby**

Little Darlings. Little Bo Peep.

BOTTOM BOARD