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INSIDE . . .

Science Of Bee Culture

Vol. 1 No. 1 - Center

ROOT PUBLICATIONS

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It's Almond Blossom time – the biggest blossom grab in history. Are there enough bees? Is there enough water? Are the bees healthy? How many are from Australia? And how much are colonies renting for? Actually, the bees don't care – almond blossoms are rich in nectar and pollen – and politics and prices just don't enter into the equation. (photo by Jennifer Beck)

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Bee Culture

THE MAGAZINE OF AMERICAN BEEKEEPING

FEBRUARY 2009 VOLUME 137 NUMBER 2

FEATURES

Science Of Bee Culture

Vol. 1 No. 1 - Center Section

DEPARTMENTS & COLUMNS

Apimondia 2009

September 15-20 – Montpellier, France

The preparations for Apimondia 2009 are well underway. About 10,000 beekeepers are expected to visit the Congress and the ApiExpo. You should prepare your tour and bookings as soon as possible to make it possible for us to give you the best service.

For exhibitors it is important to book as soon as possible as the exhibition area is becoming limited. Visit the congress website at www.apimondia2009.com to learn more.

The main Congress theme is "The bee, sentinel of the environment." This is to stress the importance of the honey bee to the environment and the livelihood of mankind. Special attention will be given to the massive losses of bee colonies around the world and scientists attending the Congress will present the results of their latest research findings. Beekeepers and scientists will meet and discuss in order to understand the causes of the problems and try to find the most appropriate solutions.

ApiExpo will be very large offering a huge variety of equipment and products for and from apiculture. Honey traders, beekeepers and their organizations will meet and discuss prices, quality issues, marketing and problems encountered in the international honey market.

In organizing this international apicultural event, we also want to celebrate the friendship among beekeepers worldwide. This is a unique feature for the Apimondia Congresses. Everybody involved in apiculture will be there to facilitate the horizontal and vertical exchange of knowledge and information and meet friends.

Individuals as well as organizations should therefore prepare their participation in Apimondia 2009 now. We are all looking forward to meeting you in Montpellier, France, at Apimondia 2009. We are working hard to make your visit at Apimondia 2009 one to remember.

Asger Søgaard Jørgensen
President of Apimondia
asj@biavl.dk

Trade Of Bees

With reference to recent assertions from U.S. beekeepers regarding trade of bees into U.S. In the long run, honey bee populations on all continents will likely become infested with every bee parasite on the planet. The trade of bees from one continent to another expedites that process and your obviosuly painful experience of bee diseases in the U.S., please allow me to make a few respectful comments.

I understand that word trade implies legal commerce, in this case import and export under certain regulations and rules, which of course can be debated regarding their efficacy.

The U.S. border was closed to all bee imports (except some made by research institutions) from 1922 until 2005. Consequently, there was no trade at all between the U.S. and the rest of the world. I am not aware of any legal importation made in your country during this period of 83 years. However, in the meantime the U.S. was invaded by tracheal mites (1984), *Varroa* mites (1987), africanized honey bees (1990) and small hive beetles (1998). All these events predate the opening of the border to trade, both Australian and New Zealand imports.

How can you blame legal trade for spreading bee diseases? I have the impression you should have used another set of words. As far as I know, the spread of diseases, either accidental or purposeful has been accomplished either by smugglers and/or by pseudoscientists with nice credentials and plenty or scientific-peer reviewed papers, who brought in undesirable genetic stock under government distraction. A good example is the unjustified introduction of Apis mellifera capensis in many European countries (like Poland and Germany) and the introduction of African bees in Brazil performed by another scientist back in 1957.

Another awful example, is the breeding ground for small hive beetles in the UK under the auspices of the Central Science Laboratories (a British government agency). If I recall, a couple of years ago a UK lab had a security breach which made possible the spread of the Foot & Mouth virus. Hope it is not the same lab taking care of the small hive beetle now.

Martin Braunstein
Buenos Aires, Argentina

Apiforestation

I am writing in response to the article "Apiforestation" by Tammy Horn in the Dec. 08 issue.

This article smacks of coal industry propaganda, and the folks who don't know what's happening to our East KY mountains might come away from this article with false impressions.

While planting sourwood trees on abandoned mine lands is a fine idea, it remains to be seen if the "unique mesophytic forest" (her description) can indeed be regenerated. It's a great concept, and there are already uncounted thousands of acres of unreclaimed strip mines to go to work on.

The author makes no attempt to familiarize the reader with the harsh realities or the scale of strip mining occurring today, nor what is being sacrificed in the name of cheap energy. Rather, she defends the reprehensible practices of a rouge industry with a rich history of complete disregard to nature and human rights.

The lack of economic diversity in Appalachia is not due to a lack of devastated lands, and us beekeepers do not need to have our productive forests pushed down and buried so we can wait around hoping to get a honey crop from a bunch of sprigs planted in crushed rock.

Ms. Horn states that it is not

feasible to do away with mining, while I, along with many others, believe that alternative energy and energy conservation are very feasible, and we could faze out strip mining without giving up our electric lifestyles.

Most alarming is her comparison of strip mining to third world deforestation caused by starving people gathering twigs to cook by, and barely stay alive. Ms. Horn seems to be telling us that it is more responsible to bury a forest under 200 ft. of rock than it is to gather firewood. I cut firewood in the mountains every year, and when my work is done, a wondrously complex forest, complete with soil, cliffs, streams, aquifers, etc., still remains.

I don't think proponents of "surface mining" can make such a claim.

I encourage you, the reader, to investigate all sides of this issue, and not to be dazzled by slick P.R. and corporate spin.

William Shepherd
SE, KY

Author's Response: *I'm not ignorant of the deforestation occurring in KY. Kentucky loses 130 acres of habitat a day, according to Dr. Steven Bullard UK Forestry Economics. That's four acres a minute.*

This loss of habitat will occur whether I do anything or not, so I don't see my choice to try to make reclamation better as being "propaganda," but we live in a democracy and the writer has a right to his opinion.

When coal companies reclaim, they have the opportunity to do so in a way that can make the land both economically and ecologically beneficial. For instance, Texas can claim $7-8.00 an acre when hunting season arrives. But in KY, that drops to $4.00 an acre during turkey season. Bird watching brings in $6.6 billion nationally, according to Southwick and Associates (2006), but coal companies are just now beginning to reclaim/reforest with the idea of birds in mind.

I don't think that the analogy to Haiti and South Africa is false, as the writer implies, either in theory or in reality. If everyone in eastern KY (or the nation) chopped wood for heat, we'd have deforestation. When there is no mining, there will be deforestation.

History proves this, i.e., Britain in 16th century, Germany in 19th century, etc. I just chose to use recent contemporary examples because I thought most people could better appreciate those examples. But industrial history shows that deforestation will happen when immediate fuel sources are not nearby (Goodell's Big Coal and Freise' Coal: A human history are good references for my opinion).

Completely beside the point, the writer proves my point: he uses electricity (90% of electricity in KY is generated by coal) to power-up a computer to send this email and then goes out and chops wood to keep himself warm. If he chooses to take the moral high ground on this issue, I completely applaud his decision. It is a luxury I wish I could enjoy too.

But John Milton wrote in "Aeropagetica" that "cloistered virtue is really no virtue."

I choose to try to recognize the complexities that our nation faces as it tries to meet energy needs. Since 50% of the nation depends on coal, and 90% of the state, I have to accept my complicity in the current electricity grid and work toward changing it for the future. Which I do by working coal company, by voting for politicians who want more progressive energy policies, by keeping options for pollinators at the discussions in which I participate. Quite frankly, I could not live with myself if I knew I had a chance to make a destructive practice more responsible – and didn't say anything. I see no morality in self-righteous silence. Quite simply, if we didn't mine coal, people would be freezing in the current Winter conditions or dying in the Summer heat...

In Coal: A Human History, *Barbara Friese says that with coal, we no longer have to choose between a quick death or a slow one with no easy consequences in choosing either way. But we are insane not to recognize the consequences of fossil fuel-based energy consumption. I'm just trying to make one consequence more responsible.*

For me, this sort of exchange will continue, I anticipate, because Associated Press wants to profile the project too. What I love about what I'm doing is putting a face/voice to two issues folks don't know much about, but it's not easy or comfortable or profitable.

When I need clarity I focus on the bees, not people. But people have a need to react and this journal provides that forum. You <u>should</u> print both his letter and my response. But I really tried to be very respectful to the writer's opinion. Either way, I'm comfortable with whatever criticism comes down the pike. As I said, KY is losing habitat whether I do anything or not, and this project makes me feel less helpless. – Tammy Horn

Gentle Ceranae

Here is a photo of wax comb from *Ceranae* bees. They are very gentle and ideal for leave-alone-beekeeping. What can be the reason that they are destroying these bees in Australia? They do not mix with *mellifera*. Such hybrids could not even be established through AI.

Geert Van Eizenga
Netherlands

INNER COVER

Florida Leads The Way

Late last year the state of Florida did something no state has had the nerve, the time, or the common sense to do. They passed a regulation that adopts a standard of identity for honey. Not that this hasn't been tried before. Other states along with Florida have petitioned the FDA to get their act together and develop this standard so that honey regulators had a legal leg to stand on when they went after people who were messing with the purity of honey. FDA has pretty much told everybody to take a hike because they don't have the money, the time or the manpower to be bothered with such an insignificant, non life threatening product like honey.

Interestingly, as I write this the new congress has FDA officials in the hot seat for not doing a whole lot of things the past deregulation-happy administration didn't want them to do. We'll see if anything comes from this new oversight team in Washington. But one thing's for sure...if enough states other than Florida pass their own regulation on what honey is and that regulation is identical in every state, FDA will be hard pressed to ignore this any longer. The fact that the industry wants a standard, the industry has a standard, and the industry is willing to do the work, the FDA darn well better get in line and use that standard when prosecuting countries, companies or individuals for playing fast and loose with the purity of the product we produce.

Several states are online to do just that I'm told...OR, CA, OH, KS, ND, SD, WI, MD, VA, NC, WV, NY, UT, and MS are already moving to do the same thing...but that leaves, well, everybody else. And even in those states, local legislators need to be convinced that their constituents are behind this and they better pay attention. So lots of work still needs to be done in lots of places.

Why bother? Well, if you know what honey is, then you can absolutely define what it isn't, and if you believe someone is selling something that they say is honey, and it's not, and now you can prove it, backed with regulations at both the state and federal level...you can clobber them. Importers of junk honey, beware. Contaminators, beware. Honey adulterers, beware. Anyone who messes with the pure and natural image of honey, beware. Finally, we're coming.

All of this is due to the incredible hard work of a wonderful lady with the drive and ambition of a dozen people. Her name is Nancy Gentry. She has pushed, shoved, pulled, cajoled, begged, borrowed and strong armed any and everybody who could help make this happen in Florida, and now she's stomping in other states to get things going everywhere. You can contact her at **farmbees@gmail.com** for information on how to get things going in your state, and how to keep them going once you start.

Thanks Nancy.

•

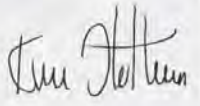
Right about today the frenzy in California is beginning to begin. Early reports signal a healthy supply of healthy bees ready to make almonds. This in no small way reflects the increased care and feeding honey bees have been getting over the past year to make sure they were healthy right about now.

Beekeeping has probably changed more in the last two years than it has in the last 20. Just think of the things that are being done right now that weren't being done by most beekeepers – whether hobby, sideline or commercial – even five years ago. Let me clarify that just a bit. Most of the techniques listed below are being carried out by those who are being successful. For instance:

- Wax swapping. Get the old out, and the new in.
- Checking for mite populations and using the least toxic, most effective treatments at the right time, the right way.
- Watching closely for Colony Collapse symptoms, even though they don't quite believe it's a real thing. At least now we know what, exactly the symptoms are, and what they look like all year long, real or not.
- Feeding. And not just feeding, but feeding when beekeepers never fed before, and feeding good feed and more of it. And keeping the feed on just a little bit longer.
- Back to the future by using more and more sucrose and less and less HFCS. That's a good thing.
- Requeening with better stock, or using their own stock that's better than they can buy, and requeening more often so the colony stays on top.
- Taking routine "health" samples to make sure their bees are staying healthy. This involves monitoring for virus and disease loads, and changing management practices to reduce, and keep problems at bay.
- Treating with healthy products for Nosema...whether the new or the newer Nosema, keeping bees clean means healthier bees, more honey and fewer secondary problems, like viruses.

You put all these things together and you can really believe that there will be enough healthy bees in California this month to do the job the almond growers are paying those hefty prices for. And that's a good thing too.

But you know the one thing that all successful beekeepers are doing, don't you? Every good beekeeper I know is gearing up for another season right now, and every one of them is keeping their hive tools sharp and their smokers lit because believe me, this is going to be another year to remember. You read it here first.



FEBRUARY – REGIONAL HONEY PRICE REPORT

We polled our reporters this month asking about routine management activities regarding health maintenance, particularly disease prevention or treatment and nutritional management.

The chart on this page shows how often our reporters engage in each of these activities…every year, only if needed, or never. The results are interesting. Especially note Nosema and AFB treatments.

More interesting however, are the groupings of each activity. For instance, when you look at feeding generally, that is combining both carbs and proteins, you get 22% feed every year, 44% never feed, and 35% only when necessary.

Varroa treatments, certainly the most important health management activity beekeepers engage in is interesting in the fact that 38% don't treat at all, ever, with anything.

Use the chart to record your activities and see where you fit.

February 2008

Treatment	% Using . . .		
	Every Year Needed Or Not	Never Have, Never Will	Only If Needed
Nosema (Fumigillan)	17	14	54
AFB Treatment	45	14	42
EFB Treatment	34	14	45
Feed Carbs			
Sucrose	24	11	35
HFCS	20	24	18
Blend	8	24	15
Other (Honey, Fondant)	8	17	20
Feed Protein			
Commercial Substitutes	15	60	25
Varroa			
Organic Acids	18	42	38
Reg. Chemical Treatments	57	14	32
Powdered Sugar	41	34	25
Drone Comb	31	38	31
IPM			
Routine Comb Replace	34	-	66
Other	22	52	26

Totals may not add up to 100 due to multiple uses, non-answers, and multiple answers.

February 2009

Treatment	% Using . . .		
	Every Year Needed Or Not	Never Have, Never Will	Only If Needed
Nosema (Fumigillan)	34	13	52
AFB Treatment	31	14	56
EFB Treatment	26	12	62
Feed Carbs			
Sucrose	37	12	51
HFCS	18	46	36
Blend	15	59	27
Other (Honey, Fondant)	18	44	38
Feed Protein			
Commercial Substitutes	25	40	35
Home Made	18	61	21
Varroa			
Any Organic Acids	23	44	33
Reg. Chemical Treatments	37	14	49
Powdered Sugar	28	46	26
Drone Comb	22	43	34
Other	29	43	27
IPM			
Routine Comb Replace.	40	17	42
Screened Bottom Board	50	30	20
Other	24	43	33

REPORTING REGIONS

	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	1.50	1.62	1.50	1.65	1.38	1.38	1.44	1.50	1.29	1.35	1.45	1.45	1.29-1.65	1.46	1.50	1.20
55 Gal. Drum, Ambr	1.40	1.35	1.40	1.25	1.28	1.21	1.40	1.40	1.40	1.40	1.40	1.45	1.21-1.45	1.36	1.33	.96
60# Light (retail)	120.00	131.33	130.00	116.00	120.00	115.00	120.50	122.50	127.00	132.65	148.00	147.50	115.00-148.00	127.54	122.36	120.54
60# Amber (retail)	120.00	123.33	130.00	113.75	120.00	110.00	113.60	125.00	128.05	128.05	139.25	138.00	110.00-139.25	124.09	119.27	117.11
WHOLESALE PRICES SOLD TO STORES OR DISTRIBUTORS IN CASE LOTS																
1/2# 24/case	52.08	61.98	45.60	45.00	64.28	50.50	45.55	64.28	64.28	64.28	49.50	82.50	45.00-82.50	57.49	53.12	42.90
1# 24/case	65.52	78.28	72.00	69.52	96.00	72.53	66.71	72.60	68.00	109.00	74.50	98.50	65.52-109.00	78.60	77.23	68.96
2# 12/case	69.72	74.72	66.60	59.50	89.00	61.13	60.80	75.00	55.00	79.24	59.33	86.00	55.00-89.00	69.67	65.59	59.81
12.oz. Plas. 24/cs	64.32	71.98	50.40	57.84	88.80	57.00	57.25	61.20	54.00	52.80	63.60	68.33	50.40-88.80	62.29	60.57	53.17
5# 6/case	76.41	83.99	78.00	67.50	78.84	60.00	69.12	77.40	60.00	56.00	72.00	90.50	56.00-90.50	72.48	77.84	69.08
Quarts 12/case	92.86	110.88	92.86	91.92	77.50	85.44	81.97	91.50	102.12	115.00	96.45	119.00	77.50-119.00	96.46	103.71	95.22
Pints 12/case	56.88	56.95	56.88	57.85	58.00	48.00	49.33	58.50	66.00	56.25	53.67	68.00	48.00-68.00	57.19	63.09	55.45
RETAIL SHELF PRICES																
1/2#	2.88	3.40	3.16	2.61	2.29	3.16	2.91	1.75	1.99	2.48	3.06	4.19	1.75-4.19	2.82	2.91	2.57
12 oz. Plastic	3.30	3.96	3.57	3.48	4.33	4.00	3.99	3.85	3.40	3.25	4.02	4.39	3.25-4.39	3.79	3.72	3.26
1# Glass/Plastic	3.83	4.49	4.90	4.81	4.91	4.67	3.88	4.30	3.70	4.61	5.29	6.00	3.70-6.00	4.62	4.66	4.16
2# Glass/Plastic	8.38	7.70	8.11	7.75	7.14	7.15	7.88	8.12	6.25	7.58	8.13	9.09	6.25-9.09	7.77	7.37	7.07
Pint	9.53	6.42	7.95	6.04	5.59	5.55	8.35	6.82	5.95	7.35	6.68	8.75	5.55-9.53	7.08	7.28	6.20
Quart	12.15	9.48	11.99	10.18	8.82	10.05	8.50	12.00	9.19	14.50	11.61	14.00	8.50-14.50	11.04	11.52	10.29
5# Glass/Plastic	15.50	15.89	19.45	16.10	20.00	12.75	15.43	17.50	18.00	14.24	17.67	20.00	12.75-20.00	16.88	16.92	15.74
1# Cream	5.25	5.80	6.36	5.50	6.36	4.00	5.58	4.90	4.50	6.11	5.54	6.50	4.00-6.50	5.53	5.45	4.91
1# Cut Comb	5.50	5.71	6.50	4.86	9.95	4.65	6.57	4.99	9.95	8.00	8.25	8.50	4.65-9.95	6.95	6.17	7.18
Ross Round	6.93	4.15	6.50	5.53	6.93	6.93	5.33	6.75	6.93	6.93	7.50	8.25	4.15-8.25	6.55	6.29	5.27
Wholesale Wax (Lt)	3.67	3.25	2.63	2.25	2.00	4.33	2.79	3.25	3.50	2.35	2.81	3.80	2.00-4.33	3.05	3.37	2.53
Wholesale Wax (Dk)	2.00	3.00	2.50	2.18	1.90	5.00	2.19	3.00	2.95	2.95	1.98	2.50	1.90-5.00	2.68	2.44	2.15
Pollination Fee/Col.	80.00	79.33	62.25	51.00	155.00	43.33	51.40	60.00	88.06	88.06	75.00	118.33	43.33-155.00	79.31	80.62	66.25

a closer look

VITELLOGENIN

Clarence Collison

Vitellogenin, like most biochemical compounds, plays multiple roles in honey bee physiology.

Vitellogenin (from *vitellus*—yolk, and *gener*—to produce) is a female-specific glycolipoprotein yolk precursor that is associated with egg-producing animals. It is synthesized by the abdominal fat body cells and is comprised of sugar alcohol (glycol), lipids or fat and protein; in honey bees the proportions of these components are 2%, 7% and 91%, respectively (Wheeler and Kawooya 1990). Vitellogenin production is regulated by juvenile hormone, and is synthesized and excreted into the hemolymph directly before yolk deposition (Amdam et al. 2003). Developing oocytes (egg cells) sequester vitellogenin via receptor-mediated endocytosis (Raikhel and Dhadialla 1992; Pinto et al. 2000). In the honey bee, vitellogenin is not only synthesized by the reproductive queen, but also by the functionally sterile workers. There is also evidence of vitellogenin production in drones, though the protein is not associated with reproduction in this caste.

The appearance of vitellogenin in the hemolymph occurs during the pupal period for both queens and workers, though at different intervals. In queen pupae, vitellogenin is excreted during an early phase of cuticle pigmentation, approximately 60 hours before eclosion (final molt to adult bee); in workers the protein appears later, approximately 10 hours before eclosion. In both castes, vitellogenin production coincides with a slight increase in endogenous levels of juvenile hormone in the presence of low levels of ecdysteroids (Barchuk et al. 2002).

Shortly after emergence, vitellogenin begins to accumulate in the queen's hemolymph, and within only three days (prior to the mating flight) it constitutes up to 70 percent of the queen's hemolymph proteins (Barchuk et al. 2002). After mating, the vitellogenin titer declines slightly, as vitellogenesis (yolk deposition) initiates. However, if mating flights are prevented, vitellogenin titers increase to as much as 90 percent of hemolymph protein; the same occurs if egg production is interrupted. Vitellogenin levels in queens are ten times higher than those observed in workers during the first few days of adult life. The queen's high production level is maintained throughout her adult life. The difference between castes appears to be related to the respective reproductive capacity of queens and workers. Queens are capable of producing 500-2000 eggs per day compared to 10-30 for laying workers. In order for oogenesis (egg production) to proceed adequately in queens, apparently early initiation of vitellogenin synthesis by the fat body is required, even though yolk deposition does not start until after mating.

"Vitellogenin is the major storage protein and builds up in bees during periods of reduced brood rearing to provide a protein reservoir instrumental for survival."

Egg-laying workers are only rarely observed in colonies headed by a fully active queen. However, when a colony has lost its queen, some of the workers activate their ovaries and can lay a considerable number of unfertilized eggs. Despite the loss of most of the worker ovariole primordia during metamorphosis, the ovarioles can become fully functional in the absence of the inhibitory queen and brood pheromones (Tanaka and Hartfelder 2004). Even though most workers never lay eggs, all exhibit a significantly elevated vitellogenin titer when they are between five and 15 days old. During this period their main function as nurse bees is to feed large quantities of glandular secretions to the larvae, queen, workers and drones and recent studies indicate that vitellogenin is converted into the hypopharyngeal gland proteins that comprise royal jelly (Amdam et al. 2003). Vitellogenin binds to the hypopharyngeal gland membranes in the heads of nurse bees, as demonstrated by Amdam et al. (2003) when incorporating a labeled amino acid into vitellogenin and tracing the label to larvae of workers and queens. As nurse bees develop into foragers, their vitellogenin production decreases progressively and finally ceases about 20 days after the adult molt (Piulachs et al. 2003).

The hormonal regulation of vi-

tellogenin synthesis in honey bees remains unresolved in many details, though the activities of two hormones have been observed. Studies have shown that the application of low doses of juvenile hormone to adult workers lead to an increase in vitellogenin levels, whereas high doses of the hormone or its synthetic analogue inhibited vitellogenin; in contrast, juvenile hormone had little effect on adult queens (Rutz et al. 1976; Pinto et al. 2000). Ecdysone (a molting hormone associated with larval development) was shown to have an inhibitory effect on vitellogenin synthesis when applied to queen and worker pupae, which corroborates the natural decrease in ecdysteroids that occurs during late pupal development (Feldlaufer et al. 1985; Hartfelder et al. 2001). Queens and workers appear to share a common control mechanism for the timing of vitellogenin synthesis, involving an increase in juvenile hormone titers in the presence of low levels of ecdysteroids.

The role of vitellogenin in drone bees is not quite as clear as in the female castes. Vitellogenin mRNA was observed in freshly molted drones, although it was not found in the pupal stage, as in the female castes (Piulachs et al. 2003). A maximum hemolymph concentration of vitellogenin was shown to occur within the first week of emergence (Trenczek et al. 1989). During this period vitellogenin represented about 5 percent of the soluble hemolymph proteins. Tracer experiments revealed that the maximum level of vitellogenin production comprises about 10 percent of the total synthesis of serum proteins until day eight, and then decreases rapidly thereafter. In drones older than two weeks, only tiny amounts of vitellogenin could be detected in the hemolymph, and synthesis had ceased. Insect vitellogenins have been implicated in the transport of sugars, lipids, phosphates and hormones (Sappington and Raikhel 1998), and these may be some of the functions of vitellogenin in drone honey bees.

Vitellogenin, like most biochemical compounds, plays multiple roles in honey bee physiology. Oliver (2007) reports that workers use vitellogenin as a reserve food supply (fat body), an immune system component, an antioxidant to prolong queen and forager lifespan, and in young bees as a hormone to regulate future foraging behavior. The function of vitellogenin in reproductive queens and nurse bees is well understood, but the presence and activity of this protein in drones largely remains a mystery.

Worker honey bees may be classified as either short-lived summer bees or long-lived winter bees in temperate zones. Protein status appears to be a major determinant of honey bee life span and vitellogenin seems to play a crucial role (Amdam and Omholt 2002). Vitellogenin is the major storage protein and builds up in bees during periods of reduced brood rearing to provide a protein reservoir instrumental for survival. Being the most abundant hemolymph protein found in both workers and queens, it strongly reflects the protein status of the bee and stresses the importance of having excellent nutrition within the honey bee colony. Colony survival during the winter and colony development in the Spring are directly associated with vitellogenin levels. BC

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LATSHAW'S MICRO INSTRUMENT FOR MICRO BREEDERS

Joe Latshaw

An Innovative And Affordable Approach To I.I.

There is currently an intense interest to develop and promote regional honey bee breeding programs. Dr. David Tarpy has likened beekeepers' interest with the localized development of honey bee selection programs to that of microbrewers. Microbreeders, as Dr. Tarpy refers to local bee breeders, are focused on developing high quality, well adapted stocks on a smaller scale than their commercial beekeeping counterpart. Regional breeding programs utilize local selection pressure to develop strains adapted to their environmental conditions. In addition, many valuable genetic resources are available within the apiaries of part-time beekeepers across the U.S., and it is important to preserve the genetic diversity within local populations. The increasing interest in locally developed stock improvement programs has also raised interest in the use of instrumental insemination (II) as a tool to assist with selective breeding programs. The Latshaw Micro Instrument is a new apparatus designed specifically for use by microbreeders.

When thinking about the use of II as part of localized breeding programs, two challenges present themselves. The first obstacle for many part-time beekeepers is price. Traditional II equipment has been too pricey for beekeepers to justify such expenditure in their own operation. The second challenge beekeepers face with the use of II in a breeding program is a doubled edged sword in the context of genetic control. The use of II results in precise control of honey bee mating, which enables more rapid selection progress. However, such precise genetic control may also result in the loss of genetic diversity over time, especially within the confines of relatively small populations. To address the issues of affordability and genetic diversity, the Latshaw Micro Instrument utilizes a highly simplified plan combined with a newly designed large capacity syringe that homogenizes/mixes semen from a large pool of drones within the body of the syringe.

The Latshaw Micro Instrument was designed for use with the flexible insemination technique. The flexible insemination technique facilitates simplified instrument design and greatly reduces the cost of the instrument. First utilized in the 1920's by Dr. Lloyd Watson, the flexible insemination technique was employed to develop the original "Instrumental Insemination" technique. Dr. Watson's "instrument" consisted of a wooden stage with fine thread used to secure the queen. The syringe was held by a micromanipulator attached to the microscope stage. A pair of fine forceps was used to grasp the queen's sting in preparation for inserting the syringe tip into the reproductive tract. Dr. Watson successfully inseminated queens using his flexible insemination technique which paved the way for further research and innovation in the field of honey bee instrumental insemination.

The Latshaw Micro Insemination Instrument is a simplified apparatus designed for use with the flexible insemination technique.

Drs. Kuhnert and Laidlaiw (1994) reviewed and evaluated the flexible insemination technique in conjunction with conventional II techniques to determine the merits of current and past insemination techniques. Their findings revealed that the flexible insemination technique, first employed by Dr. Watson, was easier for students to learn and the insemination process required approximately 18% less time than subsequent methods. Drs. Kuhnert and Laidlaw clearly demonstrated the ease of the flexible insemination technique and realized the potential it represented for a wider range of beekeepers interested in II. Being easy to use is highly relevant, especially to the beginner. Simplified instrument designs that utilize the flexible insemination technique offer an innovative alternative for microbreeders interested in II. The Latshaw Micro is a no frills, no thrills type of instrument that possesses several innovative design features centered around the use of the flexible insemination technique.

In the most basic sense, an instrument is designed to hold a queen and provide a means to manipulate and position a syringe. The Latshaw Micro Instrument consists of a small instrument base, designed to rest on the stage of a microscope, with a simple queen holder and syringe

The flexible insemination technique utilizes a pair of fine forceps to position the queen for insertion of the syringe tip.

This figure demonstrates the semen homogenization process within the Latshaw Micro syringe. One microliter of blue dye was drawn into the syringe after the semen collection was completed and allowed to remain undisturbed for 9.5 hours.

manipulator mounted on the base of the instrument. The queen holder for the Latshaw Micro Instrument consists of a small diameter tube with a ventral hook mounted on the queen tube. The ventral hook is moveable in order to position it for each individual queen. Anesthesia (carbon dioxide gas) is administered through a fitting mounted on the base of the instrument. The gas fitting also serves as a positioning device for holding the queen tube at the proper angle for insemination. Combining and consolidating the functions served by each component is another way to reduce the complexity and cost of the instrument, but still allowing for the proper movements and adjustments.

One of the greatest challenges presented by conventional instrument designs is proper alignment. Therefore, the Latshaw Micro offers a great deal of flexibility and maneuverability within a predetermined range to reduce the need for individual alignment and assembly. The upright arm or syringe manipulator allows for movement in three planes. However, to simplify instrument usage, critical distances are predetermined to facilitate instrument alignment. The upright arm also utilizes a highly simplified design employed by early instruments. Movements are based on physical operator pressure and tension slides. Simply adjust the instrument movements to the operator's desired tension and guide them in the proper direction. Again this simple yet functional movement design greatly reduces machining costs. All movements for the Latshaw Micro are based on simplified yet precise pressure movements, including the positioning of the syringe.

Another innovative design feature of the Latshaw Micro involves a larger capacity syringe. The new syringe features a large volume capacity, with direct movement controlled by a threaded plunger. The simplified design is small enough to allow the entire syringe to be placed directly in the syringe manipulator without the need for an additional syringe stand. In addition, the Latshaw Micro syringe features a built-in chamber for mixing/homogenizing semen. A syringe with the capability of homogenizing honey bee semen is highly significant in the context of recent genetic research and micro-breeding programs.

What is the significance of utilizing homogenized honey bee semen in breeding programs? Initially, the use of homogenized semen was proposed to simplify selection efforts. Theoretically, if all queens in an apiary were inseminated using the same batch of homogenized semen, differences in colony performance could be more readily attributed to the queen's genetic background, thus simplifying genetic selection. More recent research examined the benefit of genetic diversity for honey bee colonies. Tarpy and Seeley (2006) and Seeley and Tarpy (2007) showed colonies with greater genetic diversity (colonies headed by queens inseminated with a larger representation of males) exhibited a lower incidence of disease. Matilla and Seeley (2007) demonstrated that colonies with greater genetic diversity showed faster colony build-up, greater wax building, and better survivability than those colonies with less genetic diversity. The use of homogenized semen will not result in super queens, but the evidence suggests there are distinct advantages for colonies with greater genetic diversity.

An additional point to be made regarding the use of homogenized semen in micro-breeding programs is the conservation of genetic diversity within a population of honey bee colonies. Bourgeois et al. (2008) recently reported that a decline in the number of breeder queens used in the industry could result in inbreeding and decreased genetic diversity within the U.S. honey bee population. Too many beekeepers for too long have relied on a very small number of breeder queens from which to rear queens. That is to say, selecting the one or two "best" breeder queens and requeening an entire operation or selling thou-

The Latshaw Micro Instrument is quickly and easily disassembled for storage or transport in a protective carrying case.

sands of daughter queens all over the U.S. reduces genetic diversity. A great deal of genetic diversity is lost each generation using traditional practices. Natural honey bee reproduction strategies rely upon diversity and do not allow for thousands of replacement queens produced from a single queen mother. Honey bees typically issue one or two swarms to propagate and distribute genetic material. In order to more closely replicate the honey bee's reproductive strategy to conserve genetic diversity, the use of breeder queens inseminated with homogenized semen will be of great benefit. Rather than large scale queen production serving as a genetic bottleneck, it can be used to enhance genetic diversity throughout the U.S.

The Latshaw Micro is a new and innovative instrumental insemination apparatus designed to address many of the challenges facing the controlled breeding of honey bees. It is an economical instrumental insemination instrument designed for microbreeders to facilitate their growing contribution to selective breeding programs. The Latshaw Micro utilizes the flexible insemination technique first developed by Dr. Watson. Utilization of the flexible insemination technique simplifies the design features of the instrument and provides for greater efficiency and ease of use as shown by Drs. Kuhnert and Laidlaw. In addition, a simplified instrument design greatly reduces machining costs, making this new technology more accessible to a greater number of beekeepers. A second enhancement of the Latshaw Micro Instrument is the use of a newly designed large capacity homogenizing syringe. The use of homogenized honey bee semen in selective breeding programs provides a tool to promote greater genetic diversity within a population. It is imperative that steps taken by microbreeders to develop regional breeding programs be mindful of selection practices designed to conserve genetic diversity. Therefore the Latshaw Micro was developed to provide an additional tool to microbreeders working to promote regional and sustainable honey bee breeding programs. BC

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CRACKING THE POLLEN CASE

Digesting pollen, for bees or humans isn't as easy as you thought.

Jason Nelson

Every beekeeper has a secret recipe for Fall feeding and tonight I was preparing mine: Canola oil, sea salt, fresh pepper rubbed over a thick rib eye and fried in a pan to a rich, juicy crust. Oh, perhaps I should mention this was bee*keeper* feed. Honey bees aren't carnivorous, or else open feeding would just involve tethering a goat in the apiary and making a run for it. I prefer to get my protein on a plate with a pat of butter; honey bees fortunately do not.

I have a lot more in common with wasps than honey bees. Wasps have the jaws of hunters and weapons to match. They are smooth, sleek, and deadly. When they need protein to raise their brood they hunt it down and kill it. Then there's the honey bee. Their jaws are not designed to rip and slice; their stings are not laced with paralytic poisons. When it comes to selecting a protein source the honey bee prefers something less mobile, something more defenseless. Something that doesn't run away when you land near it, fight back when you grab it, or have teeth, stingers or other dangerous weaponry: something like pollen.

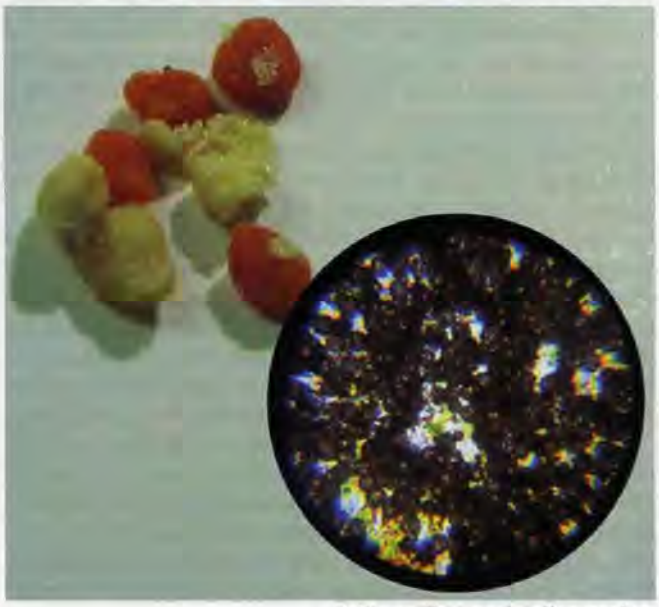
Plants create pollen in order to make more *plants*, not to make more bees. Every bee book I've read talks about the miraculous relationship between the bees and the flowers. How the flowers produce pollen and the bees ferry it back and forth for the flowers and in return the flowers let them gather nectar. When a bearded man at a chicken fried steak buffet transfers some gravy from one plate to another we don't call it a miracle. For honey bees, transferring pollen from flower to flower is more a side effect then an end goal. They might transfer some pollen for the flowers but most of it is packed away for the bees to eat. Using pollen as a primary source of protein is a great choice for a bee that's not built to hunt but it does present its own problems.

The sperm cells contained in a pollen grain are extremely fragile. Left on their own they'd be destroyed long before even a rocket propelled honey bee could transfer it from one flower to another. In nature the approach taken is to build layers of protection around the genetic payload. Almonds are covered in a nut shell. Eggs have a hard layer around the embryo inside and the world outside. Even teenage drivers get wrapped in Concorde station wagons with wood panel sides. Pollen gets wrapped up too.

As a grain of pollen matures it is prepared to leave the safe harbor of the flower and take a voyage beyond the edge of the petals. The delicate genetic package is enclosed carefully in a cellulose layer called intine which acts like a baggie to keep the DNA goo together. This inner core of cytoplasm is the real source of nutrition in pollen but the cellulose by itself blocks easy digestion. On top of the intine is the *exine* which acts like a bullet proof vest for the pollen grain. The exine is composed of sporopollenin, which is the scientific term for "incredibly tough." Sporopollenin is a compound resistant to most acids, bases, temperatures up to 250°C and immense pressure. On top of the exine is the *pollenkitt*, or "Sticky stuff on pollen." Pollenkitt acts like glue to stick pollen where it lands, as well as providing an additional layer of bubble wrap around the exine. Together these layers form a miniature plant which will germinate under the right conditions, growing a tube that can reach up to 10 inches to deliver the sperm cells right into the heart of the plant. You can think of a grain of pollen like a chocolate covered almond, if the almond were still in the shell when it was dipped. With that many layers between the honey bee and the tasty genetic filling, how does the honey bee manage to digest pollen at all?

In order to understand how a honey bee turns a pollen grain from lock box to lunch box, you have to go inside a bee. You don't have to go very far, just past the nectar crop, to the entrance to a bee's digestive organ: the *ventriculus*. The ventriculus is the organ in which digestion of pollen is performed. How do we know this? We looked inside a bee. Well, not me specifically. Researchers did. Researchers with sharp scalpels and a lot of free time cut tiny windows into the abdomen of bees and then fed them pollen. Then they watched the bees digest the pollen.

On my sixth birthday I received two rectangular gifts. One came from my parents and I shredded the paper to



Pollen pellets and pollen grains.

SEM of Dandelion pollen grain with lots of holes.

find Batman, in plastic action figure glory. I looked at the other box and saw the shape, the outline, and I knew: It *must* contain the Joker. That package came from my grandparents in Slaton, Texas. It was wrapped in plastic foil, followed by brown shipping paper, layered in shipping tape. I began to claw at the package. After a few minutes my mother tried to help. She broke two nails and passed it off to my Dad. He stabbed at it with a pocket knife. For the next few minutes every family member did their best to pry open that package. Finally my Dad went to the garage and came back with his toolbox. Batman and the tin snips defeated my grandmother and the U.S. postal service but it took a while. Inside I found *another* Batman. That day I learned an important lesson – regardless of what is inside, some packages are harder to get into than others. The same is true with pollen.

The first stage of digestion involves unwrapping the pollen grain. The lipids in the pollenkitt are stripped away like wrapping paper. Unlike wrapping paper (which is rarely chewed up and swallowed), the pollenkitt is nutritious, rich in lipids. Under the pollenkitt lies the exine. The exine structure varies from plant species to plant species. Some exines are solid smooth and rely on the host plant triggering germination. Other exines have gaping holes in them so wide you could back a (tiny) loading truck right up to the pores to offload the cytoplasm. Under the exine the intine stands as a final barrier between the bee and the feast. In the ventriculus the honey bee employs a number of methods to get past the hard outside to the creamy filling. The first of these is osmotic shock. Osmotic shock causes the pollen exine to rupture like a balloon bursting. Some types of pollen are like Ford Pintos, ready to explode. Other pollen grains are sturdy and require the honeybee to "pick the lock." These pollen grains have germination pores, which function as the plant equivalent of the exit rows on an airplane. When the pollen touches down after a crash landing on the pistil the grain germinates, opening at the pores. It then grows a tube that acts as an emergency slide for the genetic material. Honey bees use this method to open some pollen grains. Inside the ventriculus, nice and warm, the germination pores begin to swell and open. What happens next is like a scene from a alien invasion movie as the digestive enzymes seep in and out, leaving nothing behind but the empty shell. It's like eating an almond and digesting the almond from the inside of the shell. Some pollen grains are built like Volvos. These pass through the ventriculus and come out the other end not the least bit digested. While that's a win for the pollen grain, it's a loss for the bee in more ways than one. First there's the fact that all that work didn't yield protein. Secondly the bees have to burn carbohydrates on cleansing flights to get rid of the indigestible bits.

What about humans? The local health food store sells pollen. "Bee Pollen", said the sign above the counter. "Nature's Best Food," said the writing underneath. "This is real bee pollen," said the sales lady, "it's expensive because it contains all the protein bees need to satisfy all their needs." Road kill contains all the protein crows need to satisfy their needs, but people don't pay $20 for a tiny bottle of crushed, dried possum. So how do we fare in the pollen digestion?

To answer that question let's look at the six major methods known for digesting pollen. The first three involve specialized mouth parts for cracking, crushing or piercing it. Since most people don't chew each grain of pollen individually or have needle like teeth we'll proceed to methods four, five and six, which are osmotic shock, pseudo germination or just flat out dissolving the sporopollenin and intine. Six is a long shot – only a few insects are capable of dissolving the sporopollenin (and most of the compounds that would digest it would digest *us*). That leaves osmotic shock and pseudo germination. Pseudo germination is possible in honey bees because the pollen is sitting in the nectar crop and exposed to warm dilute sugar solution – perfect for convincing a pollen grain it's time to grow. The human digestive system features hydrochloric acid. In the Spring when my wife starts our garden we have rows of seed trays. "Soak generously in warm hydrochloric acid" never appears in the germination instructions on the seed packets, and for good reason. Even if we could get the pores to open the intine is made of cellulose and we are notoriously bad at digesting it. Without the nectar crop of a bee and the ability to induce pseudo germination we average digestion of 48% of pollen material. That leaves osmotic shock, and at least here we have good news. A pollen grain whose external barriers explode is every bit as digestible as a steak, even if it isn't as tasty.

So honey bees have a specialized digestive tract for extracting the nutrients from pollen. Humans can gain nutritional content from raw pollen, but the number of intact and partially digested pollen grains at the end of our gut suggests we do a poor job of it. Compared to the honey bee we're downright abysmal. I say let the bees have the pollen. You can't pan fry pollen with butter, garlic, salt and pepper. The bees have *no* idea what they are missing. BC

Jason Nelson cuts into honey bees to find out what's inside, looks at pollen grains, keeps bees and makes his family wonder what he will do next from his home in Kirkland, Washington.

PROTEIN POWER

Not All Pollens Are Created Equal

Joe Traynor

All beekeepers are aware that protein is a key constituent in a healthy bee diet – honey provides the carbohydrates, pollen supplies the protein. When it comes to pollen, though, not all pollens are created equal[1,2,3].

Flower Source	% Protein
Almond	25
Apple	25
Canola	24
Clover	24
Sunflower	15
Blueberry	14
Corn	15

Australia's Graham Kleinschmidt did much of the pioneering work on the importance of protein content of pollens. Australia's Doug Somerville made significant subsequent contributions in his classic book *Fat Bees Skinny Bees*[2].

Ashton[1] concludes that "*bees with very low crude protein levels, e.g., when coming off sunflowers, will run down very quickly if placed on a medium to heavy flow with average quality pollen support. Recovery of a colony after these circumstances could take as much as four months.*"

It is noteworthy that the three pollens in the above list that have the lowest protein levels – sunflower, blueberry, corn – have been lurking in the background in areas where CCD has raised its ugly head. In France, where colony collapse occurred at around the time neonicotinoid pesticides were introduced, sunflowers are a major flower source. In the eastern U.S., bees that have spent a good part of the Summer on blueberries appear to be more susceptible to CCD as are bees that are on a corn pollen diet.

Before CCD hit, French beekeepers had been putting bees on sunflowers for years, with no apparent problems; the same for eastern beekeepers and blueberries, but this was before *Varroa, Nosema ceranae* and viruses became established, with *Varroa,* in particular having a negative effect on the immune system of honey bees. Malnourished bees that survived in the past may well have reached a tipping point when confronted with the combination of current pathogens and a weakened immune system. Malnourished bees in California's central valley that had been successfully rented to almond growers for years, now succumb to CCD, or are too weak to be rented.

A 1995 study[4] divided bees into two groups: one fed solely with canola pollen, the other with sunflower pollen:

Pollen Source	Life Span of Bees
Canola	51 days
Sunflower	31 days

This study was done well before the advent of CCD and the remarkable 20 day difference in life span could well cause sunflower bees that survived in past years to reach a tipping point in today's world where they are confronted with the agents of CCD. The authors of this study concluded that their results indicated that *"growers of canola need not be concerned with the health of pollinating honey bees but that growers of sesame and especially sunflowers might take note of potential problems" and that bees on sunflowers "will need to be provided alternate floral or nutritional supplements source to enrich their diets and maintain colony health."* (I am not aware of any similar study with blueberry pollen). There are an amazing one million acres of canola in North Dakota (N. Dakota is the bee capital of the world in the summer, as California is during February) and N. Dakota beekeepers report reasonably good colony health even though virtually all N. Dakota canola seed is treated with neonicotinoids (the material is felt to dissipate by the time canola blooms). The above data also bring up an interesting question: should growers of crops with low-quality pollen pay a premium for bee rentals?

There has been enough information on honey bee nutrition in recent years to cause most beekeepers, especially those that supply almond bees, to embark on a supplemental feeding program (see Randy Oliver **www.scientificbeekeeping.com** for a short course on honey bee nutrition). Bees will consume a pound of supplemental feed in a week and around 16 pounds over a three-month period[5]. At up to $2/lb for feed (not counting labor) an intense feeding program will be a significant management expense, but some beekeepers are feeding up to 16 lbs figuring they can recoup this expense with current high almond pollination fees. Today, feeding programs often start in August-September (unless bees have access to an excellent Fall pollen source such as rabbit brush) and continue through the Fall-Winter months. Fall feeding in many cases is superior to Winter feeding – it provides younger bees with higher protein and vitellogenin levels and with more robust immune systems – longer lived

"Should growers of crops with low-quality pollen pay a premium for bee rentals?

A History of Malnutrition in California Almond Bees

If malnutrition is defined as less than optimum nutrition, bees in California's central valley have always been malnourished. Most bee pasture dries up in September and honey bees are faced with four long months until almond bloom starts in February. Bee colonies have adjusted to these circumstances by reducing their populations as they enter Winter; they come out of Winter with three to four frames of bees, and can build up rapidly on almond pollen in February. This had been the normal situation for years, and in the 1960s, the California Beekeepers Assn. set a realistic standard of four-frames of bees (and a laying queen) for almond pollination. Pollination fees were in the $3 to $4 range and both almond growers and beekeepers were content – growers got bees at bargain prices and beekeepers got access to an excellent pollen source that enabled them to get a jump on building colonies for Spring and Summer honey flows. Both the timing of almond bloom and the quality of almond pollen made a good fit for many California bee operations. Bees that were severely malnourished in January, recovered nicely by the time almond bloom was over and were in excellent condition by the time major nectar flows commenced.

As almond growers began demanding stronger colonies, beekeepers were forced into a supplemental feeding program. Increased pollination fees followed, but many beekeepers preferred, and still prefer, the way things used to be – a lower rental fee, but no feeding costs and less scrutiny by growers on colony strength. The demand for strong bee colonies on the part of today's almond growers has been a major driving force in the current emphasis on bee nutrition.

bees that can maintain colony populations during the Winter. Beekeepers that fed only one or two pounds of protein supplement in past years are now feeding up to 16 or more pounds in order to get top-dollar for almond bees. Because pollen can transmit chalk brood and other harmful pathogens, beekeepers should make sure any pollen they use in supplemental feeding has been irradiated (and be aware that some methods of irradiation are more effective than others).

Beekeepers should be aware that not all supplemental feeds are alike and should look to comparative studies (and reports from the beekeeper pipeline) as to which feeds are best. Going strictly by protein content is not always a reliable indication as a 2000 study showed that a commercial feed with a 30% protein content was significantly less beneficial for bees than canola pollen and only slightly better than sunflower pollen[3]. All proteins contain nitrogen (N) and analysis for total N content is the usual method of determining protein content; total N is multiplied by a conversion factor – 6.25 is used in some studies[2] – to obtain % crude protein. A problem with this is that non-protein materials (e.g., nitrogen fertilizers) can be added to a feed to boost its N content (but not its protein content). The recent recall of dog food products from China was due to adulteration with materials designed to increase their protein analysis.

Amino acids are what bees require in a protein supplement. All amino acids are proteins, but not all proteins are amino acids. No single pollen source contains the complete array of necessary amino acids in the proper proportion for honey bees. Bees require a mix of pollens, which is why feeding on a monoculture source of food is considered detrimental to bees. Even though an individual pollen can be an excellent source of protein (almond, apple, canola) a strict diet of one pollen will not supply bees with the full complement of required amino acids and a poor quality pollen (e.g., sunflower) can set the table for much worse. Some beekeepers mix powdered eggs (either yolks or whites or both) in patties for supplemental feeding. Although some reports indicate bees have difficulty using protein from eggs, these beekeepers report good results (all beekeepers would like to see standardized tests with egg materials as bee feed).

Pollen in feed mixes will lose its nutritional value over time[3]; cold, dry storage can minimize this loss. Bee-collected pollen is used in many supplemental patties, but the main protein source in patties is usually brewers yeast, because it is less expensive than pollen and has proven to be effective. Some beekeepers feel that the main benefit of pollen in patties is to make the patties more palatable so that bees will take up the protein material.

In this age of CCD, nutrition is assuming greater importance in all bee operations, large or small. The old adage *"you are what you eat"* may apply more to honey bees than it does to people. BC

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Colony Collapse Disorder

The symptoms change with the seasons, and are different in various locations.

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The bee industry has been recently plagued by unusual large-scale collapse of colonies. This phenomenon has been termed "Colony Collapse Disorder." The term "disorder" was given since the cause has yet to be determined. A disease exhibiting a group of common symptoms is referred to as a "syndrome" and may be due to one or more pathogens, poisons, or other factors. In this report we describe the year round symptoms as we've seen them across the U.S.

Overview

The symptoms of the final stages of CCD have been oft repeated but are worth reviewing.

In collapsed colonies:

- Complete absence of older adult bees in colonies, with few or no dead bees in the colony, on the bottom board, in front of the colony, or in the beeyard.
- Presence of capped brood in colonies during the time of year when queen should be laying.
- Presence of food stores, both honey and pollen, *unless* a drought or the time of year restricts availability of food resources.
- Absence of pest insects such as wax moth and hive beetle.
- Lack of robbing by other honey bees, and robbing and the return of hive pests is delayed by days or even weeks.

In collapsing colonies:

- Too few worker bees to maintain brood that is present.
- Remaining bee population predominately young adult bees.
- Queen is present.
- Queen may lay more eggs than can be maintained by remaining workers, or is appropriate for the time of year.
- Cluster is reluctant to consume supplemental food such as sugar syrup and pollen supplement.

We've been investigating CCD across the U.S. since the earliest reports. However, by the time that the terminal symptoms of CCD are seen it is usually too late to do anything other than watch afflicted colonies fail, and then try to re-build from surviving colonies, if any. We've also noted that some beekeepers, as well as some researchers, expect to see all of the terminal symptoms, regardless of time of year and stage of collapse.

Based on our observations colony collapse occurs in stages, and the symptoms vary with time of year. Many beekeepers report a two-year progression of the disorder, and some are hopeful that the third year may provide a reprieve. Whereas the third year scenario may be real or may be wishful thinking, we agree that CCD may have a biennial cycle.

The following descriptions of symptoms are based upon inspections and sampling of bee colonies in apiaries from many states, observing the collapse of 65% (46 down to three) of our own research colonies in Montana, and day to day observations of a colony that collapsed, was then placed in a five-frame glass observation hive, recovered, and collapsed again within the same season.

One Year Prior to Collapse:

There are very few visible signs of CCD one year prior to the onset of the collapse. Many beekeepers describe affected colonies as "just not doing well," having a reduced bee population, and producing less honey in comparison to other colonies in the same apiary. "Just aren't doing well" is what the colonies at the University of Montana were doing, too. Generally, colonies at this stage appear to be fully functional, and except for the lackluster honey production, the colonies seem healthy at this point in the condition.

Six Months Prior to Collapse

At this stage beekeepers often overlook indications of CCD because they are vague and can be easily missed. It requires monthly inspections, working comparisons, and keeping records to notice any decline.

Symptoms

Regardless of whether the condition expresses itself

Collapsed colony, most of the remnant bee population is on frame number five, with a few bees on the two adjacent frames. Pollen patties are ignored.

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in the Spring or Summer, organization within the hive shows slight changes. Brood nests are slow to expand. Instead the colony shows a tendency to maintain a brood nest centered in a single hive body. After the adult bees emerge the brood cells are abandoned and not reused. A midday inspection will reveal that many bees are out foraging and that the remaining bees are widely dispersed throughout the hive. This symptom may vary depending on time of day and the ambient temperature. Moreover, the population stops increasing during the growing season.

Honey and pollen production in most colonies are behind when compared to other hives in the apiary. More often the colonies are stagnating in production when compared to the previous month's inspection. Many suspect CCD colonies can maintain a static amount of honey for numerous weeks, when there is a nectar flow.

We speculate that these colonies manage to survive on nectar gathered by their foragers who in turn consume nectar during their foraging flights. The house bees feed on the nectar from the foragers, leaving the honey stores untouched and intact. Pollen is gathered but not in abundance and the pollen stores are adequate for brood production but without any extra in the colony.

These symptoms can only be detected by careful inspections and comparing of the brood nest and honey stores from the previous month. For commercial beekeepers this is an impractical observation to adopt for early CCD detection.

Three Months Prior to Collapse

At three months, the signs from the six month stage become much more obvious. A CCD colony will appear to be healthy, but is slow to grow and to collect surplus honey. Other colonies in the apiary will surpass the affected CCD colonies. At this stage, the diminished size of the bee population should be obvious and provides the first indication that something is amiss.

Symptoms

Earlier in the season a healthy hive's growing population usually requires expanding space, such as adding an extra hive body or honey super on top. In a CCD colony there's now a noticeable *decrease* in the bee population. Where once a colony was in the second or even third hive body it is now weakened by one story, dropping from three to two, or two to one and often occupying only the bottom story.

The bees may appear to be restless. When viewed from the outside, flight activity may appear to be normal, giving the illusion of a strong colony. Smaller hives often abandon the upper brood chambers and the bee population is completely contained within a few frames in the lower hive body. This is often the easiest and quickest sign of CCD for beekeepers to notice.

In the earliest stages the brood pattern may appear to be solid, but if the pupal caps are removed, it likely consists of brood of all ages, due to the replacement of dying brood. As this condition advances the lack of adult bees results in an inability to cover the brood. Capped brood cells may be abandoned and unattended. Removal of chilled brood is still obvious and abandonment and chilling can be seen on brood frames because of the "holes" in the pattern. The removal of dead larvae and pupae results in a "shot gun" pattern on brood frames. Healthy colonies can keep up with the removal of chilled brood, which makes the "shot gun" pattern of CCD colonies a strong indicator.

Like the number of bees, honey stores, too, begin to diminish when CCD occurs *late in the season.* Bees often turn to the honey within the hive, especially if the foragers are not returning. But as the foragers vacate the hive the shrinking cluster requires fewer supplies, leaving the previously gathered honey unused. The worker bees may try to move honey from upper hive bodies into the cluster proper, or into the lower body if there is time, leaving the upper hive bodies empty – no honey and no bees. However, if there is a honey flow the upper hive bodies and supers can remain full of honey, even after the bee population is decimated.

Here we see the first clear signs of the colony's inability to conduct regular routine maintenance, such as comb repair, propolizing joints, removing foreign objects, building new foundation and the like. It's noticeable that the lids of these hives come off and the frames pull out easily because propolizing has become a low priority. It is more of a lapse in hive maintenance than an actual disregard, because some hive maintenance is carried out, especially within the cluster proper. The signs of this phase are best classified as a lack of interest in the hive itself (which is the hive body and unused frames) and a narrowing of interest to the cluster itself.

A further inspection should be conducted in search for other CCD indicators listed in this treaty. This is a clear sign that something has gone wrong.

One Month Prior to Collapse

All the indicators from the three month mark are no longer vague but painfully obvious.

Symptoms

Colony strength at this phase is typically an eight frame or less sized cluster, but it depends on the time of year. Once a colony reaches this point it will decline rapidly. It is not uncommon for an eight-frame population

Young bees and queen. This is the entire remaining bee population in a collapsed colony.

CCD affected observation hive at the University of Montana campus illustrating the gradual abandonment of the brood and shrinking of the bee population. A counter reviewed that each day more and more bees left, never to return, although some foraging persisted, even when down to only a few very young worker bees. This colony expired with the queen and four workers. A supersedure queen disappeared from the opposite side of the comb, leaving only the original queen mother. Early in the disorder, both queens were laying far more eggs than the decreasing worker bee population could support.

to dwindle down to the "softball" size cluster in as little as a few days but sometimes it may take a few weeks. If it is Fall, these colonies show no signs of gearing down for the Winter because they are still maintaining brood at a summertime rate that the population cannot support. Finally, many colonies at this point repeatedly attempt to replace their queen and indicators such as supersdure cells, half torn down queen cells and unmarked queens are evident. This is the point in CCD when the colony attempts to recover its lost population at any cost.

Sometimes the original queen continues to lay alongside a supersedure queen. We witnessed this in an observation hive on the University of Montana Campus in Missoula. The colony attempted to maintain itself by having two queens. The "shotgun" brood pattern was obvious, this time the "holes" in the brood were the cleaned out cells, not the capped cells. It was not uncommon to pull full frames of abandoned brood. On many of the brood frames dead, half emerged bees could be observed with their proboscis extended. Our Electronic Bee Counter data revealed that bees flew out, but many did not return. We also saw very young, light colored bees leaving the hive to forage.

At this stage the amount of honey stored depends on the season. In Summer time, any remaining honey stores can be depleted; in the Winter the stores may be ignored.

Final Stages of Collapse

A colony with advanced CCD symptoms will show little interest in supplement feed or medication, including sucrose syrup as well as pollen patties. The age structure of the colony begins to suffer at this point. As the older bees fail to return to the hive, the colony demographic becomes increasingly younger. Eventually only young bees remain, too immature to carry out complete hive maintenance. The queen(s) appears to be in egg-laying overdrive to try to increase the population. It appears that the young bees continue feeding the young larvae as they hatch for a few days or until the colony totally collapses. Due to the lack of incoming propolis the young bees' ability to seal the hive body is almost non existent and hive covers will lift right off. New wax production ceases and there is a total lack of aggression towards intrusion. It appears that in order to perform brood maintenance all hive responsibilities are low priority.

Visual Symptoms of a CCD Colony

1. Days before its collapse the colony seems to be strong and fully functional
2. Mostly young bees remain in the hive
3. Bees are not aggressive
4. Queen is present
5. Eggs are present
6. Full frames of brood may be present
7. Brood may show signs of "shotgun" pattern
8. Capped honey and fresh nectar are often present, although not in summer collapses, which are uncommon
9. Fresh pollen has been stored in the hive if external resources are available
10. Supplemental feed (syrup and extender patties) if supplied, are ignored
11. Robbing by wax moth, small hive beetle, ants or other bees does not occur
12. No dead bees are noted around entrance of the hive
13. Bees do not show any signs of winglessness, paralysis or other adult bee diseases

Comments and Observations

Normally when a strong colony is combined with a collapsed one from the same apiary it also collapses. Once the symptoms start they seem to affect most colonies in that apiary. We've seen CCD travel like a wave through large holding yards.

Some beekeepers report that adding a package of bees to a weakened colony seems to help the colony offset the collapse. This may be explained by the package bees coming from an apiary of healthy bees. However, others report that the combined colony also collapses.

Adding healthy bees to a collapsed colony, or to the equipment from a collapsed colony, is risky. But if bees are added, or the equipment used after robbing by honey bees resumes, or the pests such as wax moth and hive beetle re-appear, the likelihood of survival of the re-populated colony is much higher. Colonies that reach the stage where fresh wax is clearly evident along the top bars usually recover.

Finally, the cause of CCD still remains an unknown. Working with the U.S. Army's Edgewood Chemical and Biological Center, we've been able to establish and can now make available to North American beekeepers services for rapid screening of bees for all viable viruses (Bee Alert working with BVS, Inc. and ECBC), as well as more comprehensive screening for all bee, insect, and plant pathogens (Bee Alert working with ECBC). By providing these services, we hope to be able to better understand the dynamics of bee diseases and pests, narrow down the search for the causative factors for CCD, and most importantly, provide tools to enable beekeepers to better manage the health of their bees. BC

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INSIDE

A Modified Two-queen System: "Tower" Colonies Allowing For Easy Drone Brood Removal for Varroa Mite Control

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Summary

Capped drone brood removal is a varroa mite control technique that reduces the need for chemical treatments. This varroa mite control technique has not been readily accepted by many beekeepers because heavy honey supers must be removed to access the brood chamber. This study investigated a way of managing hives that makes it easier to access the brood nest and the contained drone brood, making drone brood removal a more viable option.

In this study we demonstrated that the management of honey bee colonies in a two queen tower configuration and utilizing drone brood removal reduced varroa mite population growth over the course of the summer. Colonies managed in a tower configuration contained fewer mites in early September than those that were managed normally. While this system would not likely permit beekeepers to forgo alternative mite treatment methods, it would keep mite levels below economic injury levels for a longer period of time.

Keywords: cultural control, management

Introduction

There are many ways to manage varroa mite, *Varroa destructor*, populations in honey bee, *Apis mellifera*, colonies including cultural and chemical controls. Beekeepers commonly use chemicals, but the mites have developed resistance to many of them (Elzen, *et al.* 1998, Pettis 2004, Lodesani and Costa 2005). There is also the concern that these chemicals contaminate bee products (Bogdanov et al. 1998). A more sustainable option is the use of integrated pest management (IPM), which involves using a combination of several mite reduction techniques which can include chemical and cultural

controls. Drone brood removal is a cultural control technique that may be useful as part of an IPM program. This method of removing capped drone brood, and with it the reproducing varroa mites, can be very effective (Lavagnino 1995, Schmidt-Bailey *et al.* 1996, Calis *et al.* 1999, Calderone 2005). Varroa mites tend to invade drone brood more readily than worker brood so drone brood acts as an especially effective trap for the mites (e.g. Boot *et al.* 1991, Fries *et al.* 1994, Calderone and Kuenen 2001). Thus, removing the capped drone brood can greatly reduce the number of mites in infested colonies (Calderone 2005). However, drone brood removal requires the beekeeper to remove honey supers regularly to access the brood chamber. If there were a way of managing hives so it is easier to access the brood nest, drone brood removal would be a much more feasible option.

Some beekeepers use a two-queen system (Cale 1963, Hogg 1983) where colonies are maintained with two laying queens in one hive, with the two queens kept in different brood boxes by placing queen excluders between them. This management technique is thought to increase the honey bee population and, subsequently, the honey yield (Winston and Mitchell 1986). In addition, if one queen dies, the colony survives without an interruption in the addition of young bees.

In this study, we used a new hive configuration that took advantage of a two-queen system and permitted easy drone brood removal. We were able to keep the daily varroa mite drop from dramatically increasing over the summer without using chemicals and with very little effort.

Figure 1. *Hives in a tower configuration.*

Figure 2. *One side of a tower with the lid removed showing the drone frame, which is a green compared to the remaining frames, which are black.*

Materials and Methods

We started with 16 colonies in an apiary located at Betterbee Inc. in Greenwich, NY. Colonies were randomly assigned to one of two treatments: 1) normal management with a double brood chamber, queen excluder, and honey supers or 2) management in a "tower" arrangement. The tower arrangement consisted of two colonies in double brood chambers side-by-side with a queen excluder and honey supers over the center of the two brood chambers (Fig. 1). The exposed half of each brood chamber was covered by a half-size migratory cover. This setup allowed easy access to half of the frames in the upper brood nest of each colony (Fig. 2). This essentially created a two-queen system and enabled us to add and remove drone comb for mite trapping without having to remove honey supers. In addition, part of the brood nest could easily be inspected.

A one-piece plastic drone frame was added to each tower colony and the first honey supers were added to all colonies on 10 June 2005. Sticky boards were put in place in all of the hives that day as well, and were replaced every seven days until 12 August 2005. Each hive was considered separately, whether paired in a tower configuration or whether in the control group.

On 5 and 28 July, drone brood frames containing capped drone brood were removed and replaced with drone foundation. On 23 August 2005, drone brood frames were removed and replaced with drone comb that had been frozen from the previous replacement period. When possible, brood of the proper age from the removed frame was examined for varroa mites. The goal was to examine 50 capped drone brood cells per frame for the presence of varroa mites to quantify how many mites were being removed. The total amount of drone brood present on the frame was also estimated. A final sticky board was in place for three days from 9 to 12 September 2005. On 31 October, the honey was harvested from all of the colonies and the removed supers were weighed. The presence of the queen was also observed and the readiness of the colony for winter assessed.

Mite drop data from the three-day sticky board samples taken at beginning and end of the experiment, as well as during the 11 sampling periods, were analyzed using a split-plot analysis of variance design (PROC GLM; SAS Institute Inc. 1999). Treatment was the main plot factor and time was the subplot factor. Fisher's exact test was used to determine whether treatment affected queen or colony survival using contingency tables set up with three columns (treatment, status, and count).

Results

In the normal colonies (without having drone comb removed), average daily varroa mite drop increased from 3.2 ± 0.8 mites per day at the beginning of the study to 25.8 ± 6.7 mites per day over the course of the experiment (Fig. 3). In contrast, mite drop in the tower colonies, which had drone comb removed, increased from 1.9 ± 0.5 to 8.0 ± 2.9 mites per day. Thus, the change in mite drop over time was affected by treatment ($F = 5.09$; $df = 1, 28$; $P = 0.0320$). The course of the increase in mite drop over the duration of the experiment is presented in figure 4. The number of mites falling onto sticky boards was affected by treatment in five of the 11 time periods as indicated by a significant treatment x time effect (Fig. 4; $F = 4.21$; $df = 10, 154$; $P < 0.0001$).

In addition, the colonies from the two treatments produced equivalent amounts of honey with the normal colonies producing an average of 17.2 ± 4.9 kg and the tower colonies producing 15.2 ± 4.2 kg each or 30.3 ± 8.4 kg per pair ($F = 0.07$; $df = 1, 10$; $P = 0.7965$). On average, each drone frame removed from a tower colony contained 1,650 capped drone cells. Between 0 and 9 % of the drone cells that were opened contained varroa mites.

Overall, two colonies in the tower treatment and one in the control died before the end of the experiment. In addition, one queen was lost in the tower treatment. No differences between treatments were found ($P > 0.05$).

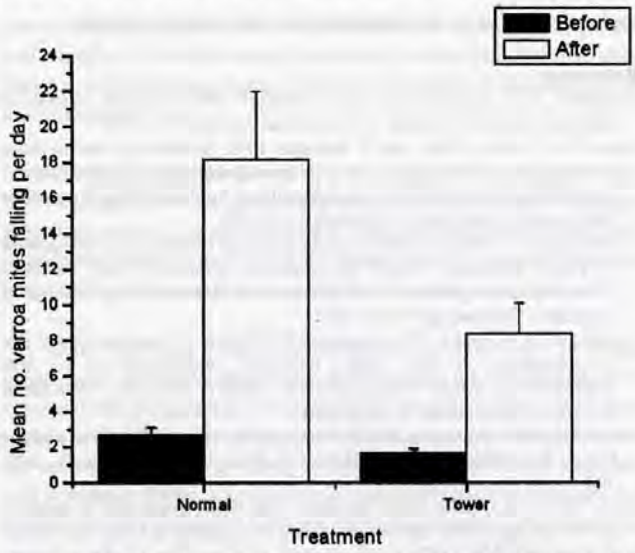

Figure 3. Mite drop (mean ± s.e.) onto sticky boards at the beginning (Before) and end (After) of the experimental period. The change in mite drop from the beginning to the end of the experiment in the normally-managed (Normal) colonies was significantly different from that in the tower treatment (Tower) (P < 0.05).

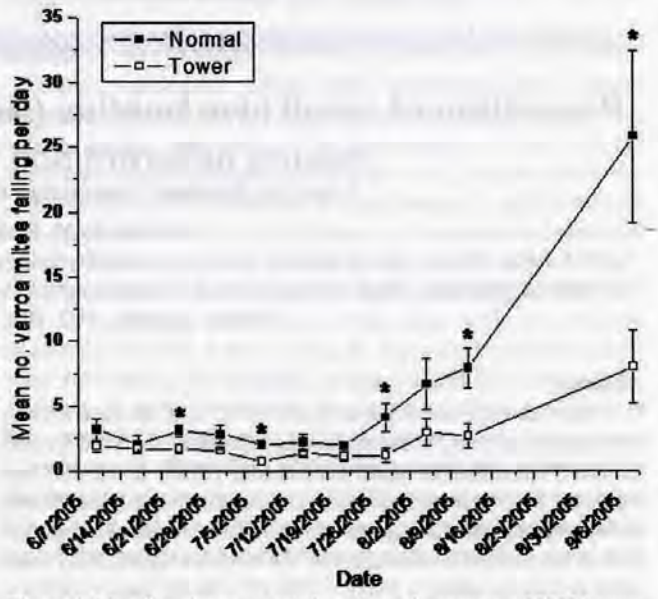

Figure 4. Mite drop (mean ± s.e.) throughout the summer of 2005 in normally-managed (Normal) colonies where drone brood was not removed or in colonies in a tower configuration (Tower) where drone brood was removed. An asterisk (*) indicates a time when mite drop differed between treatments (SNK; P < 0.05).

Discussion

Management of honey bee colonies in a tower configuration utilizing drone brood removal and a two-queen system reduced varroa mite population growth over the course of the summer. Colonies managed in a tower configuration contained fewer mites in early September than those that were managed normally. While this system would not likely permit beekeepers to forgo alternative mite treatment methods, it would keep mite levels below economic injury levels for a longer period of time.

The tower colonies went into the fall with much lower varroa mite populations than the control colonies. These findings are similar to those reported by Calderone (2005) who removed drone brood four times in a single summer. In this study, mite populations increased throughout the summer, as expected. This increase was significantly reduced when drone brood removal was employed. If mite population growth is slowed, beekeepers can confidently delay treatment until the end of the honey flow without compromising the health of the bees.

This management technique was easy to use and allowed bees to collect an equivalent amount of honey as compared to normally-managed colonies. In general, 2005 was a bad year for honey in New York and these colonies were started from packages, possibly contributing to the low yields in colonies from both treatments. In addition, the packages were started on frames of foundation and so the bees had to draw out comb, an activity that reduces honey production (Hepburn *et al.* 1984). If drawn comb is used for trapping, instead of foundation as was used in this study, the bees will not have to expend energy on wax production. In addition, previous work showed that the removal of drone comb increases honey production, likely due to the elimination of the need to care for costly drone adults (Seeley 2002).

The two-queen system did not increase or decrease the honey yield. In contrast, Gutierrez and Rebolledo (2000) were able to increase honey production using a two-queen system in Chile. In addition, Winston and Mitchell (1986) found that colonies managed with two queens contained more brood and bees than those managed with one queen, but found that the labor involved in the system negated these positive outcomes. Using the tower configuration, labor was greatly decreased, allowing the two-queen system to be profitable.

Conclusion and Recommendations

We feel that the addition of drone brood removal to an IPM program using a tower configuration will be advantageous. The use of chemical acaricides will be reduced and can be delayed due to decreased mite reproduction. The tower configuration allowed for easy removal of drone brood, allowing this cultural control method to be used without added labor. We recommend the use of this

system as part of an integrated varroa mite control program.

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Population of small hive beetles (*Aethina tumida* Murray) in two apiaries having different soil textures in Mississippi

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Abstract

Soil samples collected at 0-10, 11-20 and 21-30 cm from two apiaries in Lula, Mississippi were separately analyzed for soil texture. Populations of small hive beetles (SHB) in the soil and inside the hives were also counted. Our results showed that the two apiaries had different soil textures with different levels of infestation both in the soil and inside the hives. We recorded significantly more adult beetles in apiary 1 (May = 109.35 ± 24.42, June = 607.6 ± 136.25 beetles per colony) where the soil was predominantly silty clay and silty clay loam than in apiary 2 (May = 37.08 ± 5.40, June = 260.4 ± 54.97 beetles per colony), which had mostly sandy loam and loam soil. Regardless of soil type, the density of SHB per 1,200 cm^3 soil varied with soil depth. The density of SHB was greatest (8.54 ± 1.92 beetles) in the first 10 cm of soil in which most of the larvae and pupae were observed close to the surface of the soil. A few (0.48 ± 0.12 beetles) SHB were also found at 11-20 cm, but no beetle was found at 21-30 cm. This preference for the first 10 cm was not influenced by soil type since no consistent soil type was recorded for a particular soil depth.

Our results showed that SHB populations successfully developed in various types of soil and that vertical movement of larvae in the soil was not influenced by soil type. Nevertheless, it is possible that the discrepancy in SHB populations between the two locations may have been due to the amount of available soil moisture. In a field setting, the difference in water retention ability of different soil types and field slope (drainage) potentially affected the amount of moisture in the soil. The presence of nematodes also may have contributed to the death of developing SHB in apiary 2. This is the first report on the natural infestation of nematodes in teneral adults of SHB in the soil.

Key Words: soil type/soil depth/nematodes/honey bees/IPM/small hive beetle/*Aethina tumida*

Introduction

The small hive beetle (SHB, *Aethina tumida* Murray) is one of the most economically important pests of honey bees (*Apis mellifera* L.) because of its ability to kill honey bee colonies (Elzen *et al.* 1999, Hood 2004). Likewise, SHB significantly reduces brood production, honey production, and flight activities of bees (Ellis *et al.* 2003). Adult females usually lay eggs in protected areas to avoid predation (Lundie 1940) or hygienic behavior by the bees as observed in both African (Ellis *et al.* 2004b, Neumann and Härtel 2004,) and European honey bees (EHB) (de Guzman *et al.* 2008). Adult honey bees also can remove live beetles from observation hives (de Guzman *et al.* 2006). Nevertheless, the ability of EHB to deter adult SHB invasion depends on honey bee stocks. In colonies deliberately freed from SHB and in those with freely colonizing

beetles, Italian colonies had more beetles than the Russian bees (Frake *et. al.* 2008). The authors also observed more Italian colonies that supported SHB reproduction than Russian colonies.

Young larvae are active feeders and thus they are responsible for most of the damage in the hives. Upon maturity or when the wandering phase is reached, larvae stop feeding, leave the hive and pupate in the soil. Therefore, soil conditions greatly influence the completion of their development or survival. Lundie (1940) speculated that soil type can be an important limiting factor in the abundance of SHB. SHB's preference for light sandy soil for pupation was reported by Pettis and Shimanuki (2000). This observation agreed well with the claim that severe damage to honey bee colonies caused by SHB has been concentrated along the coastal regions of the United States having light sandy soil. In heavy clay soil in Georgia, no serious infestations were found (Delaplane as cited by Wenning 2001). Hence, Wenning (2001) recommended placing colonies in clay-based soil to prevent significant infestations.

The importance of soil type, soil moisture and soil density on the successful pupation of SHB was studied under laboratory conditions (Ellis *et al.* 2004a, Schmolke 1974). In contrast to Lundie's (1940) claim, both studies showed that soil type did not influence SHB pupation. Schmolke (1974) showed that both soil density and soil moisture are important in the successful emergence of adult beetles. However, Schmolke claimed that soil density has the most effect especially in the burrowing of larvae into the soil. Recently, an experiment assessing the importance of these three factors showed that pupation is influenced by a combination of them (Ellis *et al.* 2004a). In 2000, Pettis and Shimanuki examined soil samples in front of six colonies from three apiaries (two colonies/ apiary) in central Florida. The authors showed that about 80% and 20% of the SHB recovered were found in the first 10 cm and 20 cm of Florida's (St. Lucie) light sandy soil, respectively. The ability of SHB to pupate beyond 20 cm was not examined and no analysis of soil sample taken from every depth was conducted by the authors. Therefore, this study was conducted to determine if soil texture varies according to soil depth, and to determine if such differences affect the vertical movement of SHB.

Materials and Methods

Number of adult SHB in the colony - Two established apiaries with colonies of Italian and Russian ancestry were used in this study. A total of 44 queenright colonies (apiary 1 = 20, apiary 2 = 24) were analyzed in May 2004; only 19 (apiary 1 = 10, apiary 2 = 9) survived in June. These colonies were set on 4-colony pallets located near Lula, Mississippi. Populations of beetles were determined by inspecting individual frames, one hive body at a time, on top of a white table (de Guzman *et al.* 2006).

Density and distribution of SHB in the soil - A first set of soil samples was collected in front of 34 colonies (apiary 1 = 16, apiary 2 = 18). Soil samples were collected by digging a hole measuring 30 cm in diameter and 30 cm deep in front of a colony; one hole for each of the two sides of a pallet where hive entrances were located. Thereafter, 102 samples consisting of three slices of soil measuring about 8 x 15 x 10 cm (width x length x depth) collected with a knife from 0-10, 11-20, and 21-30 cm depths were placed in separate Ziploc® bags and stored in a walk-in freezer in the laboratory until processing. Large aggregates of soil in each sample were broken up, and were inspected both visually and under a dissecting microscope for the presence of SHB. All stages of SHB were collected and counted to determine the density of SHB per soil sample. All beetles were individually examined and dissected under a dissecting microscope for the presence of diseases, pests and parasites.

Particle soil analysis - All soil samples were analyzed at the Soil Testing laboratory of the Department of Agronomy, Louisiana State University. The proportions of sand, silt, and clay in each soil sample were determined using the Bouyoucos hydrometer method (Day 1965, Soil Survey Laboratory Methods Manual 1996).

Data Analyses - Data on the number of SHB were analyzed using Proc Mixed to determine if there was an interaction. Soil type and sampling depth were modeled as fixed effects. When no interaction was found, a Kruskal-Wallis test was performed (due to the non-normality of the data) to determine the effect of soil type and sampling depth. A paired t-test was performed to compare the beetles at the 0-10 and 11-20 cm sampling depths (where beetles were found) for each colony. Data on the number of SHB per colony were analyzed using a Wilcoxon two-sample test. A correlation was performed using Proc Reg to determine the relationship between the number of beetles in the colony and the number of beetles in the infested soil. Bee population and varroa infestation was compared using a *t*-test. (SAS Institute 2001, Version 8.2).

Results

Bee population, adult SHB population and varroa infestation - In May 2004, adult bee populations of colonies in both apiaries (apiary 1 =29,469 ± 3,779 bees; apiary 2 = 27,507 ± 2,737 bees) were very comparable ($t = 0.43$, $P = 0.67$). Similar trends ($t = 1.04$, $P = 0.311$) were observed in June (apiary 1 = 28,522 ± 5,018 bees; apiary 2 = 20,671 ± 5,628 bees). All colonies had abundant stored honey.

There were more ($t = 3.67$, $P = 0.001$) adult SHB observed in May 2004 in apiary 1 (109.35 ± 24.42, Mean ± SE, n = 20) than in apiary 2 (37.08 ± 5.40, n = 24). By June, most colonies in both sites were dead (50% mortality in apiary 1 and 63% in apiary 2). The average varroa infestations on adult bees of these colonies in May were 9.77 ± 1.6% and 4.39 ± 1.5% for apiary 1 and apiary 2, respectively. These dead colonies were probably weakened by the presence of parasitic mites and SHB took advantage thereafter. There were multiple SHB egg masses in between supers and on top of the frames, and also larvae on slimy combs in these dead

Table 1. Proportion of samples belong to each soil type at different depths for two apiaries near Lula, Mississippi

		Soil Depth (cm)		
Apiary	**Soil texture**	**0-10**	**11-20**	**21-30**
	Silt	0.00	18.75	18.75
	Silty clay	35.29	43.75	56.25
1	Silty clay loam	41.18	18.75	6.25
	Silty loam	23.53	18.75	18.75
	Clay loam	0.00	0.00	5.56
	Loam	27.78	33.33	44.44
	Loamy sand	11.11	5.56	11.11
2	Sandy loam	61.11	50.00	5.56
	Silty clay loam	0.00	0.00	11.11
	Silty loam	0.00	11.11	22.22

colonies. The average number of SHB in the surviving colonies was high with apiary 1 having significantly ($t = 2.50$, $P = 0.023$) more SHB (607.6 ± 136.25, n = 10) than surviving colonies in apiary 2 (260.4 ± 54.97, n = 9).

Particle soil analysis - Soil analyses showed that the two apiaries had different soil textures (Table 1). For apiary 1, there were four soil types identified, but their proportion varied at each sampling depth. At 0-10 cm, the majority of the samples were silty clay loam. Silty clay constituted most of the soil sampled at 11-20 and 21-30 cm deep. No proportionate sand was detectable in this location. Six soil types were established for apiary 2. Sandy loam comprised the highest proportion recorded at 0-10 and 11-20 cm while most 21-30 cm soil samples were of loam. Analyses also revealed that there was no specific soil type for each depth of soil. The soil sample obtained in front of a colony may have had either: a) the same soil types for all three depths, b) only two depths with the same soil types, or c) all depths with different soil types (for examples see Table 2).

Density and distribution of SHB in the soil - Among the 34 colonies selected for sampling soil in front of them, only 16 supported SHB pupation (apiary 1 = 9/16, apiary 2 = 7/18) (Table 2). Analyzing only these infested soil samples, no interaction between soil type and soil depth ($P = 0.962$), and no soil type effect ($P = 0.536$) were detected. However, soil depth significantly ($P = 0.0001$) affected SHB population in the soil. Regardless of soil type, most of the beetles were observed at the first 10 cm deep with a mean of 13.88 ± 5.37 beetles per 1,200 cm^3 soil sample. At 11-20 cm, an average of 1.0 ± 0.42 beetles was recorded. No beetle was found in soil sampled at 21-30 cm. There was no difference ($P = 0.297$) between the number of beetles pupating in apiary 1 soil (6.93 ± 3.34 beetles/1,200 cm^3) and apiary 2 soil (2.43 ± 1.38 beetles/1,200 cm^3). Further, there was no relationship ($P = 0.766$) between the number of beetles inside the colony and number of beetles in the soil in front of the colony. Those colonies with infested soil by the hive entrance had an average infestation of 133.75 ± 33.01 beetles per colony, which was similar ($P = 0.694$) to those colonies with uninfested soil (98.78 ± 17.17 beetles/colony) in front of them. Likewise, even if 0-10 and 11-20 cm soil have the same soil types, the first 10 cm supported more beetles than the 11-20 cm soil ($P = 0.032$, paired t-test). The same trend was observed in soil samples obtained from these two depths with different soil types ($P = 0.046$, paired t-test).

Nematode infestation - Unidentified species of nematodes were observed in several beetles collected from four soil samples (representing four hives) in apiary 2 (Table 3). No nematode-infested SHB was observed in apiary 1. Most of these beetles including body parts (with little tissue) had a few (≈ 20-100) nematodes with the exception of two young adult beetles; one with elytra (including hind wings) full of nematodes (Figure, a and b) and the whole body of the other was filled with nematodes (Figure, c and d).

Discussion

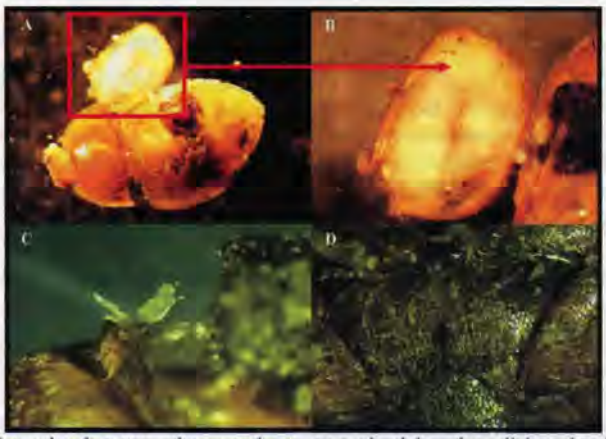
Small hive beetles spend >75% of their developmental time in the soil (de Guzman and Frake, 2007). Therefore, edaphic environmental factors such as soil type, soil moisture, soil density, field slope, drainage, rainfall, temperature and others greatly affect their biology. Our results showed that the two apiaries had different soil textures with different rates of SHB infestation both in the soil and inside the hives. We recorded more adult beetles in apiary 1 where the soil was predominantly silty clay and silty clay loam than in apiary 2, which was mostly sandy loam and loam soil. Nevertheless, our results showed that SHB pupation occurred in any type of soil. This field observation agreed with laboratory studies conducted by Ellis *et al.* (2004a) and Schmolke (1974). Ellis *et al.* (2004a) reported comparably high emergence of adult SHB (72-98%) in moist silty clay, silty clay loam and sandy loam and loamy sand soils. Schmolke (1974) also found high emergence (74-95%) in sand, loam and clay loam soil types. De Guzman and Frake (2007) observed a significant effect of temperature in the developmental periods of SHB. Thus, differences in climatic and

Table 2. Soil profile and the distribution of SHB in infested soil samples collected in front of colonies in two apiaries. Number in parenthesis indicates the total number of beetles found in the soil.

Apiary	Colony number	Soil depth 0-10 (1,200 cm3)	11-20 (1,200 cm3)	1-30 (1,200 cm3)
	1	Silty clay (1)	Silt loam (0)	Silt (0)
	2	Silty clay (10)	Silty clay (0)	Silt loam (0)
	3	Silt loam (6)	Silt clay loam (3)	Silt clay loam (0)
	4	Silt clay loam (2)	Silty clay (0)	Silty clay (0)
1	5	Silt clay loam (3)	Silt clay loam (0)	Silty clay (0)
	6	Silt clay loam (71)	Silty clay (4)	Silty clay (0)
	7	Silty clay (61)	Silt (4)	Silt (0)
	8	Silty clay (8)	Silty clay (0)	Silty clay (0)
	9	Silt clay loam (10)	Silt loam (4)	Silt loam (0)
	1	Loam (5)	Silt loam (0)	Silt clay loam (0)
	2	Sandy loam (28)	Loam (0)	Silt loam (0)
2	3	Loamy sand (10)	Sandy loam (0)	Loam (0)
	4	Sandy loam (3)	Sandy loam (0)	Silt loam (0)
	5	Sandy loam (1)	Sandy loam (0)	Loam (0)
	6	Loam (2)	Loam (1)	Loam (0)
	7	Sandy loam (1)	Sandy loam (0)	Loam (0)

Table 3. SHB population inside the colonies and nematode infestations of the adult SHB collected at 0-10cm soil in apiary 2. No nematode-infested SHB were found in apiary 1. (Note: Nematode-infested beetles were sent to an expert but identification was impossible because samples were preserved in alcohol for transport which ruined the key characteristics).

Colony #	# adult SHB in the hive	# SHB per 1,200 cm3 of soil	
		Infested	Uninfested
557	344	1 adult	0
559	603	11 adults, 12 body parts	5 adults
563	13	4 adults, 1 elytra	5 adults
575	117	1 thorax and 1 abdomen	0



Natural infestation of nematodes in teneral adults of small hive beetles collected from apiary 2. (A) an elytron full of nematodes, (B) close-up view of the nematode-infected elytron, (C) nematodes exiting between abdominal segments, (D) silhouettes of nematodes inside a beetle's body.

also soil conditions used by Ellis *et al.* (2004a) and Schmolke (1974) as compared to this study may have contributed to the differences in SHB emergence and ultimately in the number of SHB invading our colonies. Nevertheless, the populations of beetles caused deaths of colonies in our apiaries.

We also observed that there was no consistent type of soil for a particular depth of soil. Nevertheless, the density of SHB varied with soil depth. Although Spiewok and Neumann (2006) claimed that SHB constantly reproduce in all colonies but at low levels, not all our soil samples were infested with beetles. Considering only those infested soil samples, there were more SHB recorded in the first 10 cm soil (mostly just below the surface), only a few at 20 cm, and no beetle at 30 cm .These observations on soil depth agree with the findings of Pettis and Shimanuki (2000) and Schmolke (1974) indicating that most beetles pupate at <10 cm or below the soil surface. This preference of the uppermost layer for SHB pupation was probably due to the presence of decaying litter or loose organic materials for easy burrowing of larvae as well as emergence of adult beetles.

Based on laboratory studies, Schmolke (1974) showed that SHB pupation was not influenced by soil type. Although Schmolke (1974) observed that both soil moisture and soil density affected adult emergence, Schmolke claimed that soil density has the most profound effect especially in the burrowing of larvae into the soil. Recently, Ellis *et al.* (2004a) observed that a combination of soil moisture, soil density and soil type significantly affected pupation success in the laboratory. In a field setting, however, the amount of precipitation, field slope and others can potentially affect soil moisture levels. Our apiaries were about 2.88 km apart. It is likely that both locations had received similar amounts of rain. From May to early June, it rained at least once a week (www.weatherunderground.com). However, different soil textures have different soil moisture retention curves. Macdonald and Ellis (1990) demonstrated that soil samples held at a bulk density of 1.5 g/cc with a moisture level of -0.38 bar is equivalent to 29% moisture for silty clay, 26% for loam and 11% for loamy sand. Although apiary 1 was predominantly silty/clay, the colonies were positioned at the edge of a creek allowing rain water to drain into the creek while possibly supplying enough soil moisture for successful SHB pupation. Several trees were also present along the creek which provided some shade. On the other hand, apiary 2 was on a slope allowing fast drainage and drying of its sandy loam soil. However, the presence of trees in apiary 2 may have provided enough shade to maintain soil moisture favorable for the growth of biotic agents.

The presence of biotic agents such as pathogens and parasites can regulate populations of soil-dwelling insects. Two species of entomopathogenic nematodes have been shown to be infective against prepupal stage of SHB under laboratory conditions (Cabanillas and Elzen 2006). In this study, we found teneral adult beetles infested with unknown species of nematodes in apiary 2 only. No nematode-infested beetle was found in apiary 1. These infested beetles appeared to be intact but when dissected the inside tissues were devoured by nematodes. Several nematode-infested body parts of adult SHB such as thoraces and elytra were also recovered. No larva or pupa was found infested with nematodes. This is the first report of a natural infestation of nematodes in teneral adults of SHB in the soil. The extent of nematode infestation in the soil was not determined. Nevertheless, the level may have been enough to significantly decrease the number of adult beetles emerging, which can potentially become the scavengers of established colonies.

Conclusion and Recommendations

SHB population successfully developed in various types of soil. They also preferred to pupate just below the surface of the soil; larvae did not move deeper into the soil to pupate even in soil having the same soil types at different depths. Thus, selection of apiary sites is very important. By avoiding putting colonies under trees where decaying litter or loose organic materials are abundant, pupation success may be reduced. Dissipation of soil moisture necessary for SHB pupation is expected in exposed apiaries. However, the use of parasitic nematodes in the soil may also help reduce SHB populations in shady apiaries. Their use can be an essential component of an IPM (Integrated Pest Management) program designed to control SHB.

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Effects of *Varroa destructor* Infestation on Honey Bee Queen Introduction

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Summary

The varroa mite (*Varroa destructor*) is very detrimental to honey bee, *Apis mellifera,* colonies that are not genetically resistant. Italian colonies are known to be susceptible to mites, and queen introduction has been reported to be more difficult in Italian colonies in recent years. This study compares supersedure rates in Italian colonies to infestation levels of *V. destructor.* Sixty-one Italian colonies divided into groups with comparatively high and low levels of infestation were observed for any queen changes during six weeks following the introduction of a mated queen. Colonies that had supersedure queens were smaller and had higher rates of mite infestation than colonies that retained their original queen. Supersedure and colony deaths were greater in colonies that were more highly infested.

Apis mellifera / supersedure / Varroa destructor

Introduction

The varroa mite (*Varroa destructor*) is an external parasite of the honey bee (*Apis mellifera*) that feeds on the hemolymph of immature and adult bees (Harbo and Harris, 2001). This specialized blood-feeding mite species reproduces within sealed brood, showing a strong preference for drone brood over worker brood (Martin, 2001). Parasitism causes weight loss, wing deformities and sometimes loss of appendages of the emerging bee (De Jong et al., 1982b). High infestation of V. *destructor,* in colonies that lack innate mite suppression characteristics, ultimately leads to the death of that colony (Harbo and Harris, 2001). Mites from a collapsed colony can be dispersed to other colonies on adult bees through behaviors such as robbing, drifting and absconding (Martin, 2001). This parasite has spread rapidly and now infests most of the world's *Apis mellifera* causing much concern to beekeepers (Rinderer at al., 2001; Sanford, 2001).

Colonies naturally rear new queens (supersedure) when old queens are lost or failing and prior to swarming. Beekeepers take advantage of the queen replacement process to create colonies having queens of selected stock. Original queens are removed from colonies and, as the queen replacement process continues, new queens of selected stock are placed or "introduced" into the colonies. Most introductions of new queens are initially successful. However, some introduced queens remain in the colonies only a short time before they are superseded. There are several reasons, beyond the scope of this study, which could cause queen introductions to fail including queen age at introduction, climate, availability of nectar and pollen, general foraging conditions, worker bee behavior toward the new queen, season of queen introduction and general hive conditions (Rhodes et al., 2004; Mangum, 1997). Introduction difficulties are a concern to beekeepers since queens are costly and colonies that fail to accept new queens either develop more slowly or are lost (Rhodes et al., 2004).

There have been reports that rates of supersedure soon after introducing new queens appear to be higher than in past years, especially for Italian honey bees (Guzman-Novoa et al. 1998; Pettis et al., 2004). Italian honey bees are known to be very susceptible to infestation by varroa mites (Rinderer at al., 2001). We suspected that high mite populations may cause an increase in queen supersedure rates. Little or no data are available on the relationship of mite populations to supersedure rates; therefore we conducted a study to determine if higher levels of varroa mites in Italian colonies are associated with queen introduction failure and higher supersedure rates.

Materials and Methods

Sixty-one queenless colonies were prepared by splitting

established Italian colonies. Prior to splitting, rates of mite infestation for adult bees had been estimated in the established colonies from samples of adult bees (200 to 400 adult bees). We chose six colonies with low infestations ($x = 1\% \pm 0.2$) and five colonies with high infestations ($x = 16\% \pm 0.7$). We divided these colonies to produce 34 queenless units considered to have high infestations and 27 queenless colonies considered to have low infestations. All colonies had three 2.5–3 frames of brood on 16.5 cm Langstroth frames and 0.5 to 0.75 Kg of worker bees. The 61 colonies were moved to a new apiary location and arranged randomly by coin toss.

Italian queens were purchased from one California queen breeder for this experiment. Queen's were installed into each colony using a "California mini-cage" with candy release. Queens were both marked with paint and wing clipped for later identification. Eight days after introduction, colonies were inspected for the presence of the marked queens. At that time all queens were seen and considered to be initially successfully introduced. Three weeks later, colonies were inspected for the presence of marked queens and the hives were expanded with an additional box of comb as necessary to prevent swarming.

Six weeks after queen introduction the colonies were again examined. Their queen status was determined. Colonies either had a laying introduced queen, a laying supersedure queen, a virgin supersedure queen or queen cells. Colonies in these last two groups were considered to be in the process of superseding and were classified as supersedure colonies along with those having a laying supersedure queen.

As well as determining the status of the queens, colonies were evaluated for size and mite infestation using the procedures of Rinderer et al. (2001). Estimates of mites in colonies and the sizes of colonies were obtained from: (a) counts of mites in 200 sealed worker brood cells (50 from each side of two combs), (b) counts of mites in 50 sealed drone brood cells (25 from each side of one comb or from several nest areas when drone brood was scattered), (c) the percentage of adult bees infested as determined from washes (in a soap and water solution (Rinderer et al. (2004)) of a sample of 300 to 600 adult bees, in which the number of bees and mites in the sample were counted, (d) comb by comb estimates (to the nearest 5%) of the numbers of sealed worker and drone brood cells in the hive, and (e) comb by comb estimates of the numbers of bees (to the nearest 5%) which make up the colony (Rinderer et al., 2001). The mite counts from brood sampling were obtained by opening cells through the center of the brood pattern and identifying the number of adult female mites within each cell.

The effect of mite levels on colony death rates and supersedure rates were evaluated with Fisher's Exact Tests. A third Fisher's Exact Test (SAS version 8.2, SAS institute, 2001) was used to compare long term success of queen introductions between the two infestation groups. Unsuccessful longevity of introduced queens included supersedures and colony deaths.

A series of two-way ANOVAs with infestation level and supersedure classification (colonies that did and colonies that did not supersede) used as fixed effects (SAS version 8.2, SAS institute, 2001) were calculated. Three measures of numbers of mites (number of mites infesting brood, number of mites infesting adults, and total colony mites), three measures of the rates of infestation (percentage of brood infested, percentage of adults infested and the percentage of infestation for the entire colony population of brood plus adults) and three measures of colony size (numbers of brood, numbers of adult bees, and the total colony population of brood plus adults) were analyzed.

Since the variables related to numbers of mites and percentages of infestation had significant or nearly significant interactions between the fixed effects of infestation level and supersedure, a series of t-tests were conducted to better understand the nature of the interactions.

Results

Initial levels of mite infestation estimated from samples of adult bees were classified as high or low. Five of the colonies with high infestations died within the first three weeks of the study indicating that the queen introduction failed without a successful supersedure queen being produced. A comparison of the death rate between highly infested and less infested colonies was statistically significant (Fisher's Exact Test $P = 0.05$) (Fig. 1a). After three weeks, nine of the more infested colonies had lost the introduced queen and were in the process of producing a supersedure queen. One of the less infested colonies was superseding its queen. This difference in supersedure rate is statistically significant (Fisher's Exact Test $P = 0.007$.) (Fig. 1b)

After six weeks, of the 29 colonies in the highly infested group, 15 produced supersedure queens or were in the process of superseding (Fig. 1b), and of the 27 colonies in the low infestation group, 10 produced supersedure queens or were in the process of superseding. The difference after six weeks between the supersedure rates in the highly infested colonies compared to the less infested colonies approaches significance (Fisher's Exact Test $P = 0.11$) (Fig. 2a). We also compared requeening failures between the highly infested and less infested colonies. Both colony death after queen installation and supersedures were considered requeening failures. Of the 34 colonies in the highly infested group, 20 experienced queen loss and of the 27 colonies in the low infestation group, 10 experienced queen loss. The difference in the queen failure rate between highly infested and less infested colonies is significant (Fisher's Exact Test $P = 0.04$ (Fig. 2b).

ANOVAs for all of the colony size measures (combs of brood, numbers of brood, combs of adult bees, numbers of adult bees, and overall colony size) (Table) showed insignificant differences between colonies originally having high or low levels of infestation. Generally, colonies originally classified as having lower levels of infestation had numerically larger amounts of brood and adult bees. The percentages of numerical size differences varied: numbers of brood, 16% larger; numbers of adult bees, 6% larger and total colony size, 13%. For the comparison of colonies that had superseded to those that had not superseded, the colonies with supersedure queens were significantly smaller for all measures of colony size (numbers of brood, $P = 0.004$; numbers of adult bees, $P = 0.002$ and overall colony size, $P = 0.0008$). These measures were 42%, 61% and 48%, respectively, larger in those colonies that had not superseded.

The ANOVAs of absolute measures of varroa mites (mites in worker brood, mites on adult bees and total colony mites) (Table) indicated that no significant differences occurred either for the comparison of highly infested colonies and less infested colonies or for the comparison of colonies that had superseded or colonies that had not superseded. Numerically, colonies designated as having lower infestations had a slightly lower number of mites in brood (2%); a higher number of mites on adults (17%), and a higher number of overall total colony mites (2 %). Colonies that superseded had numerically lower numbers of mites on worker brood (17%), on adult bees (4%), and overall total colony mites (14%). However, the

analyses of the three measures (mites in brood, mites on adults and total mites) all had interaction terms that were either significant or approached significance (mites in brood, $P = 0.09$; mites on adults, $P = 0.008$; total colony mites, $P = 0.04$).

T-tests used to examine the nature of the interactions revealed that colonies designated as less infested that did not supersede had numerically fewer mites (mites in brood, 25% (Fig. 3a); mites on adults, 63% (Fig. 3b) and total mites 44% (Fig. 3c) than more infested colonies that did not supersede. However, colonies designated as less infested that did supersede numerically had more mites in brood 66% (Fig. 3a), and total mites 80% (Fig. 3c). Less infested colonies that had supersedure queens had significantly ($P = 0.05$) more mites on adults (170%) (Fig. 3b). These directionally contrasting differences in mite numbers between the groups that superseded and the groups that did not supersede probably resulted in the interactions identified by the ANOVAs.

Similar results were observed in the ANOVAs for proportional measures of varroa mite infestation (Table). No significant differences were detected for the comparison of colonies with high and low infestation levels although numerically, colonies originally designated as having lower infestation levels had a higher percentage of infested brood (11%), a higher percentage of infested adults (12%) and a higher overall infestation (11%). Significant differences or differences approaching significance were detected for the comparison of colonies that superseded and those that did not. Colonies that superseded had higher rates of infestation of brood (33%) ($P = 0.17$), of adults (60%) ($P = 0.02$) and overall (55%) ($P = 0.05$). The analyses of the three measures (percentage of brood infested, percentage of adults infested, and overall percentage of infestation) all had interaction terms that were either significant or approached significance (percentage of brood infestation, $P = 0.11$; percentage of adults infested, $P = 0.04$ and overall percentage of infestation $P = 0.06$).

T-tests used to examine the nature of the interactions revealed that colonies designated as less infested that did not supersede had numerically lower percentages of infestation in comparison to the colonies designated as having higher infestations that did not supersede (percentage of brood infested, 17% (Fig. 4a); percentage of adults infested, 27% (Fig. 4b) and overall percentage infestation 22% Fig. 4c). However, colonies designated as less infested that did supersede numerically had higher rates of infestation than colonies designated as more highly infested (percentage of brood infested, 57% (Fig. 4a), and percentage of adults infested 82% (Fig. 4b) and overall percentage of infestation 89% (Fig. 4c). These directionally contrasting differences in infestation rates between the groups that superseded and the groups that did not supersede probably resulted in the significant interactions identified by the ANOVAs.

Discussion

Increased difficulties with requeening colonies that have

Fig. 1a

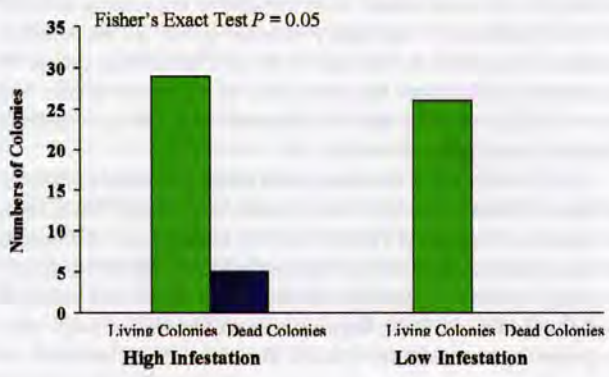

Fig. 1b

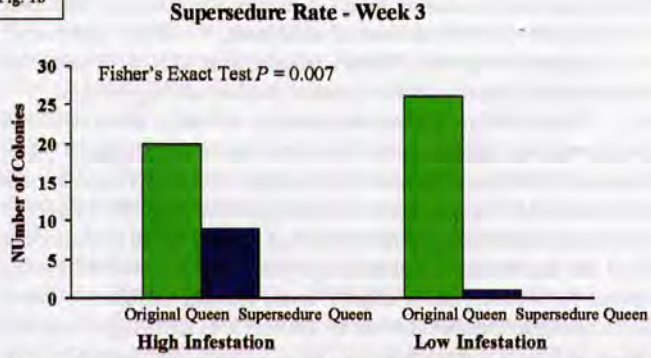

***Figure 1**. For colonies with high and low infestations three weeks after the introduction of mated queens to queenless colonies, comparisons of: a) numbers of surviving and dead colonies and b) surviving colonies having original or supersedure queens.*

Fig 2a.

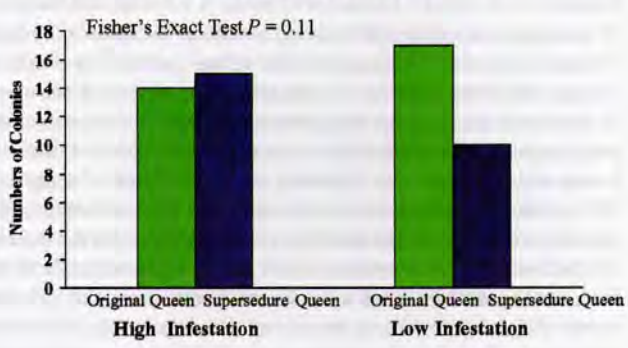

Fig 2a.

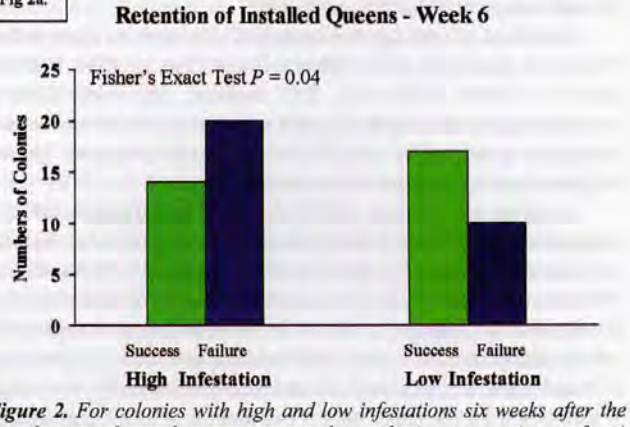

***Figure 2.** For colonies with high and low infestations six weeks after the introduction of mated queens to queenless colonies, comparisons of: a) numbers of surviving colonies with original and supersedure queens and b) numbers of colonies with requeening successes and failures (dead colonies and colonies with supersedure queens).*

been reported in the past decade could have multiple nonexclusive causes. Known causes such as poor mating and unfavorable field conditions (Laidlaw, 1979) probably continue to cause problems as they have in the past. However, increased difficulties likely are caused by conditions that are either new or have increased in intensity in the past decade or so. The presence of varroa mites in colonies has become ubiquitous in the United States. Varroa is becoming more difficult to control as mites develop resistance to widely used miticides (Sanford, 2001). Although this study does not extend to secondary effects such as queens having poorer mating success in commercial settings that have elevated levels of varroa, such effects are also possible.

Colonies were reduced in size as a consequence of supersedure. This is an expected result of a colony having a break in brood production especially when the period of observation is only six weeks. After a longer period, colonies with supersedure queens may grow to be equal in size to colonies in the same apiary that did not supersede. Also, supersedure is a natural re-queening process in honey bee colonies which provides colonies with young vigorous queens. Supersedure queens in honey production or pollination apiaries have an excellent chance of long-term success. However, commercial colonies that supersede the queens installed by beekeepers have a temporally reduced size that makes them less likely to meet timely commercial honey production and pollination goals.

The original assignments of colonies to high or low infestation groups appear to be accurate. First, the colonies designated less infested had numerically more brood and bees than colonies designated as more highly infested. This is consistent with mites debilitating colonies prior to the colonies showing easily measurable deleterious effects. Second, of the colonies that did not supersede, the colonies designated as less infested had numerically fewer numbers of mites infesting brood and adults. Variable amounts of different age classes of brood placed into the experimental hives may have resulted in variable mite reproductive rates within colonies which may have blurred but did not eliminate the differences between the high or low infested groups.

The t-tests that were used to examine the significant and approaching significant interactions between the infestation classification and the supersedure classification all had similar

Colony size measures					Infestation		Supersedure	
		df	F	P	High	Low	Yes	No
Sealed	Infestation	1	1.12	0.30	11097	12886	9477	13507
Worker	Supersedure	1	8.94	0.004	±849	±983	±1101	±689
Brood	IxS	1	0.02	0.88				
Numbers	Infestation	1	0.10	0.75	5294	5635	3966	6390
of Adult	Supersedure	1	10.56	0.002	±597	±433	±501	±448
Bees	IxS	1	1.15	0.29				
Total	Infestation	1	0.84	0.36	16391	18521	13444	19897
Colony	Supersedure	1	12.67	0.001	±	±	±1570	±875
Size	IxS	1	0.31	0.58	1242	1326		
Absolute number of mites in colonies		df	F	P	Infestation High	Low	Supercedure Yes	No
Mites in	Infestation	1	0.05	0.83	1171	1149	1032	1241
Worker	Supersedure	1	0.48	0.49	±177	±156	±186	±153
Brood	IxS	1	2.92	0.09				
Mites on	Infestation	1	1.70	0.20	270	315	285	296
Adult	Supersedure	1	0.05	0.83	±47	±52	±72	±36
Bees	IxS	1	7.57	0.008				
Total	Infestation	1	0.26	0.61	1441	1464	1317	1537
Colony	Supersedure	1	0.28	0.60	±214	±189	±236	±179
Mites	IxS	1	4.38	0.04				
Percentages of Infestation		df	F	P	Infestation High	Low	Supersedure Yes	No
Percent	Infestation	1	0.89	0.35	6.2	6.9	7.8	5.9
Infested	Supersedure	1	1.97	0.17	±0.7	±1.4	±1.7	±0.7
Brood	IxS	1	2.52	0.11				
Percent	Infestation	1	1.52	0.22	5.7	6.4	8.0	5.0
Infested	Supersedure	1	6.19	0.02	±1.0	±1.2	±1.7	±0.5
Adult Bees	IxS	1	4.20	0.04				
Total	Infestation	1	1.23	0.27	9.2	10.2	12.4	8.0
Colony	Supersedure	1	4.15	0.05	±1.2	±2.2	±2.8	±0.9
Infested	IxS	1	3.46	0.06				

Table. *ANOVA's comparing measures of colony size (numbers of sealed worker brood, numbers of adult bees and total colony size), numbers of mites in colonies (mites in worker brood, mites on adult bees and total colony mites), and percentages of infestation (percentage of brood infestation, percentage of adults infested and overall percentage of colony members infested) for colonies established with comparatively high and low levels of varroa infestation which retained their original queen or had a supersedure queen six weeks after queen introduction.*

trends. Of the colonies that did not supersede, those designated as having lower levels of infestation did have numerically lower levels of infestation. However, the colonies that did supersede that were designated as having lower levels of infestation, had numerically higher levels of infestation. The cause of this interaction is unclear. If we erred in the original classification of some colonies and the wrongly classified low infestation colonies actually had high infestations, then those high infestations were associated with supersedure. It is more likely that the original classification was more or less correct and that some biological cause resulted in the higher levels of infestation in the superseded colonies that had previously had lower infestations. Those colonies generally had supersedures that started later than the supersedures in the colonies designated as more highly infested. Mites may have reproduced on brood from the original queen prior to supersedure and produced a larger population which later infested the progeny of the supersedure queen. In the more highly infested group, a comparatively quick rejection of the original queen followed by the lack of brood production attending the supersedure process may have resulted in a lessened opportunity for mites to reproduce in these colonies.

While the differences underlying the interaction make analysis and interpretation more complex, the infestations rates between the colonies that superseded and those that did not remains clear. Considering absolute numbers, there were no differences between the colonies that superseded and those that did not. However, since the colonies that superseded were smaller, the rates of infestation of both adults and the overall colony were significantly higher. The rate was numerically higher for brood infestation in colonies with supersedure queens. As these colonies with supersedure queens grow it is reasonable to expect that the mite populations will reach damaging levels more quickly than they would in the colonies that did not supersede.

Conclusion and Recommendations

The data presented here provide strong evidence that elevated levels of varroa in colonies increase reqeening difficulties. Both supersedure rates and colony death following requeening efforts were elevated as direct effects of higher infestation rates. Perhaps any varroa infestation enhances supersedure rates.

Also, supersedure increases rates of varroa infestation. The break in brood production during the supersedure process causes decreased colony size which results in colonies with supersedure queens having higher rates of varroa infestation.

It might be productive for beekeepers to treat colonies they intend to re-queen or divide prior to queen introduction. Also, it might be productive to target colonies that have supersedure queens for an additional or an earlier treatment for mites.

Acknowledgments

Our thanks to Gary Delatte, Tony Stelzer and Joshua Wales for their fine technical assistance in helping set up this experiment.

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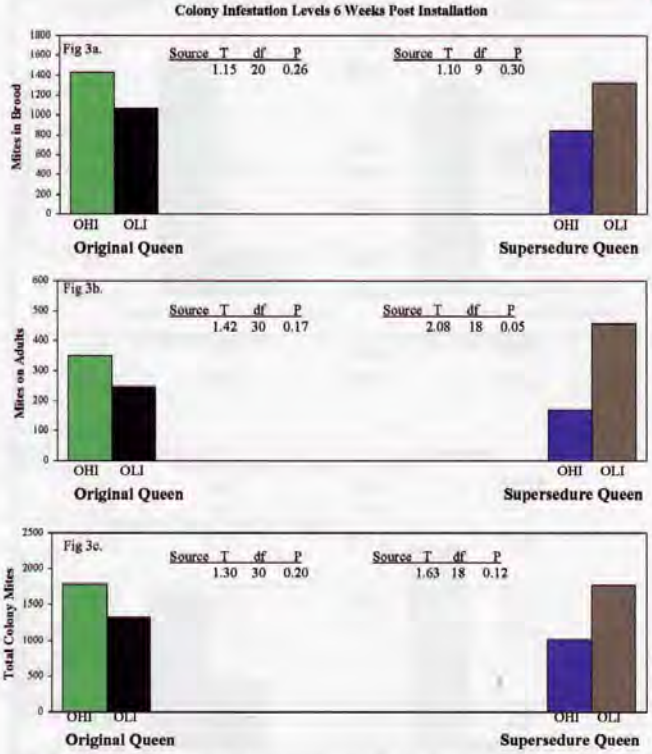

Figure 3. T-tests comparing the numbers of: a) mites in sealed worker brood cells, b) mites on adult bees and c) total mites in colonies established with comparatively high and low levels of varroa infestations in colonies that retained their introduced queens or had a supersedure queen six weeks after queen introduction. (OHI = originally highly infested; OLI = originally less infested)

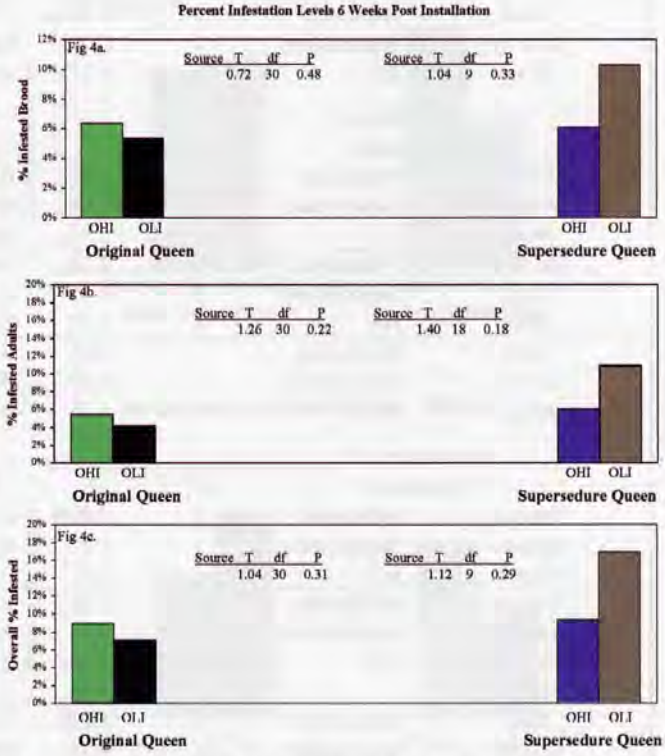

Figure 4. T-tests comparing the percentages of: a) sealed worker brood cells infested with varroa mites, b) varroa mites on adult bees with mites c) overall varroa mite infestation in colonies established with comparatively high and low levels of varroa infestations in colonies that retained their introduced queens or had a supersedure queen six weeks after queen introduction. (OHI = originally highly infested; OLI = originally less infested)

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Risk of feeding honey bee colonies pollen substitute patties in winter when small hive beetles, *Aethina tumida* Murray (Coleoptera: Nitidulidae) are present

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Summary

The discovery of small hive beetle (SHB) larvae in honey bee colonies in winter when pollen substitute patties were fed prompted research to investigate the risk of this activity. Thirty-two honey bee colonies were equalized for bees and brood in fall, 2006, and half the colonies were fed pollen substitute patties continuously from 10 December 2006 – 20 March 2007. A pollen substitute patty was placed across the top bars in the center of the brood chamber of each treated colony for the duration of the project. Capped brood was measured as a colony strength parameter in each colony on 10 December and during each follow up visit. SHB larvae occurred throughout the investigation in colonies having pollen substitute patties and were found primarily concentrated in the patties. SHB larvae were unable to develop past the larval stage and apparently were unable to survive once leaving the warmer area just above the bee cluster as many dead larvae were found on the bottom board. SHB larvae rarely occurred in control colonies receiving no pollen substitute patties. There was an increase in capped brood found in colonies fed pollen substitute patties compared to control colonies. The results of this investigation indicate low risk by beekeepers who feed their colonies pollen substitute patties in winter when conditions are unfavorable for SHB reproduction. However, beekeepers should be conservative in feeding pollen substitute patties when SHB adults are present in late winter or early spring when mild temperatures may persist and result in beetle reproduction earlier than normal.

Keywords: *Apis mellifera*, honey bees, *Aethina tumida*, small hive beetle, pollen substitute patties, pest control

Introduction

Small hive beetles (SHB), *Aethina tumida* Murray, have spread throughout the United States and can become a major problem for beekeepers when conditions are favorable for beetle reproduction. The SHB adults feed on honey bee brood, pollen and honey (Ellis et al. 2002), but the SHB larvae are more devastating as they destroy comb and cause the honey to ferment (Lundie 1940; Schmolke 1974). SHB can decimate even strong honey bee colonies (Hood 2004) and can vector viruses (Eyer et al. 2008). Since SHB have been reported to potentially vector a honey bee virus, the SHB may be implicated in possible spread of colony collapse disorder (CCD). However, no reports or surveys have suggested a relation between SHB activity and CCD.

SHB adults may live up to six months (Pettis and Shimanuki 2000; Hood 2004) and are capable of successfully overwintering in the colony cluster in temperate areas of the world (Hood 2000). Normally other life stages of SHB do not overwinter inside or outside the hive in winter in cooler climates, but Pettis & Shimanuki (2000) reported finding SHB larvae, pupae, and adults in Florida in winter (February). As temperatures increase in spring, adult SHB break cluster with the bees and will begin their first reproductive cycle depending on favorable conditions which are unknown presently.

Some commercial beekeepers feed pollen substitute patties in winter to maintain or increase colony strength for package bee production in spring or for early-year pollination purposes. Anecdotal reports by this author and others have indicated that beetle larvae appear in winter in cooler climes when colonies are fed pollen substitute patties placed above the colony cluster. The beetle larvae occurred even in cold weather when SHB larvae were unexpected. This investigation was conducted to determine the level of risk taken when beekeepers feed pollen substitute patties in winter when adult SHB are present. Here, I test the hypothesis: SHB do not reproduce inside managed honey bee colonies in temperate areas of the world in winter when colonies are fed pollen substitute patties.

Materials and Methods

Thirty-two honey bee colonies were equalized for bees and

brood in fall, 2006, and four apiaries were established with eight colonies per yard in Pickens County, South Carolina, USA. All test apiaries had previous history of SHB activity and each colony had SHB present when the investigation began. Four colonies in each apiary were randomly selected to receive pollen substitute patties (Global Patties, Bay 2 -8 Eastlake Way NE, Airdrie AB T4a 2J3) continuously from 10 December 2006 – 20 March 2007. One pollen substitute patty containing 4% bee pollen was placed across the top bars in the center of the brood chamber immediately above the colony cluster. As patties were consumed, an additional patty was added to the treated colonies. The remaining four colonies in each apiary received no pollen substitute patties. Capped brood was measured as a colony strength parameter in each colony by placement of a scribed 25cm² piece of Plexiglas over each side of brood frames on 10 December and during each follow up visit to the apiaries. Colony strength was measured by counting the number of 25 cm² of capped brood. Each 25 cm² of capped brood was counted as one unit. The total number of units of brood counted for each colony was used as an estimate of overall colony strength. SHB adults and larvae were surveyed in colonies on 10 December 2006, 3 January, 15 January, 27 February, and 20 March 2007. The soil within a two foot radius in front of each hive was disturbed and observed for SHB pupae during each sampling visit. SHB adults were surveyed inside colonies by counting beetles under the inner cover and on the three interior sides and the bottom board of the brood chamber following removal of five brood frames (Hood and Miller 2005). A total colony examination including frames was conducted to assess SHB larvae counts. Weather data were obtained from the Clemson University Climatological Station which was located within 2.4 miles (3.9 km) of each test apiary.

Data were analyzed by a randomized block repeated measures design analysis of variance (ANOVA), recognizing colonies treated with pollen substitute patties or colonies with no patties as controls as main effects and apiary locations as block effects. Means were separated with least significant difference test and differences were accepted at $P \leq 0.05$. All analyses were conducted using the software package SAS (SAS Institute 1992).

Results & Discussion

SHB larvae occurred throughout the investigation in colonies having pollen substitute patties and were mainly found concentrated in the pollen patty. Normally, SHB larvae develop to the last larval stage (wandering phase) and then exit the colony and pupate in the soil (Lundie 1940). However, during this investigation, SHB larvae did not develop past the larval stage and apparently were unable to survive once leaving the warmer area located immediately above the winter cluster as many dead larvae were found on the bottom board. No SHB pupae were discovered in the soil in front of the colonies. SHB larvae occurred rarely in control colonies having no pollen substitute patties during this investigation (Table 1). There was a significant ($P = 0.036$) increase in capped brood found in colonies fed pollen substitute patties compared to control colonies which received no patties (Figure 1). By the end of these investigations, the colonies that received the pollen substitute patties appeared more robust as a result of increased colony strength.

There was no difference ($P = 0.370$) in the number of SHB adults surveyed in the colonies having pollen substitute patties compared to colonies having no pollen substitute patties during this investigation. As expected, the SHB adult counts were extremely low (Table 1) as a result of the sampling technique which was dependent on SHB activity away from the colony cluster during cold weather. Maximum daily temperatures during the 99-day investigation ranged from 36° F (2.2° C) to 80° F (26.7 ° C) with only 53 days (Dec/12, Jan/12, Feb/12, Mar/17) above 57° F (13.9° C) which is the approximate winter clustering temperature for honey bees (Phillips and Demuth 1914).

Table 1. Colony parameter means (SHB larvae, SHB adults, and colony strength) in honey bee colonies fed pollen patties (N=16) and control colonies fed no pollen patties (N=16). Colony strength was estimated by total 25 cm² capped brood. Means followed by different letters are significantly different ($P \leq 0.05$). Means are followed by standard errors.

Treatment	SHB Larvae (alive)	SHB Adults	Colony Strength
Colonies fed pollen patties[1]	15.68 (±30.78) a	1.32 (±1.97) a	56.19 (±50.42) a
Control colonies w/o pollen patties	0.17 (±1.0) b	1.44 (±2.44) a	25.46 (±24.61) b

[1]Global Patties, Bay 2-8 Eastlake Way NE, Airdrie AB T4A2J3.

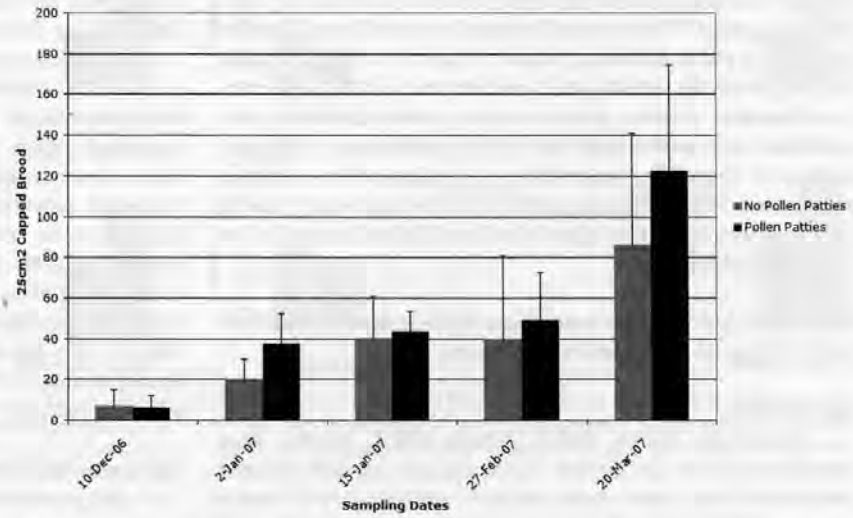

Figure 1. *Colony strength as measured by 25 cm² capped bee brood in colonies fed 4% pollen substitute patties (N = 16) versus control colonies fed no pollen paties (N = 16) on five sampling dates. Vertical bars represent standard errors. [1]Global Patties, Bay 2-8 Eastlake Way NE, Airdrie AB T4A2J3.*

SHB successfully oviposited and beetle larvae survived in test colonies that had pollen substitute patties above the colony cluster even when daily minimum temperatures fell below 32° F (0° C) (Table 2). No SHB larvae developed past the larval stage during this investigation and no larvae were discovered in the colony cluster which is where SHB adults normally overwinter in temperate areas of the world (Hood 2004). Apparently, the mature larvae were unable to survive when they moved away from the area above the cluster in an attempt to pupate. The SHB larvae were dependent on the warmth from the colony cluster for survival and were unable to survive colder conditions.

Conclusions and Recommendations

The results of these investigations indicate low risk by beekeepers who feed their colonies pollen substitute patties in winter in temperate areas of the world when conditions are unfavorable for SHB reproduction. Apparently, the SHB larvae were dependent on the warmth from the colony cluster for survival and no damage to comb occurred in the brood area or the area adjacent to the pollen substitute patties. However, beekeepers should be conservative in feeding pollen substitute patties when SHB adults are present in late winter or early spring when mild temperatures may persist and result in successful beetle regeneration earlier than normal. Therefore, the hypothesis tested during this investigation is accepted as SHB were not able to reproduce inside beehives in winter when colonies were fed pollen substitute patties.

Table 2. Means of SHB larvae counts in colonies fed pollen substitute patties (N = 16) on five sampling dates. Pre five-day average minimum temperatures and lowest minimum temperatures during pre five-day sampling dates.

Sampling Dates	Mean SHB (alive) Larvae Counted (N=16)	Pre 5-day Average Minimum Temperatures F° (C°)	Lowest Minimum Temperature (F°) During Pre 5-day Period F° (C°)
10 Dec 2006	2.6	26.2 (-3.2)	16 (-8.9)
3 Jan 2007	17.3	41.2 (5.1)	29 (-1.7)
15 Jan 2007	40.6	36.4 (2.4)	25 (-3.9)
27 Feb 2007	4.6	39.0 (3.9)	28 (-2.2)
20 Mar 2007	7.4	41.0 (5.0)	28 (-2.2)

To maintain strong bee colonies through winter for early pollination purposes, some commercial beekeepers may feed pollen substitute patties in fall to increase the number of honey bees available to pollinate winter blooming crops, such as almonds in California. Other beekeeping operations which are stationary may feed pollen substitute patties to colonies to supplement poor natural plant-derived pollen production. Additional research is needed at other times of the year in temperate areas of the world to investigate the risk of feeding pollen substitute patties to honey bee colonies that are infested with SHB, especially in fall. The seasonal buildup of SHB in Australia and the United States has been reported to occur in late summer and early fall (Spiewok, et al. 2007; Nolan and Hood 2008). SHB reproduction subsides in late fall in temperate areas of the world (Nolan and Hood 2008) and fewer SHB larvae are found normally in bee colonies. Although, feeding colonies pollen substitute patties in fall may result in unexpected late season SHB reproduction which may lead to an increase in the number of overwintering adults. Feeding colonies liquid pollen substitute may be preferred during warmer periods, but further studies are needed to investigate this alternative. Beekeepers should practice good management recommendations that minimize the number of overwintering SHB. An effective SHB management program should include minimizing the number of overwintering SHB in honey bee colonies and delay their reproduction in spring.

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'Bout a 100 – Sideline Beekeeping

FACING THE CHALLENGES OF SIDELINE BEEKEEPING - REDUCING COLONY LOSSES

Larry Connor

We have worked up to item Number four on my list of 10 challenges that sideline beekeepers are grappling with in the current era. I had listed this as Winter Loss Management, but that may be too narrow a term since many beekeepers lose colonies at times of the year other than the wintertime. For Northern beekeepers the losses experienced during the year often peak in late Winter when the colony runs low on reserves of pollen and stored honey (or sugar fed to them by the beekeeper). Recently beekeepers in various parts of the country have lost as many as 90% of their colonies from the time of set-up to late winter inspections for Winter survival. Compare this to the pre-mite average and expected winter loss of 10 to 15 percent. Even when earlier versions of CCD (at the time these were called disappearing disease, fall dwindling and other terms) were present, routine losses of 90% were rare.

No other commodity group tolerates losses of this magnitude. If chicken farmers lost 90% of their flock every year the feathers would fly in state houses and in Washington. The CCD publicity has increased awareness, but not done as much for research funding as many of us would like.

I have no data on how beekeepers pay for colony replacement when they lose 90% of their bees, but I am pretty sure that in the current financial crisis, the supply of money available to fund small businesses has undoubtedly dried up and has impacted the beekeeper's capability of financing replacement or expansion. Further, since middle-sized beekeeping operations of 100 to 500 colonies are usually shown the door at the bank, there are beekeeping businesses that are no longer able to pay on their second and third mortgages with a lack of income from honey sales or pollination service contracts. It is not a good time to borrow money for beekeeping, and it is not a good time to have considerable debt in a beekeeping business.

So this article focuses on the steps the semi-professional beekeeper can take to increase Winter (and overall) colony survival with the objective to reducing or eliminating the cost of colony replacement. If you have hard-earned and carefully saved funds from income from bees and honey, this may permit you to expand your operation to a manageable colony limit.

How many colonies can one person manage while putting in a day at the office or factory, or while retired? I am sure that each of us thinks we can do more during the Winter months than we do during the mid-Summer heat wave, a time when we are thinking we should have taken up a cooler business interest. We tend to over-estimate the number of colonies we can operate and way under-estimate the cost of doing business and the time it will take to carry on a simple task. Some people are just luckier than others – for some folks, equipment never breaks, hive tools are never lost, help always shows up on time, and they never have to chase after a customer for payment. For the rest of us, we need to figure in a huge dose of industrial tail chasing: going around in circles and not getting anything accomplished!

Let's discuss the reasons why colonies do not make it to their first birthday. For starters I will remind you that in nature, swarms have one chance in six in reaching their first birthday, especially swarms that occupy a new cavity without beeswax present. Also, colonies in nature have an 80% chance of getting one of these diseases by the end of the first season: American foulbrood, chalk brood, sac brood and European foulbrood. Cornell University's Dr. Tom Seeley, who made these observations in New York and New England, shows that bees in nature have a tough time surviving.

"I have no data on how beekeepers pay for colony replacement when they lose 90% of their bees, but I am pretty sure that in the current financial crisis, the supply of money available to fund small businesses has undoubtedly dried up and has impacted the beekeeper's capability of financing replacement or expansion."

So should beekeepers accept five dead colonies for every six they set up in the Spring? Well, experience shows that we do not need to accept this level of loss. In fact, the old standard of 10 percent Winter loss seems to be the goal we should all be aiming for as we manage colonies. Here are some keys to keeping colonies healthy and strong during the production season, and in the right condition to survive the Winter:

Avoid disease contamination – The industry has been relaxed about selling used equipment to other beekeepers without inspection or treatment. A growing number of states have minimal, or no, inspection services. If you have state inspection, use it. But if you do not, then you should avoid used equipment due to the disease risk and the chance of homemade boxes and frames that will not fit standard equipment. In a few places used equipment may be fumigated by gas or treated with radiation, but these are services not found in most areas. Does this mean that you must use new equipment? I suspect it usually does. This may be one dimension of the CCD/Disappearing Syndrome, so why buy – or accept trouble – by using unknown used equipment?

One recommendation I make later to use increase

nuclei instead of package bees, means that you may need to accept used equipment from the beekeeper who supplies the initial nuclei. My suggestion is to only purchase nuclei from beekeepers who date their frames and can provide you with a colony with combs less than three years of age. A tough find, I know, but in the past too many beekeepers got "rid" of old combs by putting them into nuclei hives because new beekeepers "don't know much." Talk about lax standards!

As an established beekeeper, take the time and money to expand with new equipment, especially frames and foundation. Your goal is to minimize contamination from disease, and to reduce combs contanminated with miticides and other pesticides.

If you do have a barn full of used equipment and must use it for expansion, let me offer the following suggestions. First, keep the equipment and resulting hives isolated from the rest of your operation. Second, inspect more frequently for diseases. Third, rotate three combs out of the equipment every season. If you run nine frames in the brood box, this means that you would use three new frames in 2009, three new in 2010 and three new in 2011. Now the entire box is filled with newer frames. So in 2012 replace the box. In 2013 restart the comb replacement with three new combs to replace the ones introduced in 2009.

Scale back your ambitions – We are all eager in February to make more equipment than we can wisely run. If you need to make more extensive inspections for disease than you have in the past, you should plan to manage fewer hives in 2009. This is especially true if you have experienced losses of over 50 percent of your hives in two of the past five years. Expansion should be in smaller steps of 10 to 25 percent per year. Doubling, the old standard of pre-mite beekeeping operations is to be avoided.

"We tend to over-estimate the number of colonies we can operate and way under-estimate the cost of doing business and the time it will take to carry on a simple task."

Having decided to run 80 colonies instead of 120 in 2009, you can focus on being much more efficient with those colonies, so that they are nearly all productive honey producers and pollination units. Think about how to make more profit per hive. That may mean less honey, more bees, and higher retail prices for both honey and pollination services.

Summer Increase is part of your plan – More and more beekeepers are making Summer nuclei and overwintering these colonies. They provide a lower cost method of increasing colony numbers and for making up winter loss next season. If both colonies and nuclei get through the winter in great shape, you are now in the position to expand (be cautious) or to sell some of the increase colonies in the spring for cash at a premium price – you have an overwintered colony with a tested queen!

Look at the colonies you have in the Spring, as the nectar flow is about to begin and divide all colonies into two groups. The first group is for honey production, and they will not be weakened for the production of nuclei. You will need to inspect every frame to maintain a swarm prevention program, but when the nectar flow starts, these colonies will be ready for honey production. Super early (early May along the 43° parallel), rather than waiting until the flow is well underway. Reverse the brood nest to increase space inside the colony and add combs and frames so the bees are not crowded.

French bee breeder Maria Bolt inspects colony containing a breeder queen. The telescoping cover has been removed, and she is lifting the inverted candy board where bees have consumed food. Photo taken early November, 2008 outside Toulouse.

The second group will not be used for honey production, but for the production of new colonies over the remaining Spring and Summer. Do a full colony division into two, three, four or more colonies (not too many – remember these are the weakest colonies so don't get greedy!). If you divide these colonies in June after you have started queen rearing or can purchase cells from a neighbor beekeeper, you will need to attend to these colonies for queen/colony evaluation and probably strength reduction as the season progresses. Make more nuclei with the extra frames of brood and bees, getting more queen cells locally.

Use only locally adapted queen stock – Yes, you have read this before if you are a regular reader of this column (thank you for that). My observation about beekeepers who have routinely lost the largest number of colonies is this: they are using package hives with un-adapted queen stock. Each of these elements is a contributor to the losses.

Package bees are artificial swarms. One in six natural swarms survive to the first birthday. Artificial swarms often do as badly or worse. Swarms contain the colony's

Closeup of candy feeder.

queen and her pre-conditioned bees. Packages contain a foreign queen and bees shaken from the brood nest. They bounce around in a truck and are dumped into your hive. It is no wonder that they do poorly. Queens fail to be accepted or they are superceded early, maybe in the first month but certainly during the first season. There are some seasons where packages perform with few problems, but there are many years where they do poorly. Look at your averages: Over the years are your package bees surviving at the 75 percent level AND disease free or do you loose more than that? And what is the supercedure rate the first season? Is it under 25%, or is it over 50%?

The use of locally produced nuclei with locally adapted queens is a step toward improvement, but is it NOT a guarantee of perfect success. For that you may need to produce the increase yourself, under conditions that you have tested during prior years and found to be most agreeable to you and your colonies.

Early Mite Control – Waiting until October to treat for mites with a chemical is often too late (unless you are using one of the systems where the colony needs to be brood free). If you use screened bottom boards and powdered sugar for *Varroa* mite control, you have probably discovered that you must stay on top of the treatments or the mite levels grow rapidly from mid-Summer on when the drone population declines and more and more mites are negatively impacting worker larval development.

Unless you have mite resistant stock, and are surrounded by mite resistant colonies in other beeyards, you need a mite control method. If you do not have mite control in the area, the colonies that are dying will produce worker bees that are loaded with mites that will be attracted to your mite free colonies and suddenly you have resistant colonies with *Varroa* mites.

Delayed mite control, often associated with the parasitic mite syndrome (European foulbrood-like symptoms, deformed and detached wings), usually results in the colony dying before the first of year. Other colonies will delay death, but they will die.

Overwinter Feeding – While we looked at late Summer and Fall nutrition earlier in this series, I need to repeat the need for feed for bees in the Winter. More and more beekeepers are using candy boards, solid sugar boards placed upside down over the bees. The moisture from the bees liquefies the sugar and the bees empty the boards with ease, as they are not forced to leave the brood area of the hive. For further instructions check out the Penn State free publication link to *Basic Beekeeping*, originally written by Dr. Clarence Collison and revised by Maryann Frazer and Dr. Dewey Caron: **http://pubs.cas.psu.edu/FreePubs/pdfs/agrs93.pdf**. Check page 36 for instructions on making sugar candy. On that page the beekeeper feeds the candy over the inner cover. In my recent visit to France, beekeepers there were inverting the sugar candy to utilize the moisture and the mass of bees in the cluster to liquefy the solid and provide ease of uptake. Apparently the bees are adaptive enough to feed themselves when hungry! BC

For further information on making Summer increase colonies, consult Connor's Increase Essentials, *available from most bees supply companies and from* ***www.wicwas.com*** *bookstore. Many bee clubs have the book in their club lending library.*

The Honey Bees' Natural Nest

James E. Tew

The reality of winter beekeeping

A few days ago, as I was having some home improvement work done, one of the workers said, *"I don't suppose there is much for you to do with your bees during the Winter."* He was right, there's not much we should be doing during cold weather. Knowing that I was drafting out this article, and with insight I was not expecting, he then asked, *"Well, what is there to write about during the Winter?"* This guy was suddenly asking potentially painful questions. I countered with, *"There is always more to learn about bees – regardless of the season."* Right now, outside the bees are in their quiescent state awaiting Spring. Though it's Winter now, the process for a colony surviving – throughout the year – started last Spring. The way they run their natural nest is critical to their annual survival.

The natural nest cavity

When searching for a home, bee scouts usually look for a surprisingly small cavity – maybe as small as one-foot-cubed. Finer features of a future bee home are (1) It should be dark inside, (2) It should have a defendable entrance, (3) It should be dry, and (4) It should not have anything else living there such as birds, squirrels or ants. Ideally, it should not be on or in the ground. When tearing into trees, early beekeepers were confronted with a morass of bees, comb, brood, and dripping honey. How could any structure be found in something so chaotic? As we now know, the bee nest is a highly structured living environment. Understanding that structure can make one a better beekeeper.

The population of the nest

Wild nest populations and sizes vary significantly. How quickly, if ever, a colony can fill a cavity varies greatly; therefore, some nests are large while others stay relatively small. Reasons for size variations could be: genetics, presence of diseases and pests, the availability of nectar and pollen resources, water resources, or just blind luck (tornadoes, lumberjacks, or the natural death of the host tree). In fact, as humans have altered the world's environment, suitable nesting sites have become much dearer to scouting bees forcing them to accept sites not perfect for their needs. Not infrequently, a swarm is forced to actually build in the open, a fatal decision for most nests within the temperate parts of the U.S.

Nest fixtures

The natural bee nest is plainly furnished with wax combs only. Though bees can diligently modify the nest cavity to a degree, for the most part they must accept the space as it is. Along the top and sides of the nest, surveyor bees will lay out the beginning midrib of combs and other bees will begin to construct comb along those lines. We don't know how these bees measure out the spacing needed when laying out for dimensions for future comb but we have long ago discovered that bees require living and working space – or the famous *bee space* concept that allowed the subsequent development of artificial domiciles.

When bees first occupy a new nest cavity, the first matter of business is to construct worker comb and to set up housekeeping by getting a brood nest started. Besides being an area to nurse developing worker bees, worker-sized comb can also be used to store nectar, pollen, and occasionally water.

Combs seem to be produced almost mystically. The bees will mass together into a group called a cluster. The cluster is not a rigid structure but is fragile and temporary. As bees hang in such a cluster, the force of gravity will cause it hang perpendicular with gravity. In essence, combs are built inline with gravitational pull. Later, within the dark hive, this orientation with gravity becomes important in orienting the dance language communication procedure. Four pairs of wax glands on the ventral surface of the bees' abdomen produce virgin wax. Comb constructing bees pass a newly produced wax flake forward from back feet to their mouths where

A natural nest cavity. Note external comb pieces on left side of tree.

An exposed honey bee nest (L. Funderburg photo).

the wax is chewed, pulverized and enzymes added. After a short time, the wax particle is molded, using the bees' trowel-shaped mandibles, into part of a developing cell. It's a communal effort. Other bees may reshape previous efforts before adding their own contribution of wax to the new cell, but finally a new cell is produced. No doubt no single bee actually constructs a single cell. Experienced beekeepers have seen the completed cells in use near the top of a new frame while lower on the comb; shallower cells will still be under construction. Bees build comb as needed. For the beekeeper, new wax is nearly snow white and is valuable for candles and other wax-produced products.

Cell Shapes

Individual cells are classic hexagons. Upon mathematical review, this configuration provides the most strength and space efficiency of all common geometric configurations. The cell base is important in that it is not simply a flat plane, but is pointed in such a way that each hexagonal cell base provides one third of three cells on the opposite side of the comb. Hexagonal shapes are efficient in both space and building materials.

The importance of a nectar and pollen flow

Inexperienced beekeepers are frequently disappointed that all brood chamber space and super space is not used by the bees during a particular season. Indeed, beekeeper-supplied foundation may even be chewed up and mangled by bees not building comb on it (though such damaged foundation will probably be successfully used during subsequent productive seasons). Bees will ***only*** construct comb on the impetus of a nectar flow and a space shortage. Simply stated, bees must have building material before they can build. Nectar provides that building material, but an unusual building material it is for it can also be stored as honey rather than restructured into wax. Bees will not use stored honey to construct significant amounts of new comb. Again, the experienced beekeeper will provide drawn comb for the bees to store the crop rather than requiring bees to rebuild comb each year.

Comb is expensive

Comb is costly for the bees to build. It has been shown that bees must metabolize about seven to eight pounds of honey to produce one pound of wax. But with that one pound of building material, bees can build 35,000 cells in which they can store 22 pounds of honey. Consequently, their approximate net gain after consuming eight pounds of honey is 14 pounds of stored honey plus reusable comb. It takes about 10,000 bees, over a three day period to produce one pound of wax. That one pound will be made up of about 500,000 scales. Comb construction for the beehive is clearly an investment. Inexplicably, cappings and other wax particles are not reused to any degree, but are allowed to drop to the bottom board where they either accumulate or are discarded in front of the colony. New wax is soft and pliable and will break easily, but as the comb ages it becomes reinforced with old cocoons and propolis. Whereas new comb is snow white, old comb is nearly jet black.

Types of comb cells within the nest

Worker comb is, by far, the most abundant within the colony. As mentioned above, worker-sized comb (about five cells per inch) can be used by bees to house developing worker bees or to store honey and pollen. Larger cells, about four per inch, are used to produce drone larvae or to store honey and pollen. Distorted cells or cells of intermediate size can occur that are used by bees to splice different sizes of cells together. In other words, worker comb will be filled with patches of drone comb with small amounts of *transitional* comb wherever needed in order to make a piece of solid comb. Some worker cells may be drastically modified or special cells may be built purposefully for raising queens. As you would expect, this type of specialized comb cell, though distinctive, is the least seen of all the cell types. A modification of queen cells is queen cups which are simply queen cells that are not in use. Worker cells, drone cells, queen cells and transitional cells make up the types of comb within the colony.

Brace comb, burr comb, or ladder comb

So far as I can tell, brace, burr and ladder combs are terms describing the same structure. Bees will frequently build brace comb between frames, above or below frames, or on the bottom board – especially after a colony has been recently moved. Anywhere bee space is violated, additional comb may be build that is a nuisance to beekeepers in commercially manufactured hives. Normally, in managed hives, it is scraped off and melted as high quality wax. Within wild nests, it remains in place and helps give rigidity to the overall nest.

Bee space

The concept of *bee space* has been mentioned several times. Within both wild and managed hives, bee spacing must be implemented. Bee space is generally considered to be anything between ¼" and 3/8". Space less than ¼" will be filled with propolis while anything greater than 3/8" will have either comb or brace comb built within the space depending on its size. The Reverend L.L. Langstroth is generally given credit with conceptualizing and describing in the literature the concept of bee space.

Propolis – Natural caulking compound

Propolis is a hive product that is little known outside of the inner circles of beekeeping. It begins as a resinous material collected from the buds of trees or from resins from softwoods. Wax and other byproducts are added to make propolis. It has several uses, including being used to seal the hive structure.

Though stringy and sticky when fresh, propolis dries hard and brittle. It is soluble in alcohol and has a pleasant weedy odor. Since there is no difference between the two, both wild and managed bees will collect propolis. Caucasian bees are renowned for collecting copious amounts of propolis and will actually very nearly close an entire colony entrance if left to their own schemes.

Propolis is the material that causes the hive to crack sharply when opened. Propolis was the primary demon that relegated so many hive designs to beekeeping's junk heap. If colonies are not opened for several years, propolis will make the hive very nearly indestructible.

Propolis, along with pollen, darkens white wax over a period of just a few years. Additionally, in addition to being used to polish cells, propolis is added to the wax that covers cappings therefore giving them a different appearance than honey cappings.

Propolis is bacterially active and will restrict bacterial growth. In addition to being used to make primitive varnishes, propolis has been used in toothpaste in countries other than the U.S. Probably due to this antibiotic characteristic, propolis is used to entomb anything the bees can not move – such as a dead mouse or a small tree twig.

Inside the warm dark nest

Inside the warm, dark nest, bees probably communicate by pheromone perception (which is a type of smell), touch, and other sensory perceptions such as gravitational sensitivity or electro-magnetism. It is also incredibly crowded. Bees are literally shoulder to shoulder. Yet, all these characteristics vanish when the beekeeper removes the top from the hive. All is visible and the normal way of the colony, with the application of smoke to mask the effective communicative odors, is totally disrupted.

Within the undisturbed dark hive, everything has a unique odor: workers, queen, drones, nectar, wax moths, brood, pollen, the hunger of larvae, danger, whether or not larvae are in the correct cell – everything seems to have an odor cue within the dark hive. As beekeepers, we crudely use smoke to mask this elegant chemical communication. Temperature must be regulated to about 95°F in the brood nest, nectar must be enzymatically reduced and excess water removed to form honey; brood must be fed freshly collected pollen and this hive-city must be defended from intruders and pests.

This society must be kept in balance. In a full-strength colony, about 60,000 sterile workers, one fertile queen, and about 400-600 drones make up the population of a strong hive. Developing brood must be produced in anticipation of upcoming nectar flows or winter seasons. All these individuals come together to form the super-organism – the bee nest. Individual bees are incapable of supporting themselves for more than a few weeks under ideal conditions. The total bee nest is the animal – not the individual bee. Such is a day in the life of a bee in the nest.

So, while it may be Winter

So it may be Winter right now, but I know that a complicated system is working in my beehives. In fact, it's a system so complicated that I can't do much to help so I just write about it for you during these during these cold months. BC

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Pondering Pollination

Kim Flottum

There's more to just collecting a check when it comes to pollinating crops. Know what you're getting into before you can't get out.

So, have you been thinking of more ways to make money with your bees this year? Money's tight. Queens are $20 or more. Packages more than $50, close to $70 in some places. Gas is cheap right now but who knows what it will be come August? Maybe you've been getting by using mite controls not quite right or not quite good enough so you'll have to spend more there....and of course there's all that Nosema stuff you have to buy now that you didn't before. And feeding...who knew you'd have to feed so much...some beekeepers are using more than 30 pounds of pollen substitute per colony just to get their bees through the tough times.

But honey is selling pretty good right now and the price is right, so maybe just keep doing that? The cheap stuff isn't coming in quite as fast as it was and even so it isn't competing with yours at the farm market... or is it? But all that flap about contaminated Chinese honey has sure helped sales. But now that farm market and store you sell at want you to carry the liability insurance they used to have, so they can reduce costs and just to make sure the blame lies somewhere else. That's going to put a heck of dent in those increased profits you were planning on, right?

And what about a fall back if they cut back at work? Or your spouse loses his, or her job completely? It's happening all over these days. Yup, the bees gotta earn more this year. Gotta not only pay for themselves but put something in my pocket is what I hear more and more. And because they cost more you have to make more just to stay even. It's always something, isn't it?

Well, there's lots of ways to make more money with bees...get everything out but the buzz is what they say. Candles and wax products of course. Raising or just selling queens is good, but tricky. Selling packages or nucs can be exciting, profitable or horribly expensive. Producing pollen, propolis, bees, brood and selling beekeeping supplies can all add to the bottom line this year...and maybe you should be looking into one of more of those income possibilities.

No, I haven't mentioned pollination, yet. So let's look at that as a way to make money, not screw up your honey business, and keep your friends and family on your good side for the rest of the year.

The first question you have to answer is "Should I even consider this?" And to answer that you have to know what it is you'll need to do. So let's take a look.

Briefly, you need enough healthy colonies at the right strength ready at the right time in equipment that's in good condition with a safe way to move them to and from, and maybe to and from again, having enough money to pay for everything before you get paid for moving and more than enough time to do all of this when it needs doing and friends to help and a family that doesn't mind and with full knowledge that you may not even get paid, may not make a honey crop because you decided to do this, may expose your bees to real nasty stuff and not get any compensation for that, and may live to regret ever thinking this was a good idea. OK?

If you're square with all of that, then the rest is pretty easy.

Here's what else you need to know...

- Know all about the crops you want to pollinate, whether apples, blueberries, almonds, pumpkins, whatever...everything about growing them, the flowers, timing bloom date, the pests and spray schedules and how many colonies/acre they need.
- Know all about raising bees, and keeping them healthy, all year long, especially with all this new stuff going around.
- Know your business model...costs, expenses, labor, insurance, contingency plans, family interactions, contract requirements.

Then there's your responsibilities when you actually raise your hand for this job...these are questions you must have answers to long before you ever pick up that first hive that first night.

- Who are you working for, exactly... who is going to pay you?
- How many colonies do you absolutely have to have to do this? And how many will you need to make sure you have that minimum number (I always figure 20% extra, just so you know).
- Do you have a plan B...getting extras if you need them at the drop of a dime?
- When do they need to be delivered, and can you deliver them then?
- How much notice from the grower do you need?
- Where will they go in the field or orchard, exactly?
- What about obstacles in the field or orchard that you can't see at night...irrigation pipes, drainage ditches, small trees, puddles and ponds?

- And what about irrigation...are your bees going to get irrigated and not be able to fly, or will you not be able to work them?
- Do you have a truck turnaround nearby so you can get in and out? And what if you get stuck? Can the owner help?
- Could you just deliver the bees, and let the grower place them where he wants, as long as it's a safe place?
- What about pesticide applications when your bees are around? Be especially careful about the use of fungicides anymore, as labels say they are safe, but mostly, they are safe for adult bees...nothing is said about what happens when blossoms are sprayed and adult foragers bring back fungicides on pollen that is fed to the young...too many of these chemicals are showing up as serious problems for larvae, and nobody is watching out for it...don't allow fungicides, ever. Don't let your bees be killed legally.
- What about the new chemicals? Some beekeepers are opting out of contracts with growers that are using the neonics on their crops because they feel there is a sublethal effect of these on both adults and especially the young back at the hive. Don't let your bees be killed legally.
- Are there competing floral sources?
- Where should you aim the flight paths?
- What happens if there is a flood, a fire, or theft or vandalism and hives are lost or damaged...who pays and how much? And where will replacements come from?
- What if someone is stung and has that fatal or near fatal reaction...someone walking by, or someone working for the grower, or for you?
- Is your help covered for accidents, or are you simply praying nothing bad will happen?
- Do your bees have access to safe water? How do you know?
- What happens if the owner dies when your bees are there?
- How strong do the colonies need to be?
- Is this an average strength, or is every colony measured?
- Who measures, and with what criteria, like time of day, temperature, who is doing it, when are they doing it, and is there a minimum or a maximum or a bonus or a penalty?
- Do you have access to your bees anytime you want?
- How much do you get paid for weak colonies, for average colonies, for strong colonies...and most important, when do you get paid?
- Do you have a contract that spells all this out, that is signed by both you and the grower? Do you think you should have one?

"There's lots of ways to make money with bees. Most of them are easier than pollinating crops."

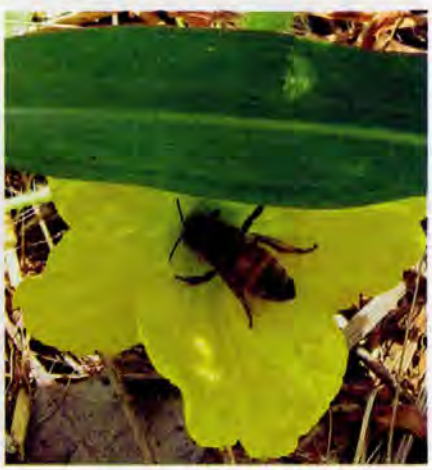
This gives you a good start and if you've answered all of these questions and are still of the mind to do this, then there's one more trick to this trade that you have to figure out...like, how much do you charge?

And of course the answer is quite simple...*how much does it cost* you do make all of this happen, on a per colony basis, or per truckload basis, or per orchard basis, and *how much do you need to make* to make this worth your time. How much profit do you need, and when do you need it by? And yes, there are more issues that you need to consider. For instance, are you including all of your costs...

- Sales time...that is, the time you spend looking for growers that are looking for pollination.
- What if you have to get someone else's bees to cover your shortfall? Do you know how much that will cost you and have you built that cost into your pricing structure, just in case?
- Recall all of your management costs, including pest and disease controls, liability insurance, travel time to and from yards and to and from (especially from growers), new or used equipment costs, bee equipment repair costs, bee and queen replacements, nets, ropes, tie-downs, motorized hive movers, labor and labor costs (including insurance, down time waiting for labor to show up, slow time while labor learns the ropes, hiring labor costs), depreciation costs, time spent on the phone getting the growers, labor, transportation and family organized, honey work, building and vehicle use, evaluating colony strength costs, attorney fees for evaluating contract costs, feed (lots of this if you are pollinating), fuel, time at meetings and reading to learn about what to consider for costs, truck repair costs, worry time...
- And one almost nobody considers...What's your opportunity cost. What could you be doing with your bees and your time other than pollinating...like making and selling honey at today's high prices, making splits, raising queens or packages, staying home and assembling equipment or taking better care of your bees so they are healthier, working more at your daytime job, family time, not wearing out your truck and equipment, not having to fix things labor broke or finding things labor lost, delivering honey, finding new honey customers, collecting pollen or propolis, making candles or other wax products, sleeping...

At the EAS meeting in Kentucky last year, Tom Eiseles, a commercial beekeeper from Indiana who makes most of his money as a pollinator presented an interesting method of calculating some of his costs that I think worth sharing.

He took most of the costs men-



tioned above into consideration and figured his pollinating price per colony to be $70.00. That price would profitably produce what he called a 'box' of bees. That was for a single crop, one time. Additional crops at the same location drew a charge of only half, or $35.00 per colony, but if continuous crops...say apples, then strawberries, then cukes and finally pumpkins all at a small farm market, the cost was $110 per colony. This price did not include a delivery fee, which I thought was interesting. He would calculate that separately and offer a rental fee on a per colony basis, *plus delivery.*

His delivery fee schedule was ingenious. He figured $4.00 per mile, one way, whether there were 16 or 160 colonies on the truck. Operations close to him pay less per colony than those further away, and those that order more colonies, no matter the distance, get a price break too. Makes sense, right? When you figure it, the way he works his bees the delivery fee really comes down to $1.00 per mile because he has to return home empty after delivery, he makes at least one trip back and forth during pollination to check colonies, and he has to return once more to retrieve them. $1.00 per mile. You may quibble about what a box of bees is, but his delivery charge works no matter what's in the boxes.

He had other sage advice that I pass along because it is worth repeating. The biggest problems encountered when in the pollinating business according to Tom... First, check your ego at the door. Second, the efficiency of scale is what separates the professionals from the hobby guys. Next, you can't have friends. And you absolutely have to have a plan B, C, and on to Z when it comes to honoring your contracts.

According to Tom the four biggest obstacles to being successful in the pollinating business are, first, be on time. Be on time getting bees into the crop, and on time getting them out of the crop. Second, have bees at or above the strength you said they would be at. Not average, not mostly, but all, at or above. Third, be presentable. Be clean, be friendly, be professional, be honest, be sober, and be good. By his figures it costs him 17 times more to get a new customer that it costs him to keep an established customer. The payback for getting new customers can be a long time so don't lose anybody you want to keep. By the same token get rid of those that cost and cost and cost because of picky little things they forgot about. And finally, price. Set a price, agree to that price, and then live by that price. What price...well, how much are you worth? Think about the worst day, or maybe the worst night you ever had in a bee-yard...absolutely the worst, and put a price on that time per hour. That's what you are worth. Cost is a totally different matter. If you figured your costs beforehand, you won't have a surprise when it comes to pricing because everything will have been figured in already...there won't be any surprises. None. Ever.

Everything here should be in a Pollination Contract, and we'll look at the details of drawing up one of these next time (we'll miss the almond crop, but if you don't have that figured out by early February, it's way too late to get it fixed now anyway). In the mean time, google Pollination Contracts and see what you find. Then check in here and we'll get a good one put together that will let you do business, and not lose your shirt. BC

Vernon Stock Queen Production

Bill Ruzicka

Raising Hundreds Of Queens And Improving Our Stock

Vernon Stock History & Present Maintenance

The Vernon Stock Improvement project was originated by Provincial Apiarist John Corner, I believe, in 1980 - 1985. John Gates got his first Apiary job in this project and stayed with it. As I recall, about 30 beekeepers donated two to five hives (the best we had). From these strains, through artificial insemination, in five years the program improved bees for local conditions and Vernon stock was created. As part of the project everyone (including myself) was taught how to raise queens, graft and learn the principle of selecting stock. During the project we requeened our hives with this stock. At the end the research team returned the hives and stock to the beekeepers to keep.

To the best of my knowledge I am the only one left who has kept this stock without knowingly introducing another strain into it. Keeping a line without inbreeding was my decision and one of my "inventions is how": Our breeder hives go through all of the rigors of our operation including pollination and are sold after grafting new generations from them as breeder queen nucs. (We do not cage and mail breeder queens. We mail them in nucs.) We sell one Queen-right and one Queen-less, four-frame nuc from each of our pollination units. From what is left, at the end of May we have 800 - 1000 queen mating units with three to eight frames. They have been celled from 20 breeders in even numbers (maximum 50 daughters from each breeder). At this stage we already start our new selection as the hives are marked for good behavior, brood pattern, hygienic behavior, honey production, and speed of development. Anything we do not like gets killed, and the bees are slashed together. The good ones are laying eggs in single boxes with queen excluders and honey super on until August.

Depending on the year, between the 3rd week of July and mid August, 144 singles are put on top of other singles to create wintering colonies. We catch and sell 140 queens. Those are the tested queens we advertise for sale. If we have some extras we catch them and put their bees and brood above the queen excluder. By Labor Day the brood is born and the combs are full of honey.

All of our wintering units are scaled and fed to the proper wintering weight 125 lbs for two-high colonies and 65 lbs for eight-frame colonies. The initial weight is written on front of the hive. Yellow and red pins are put on as ration for food-feed. When they are taken away in exchange for full or half feeders, we stop. It prevents hives from being honey bound. We also record mite levels and check for any diseases at this time. We give another mark for wintering strength, spring development, stores consumption, or conservation.

In April we select 60 possible breeders; those breeders get a drone comb to produce our mating drones. At the same time we put in two MiteGone formic acid pads. Our drones are reared and born during formic acid treatment, and we have had no problems with drone sterility.

In mid-May, by the end of pollination, we bring all our hives, including those 60 designated breeders into one yard and select the final 20 as breeders. All our hives are now in the "Bob yard," where all the nucing, queen rearing and mating is now done.

In one day, I graft 2000 cells evenly from 20 selected breeders. The selected breeders are made into queenless starters, finishers, cell builders, incubators and caged virgins banks, all at one. We take the selected breeder apart. In its place we put a Queen excluder under an empty, but wet from extracted honey, Dadant super. We put second Queen excluder on top of it. Then on the second excluder we put a deep box with two two-frame size inner feeders. Feeders are filled with thin feed, leaving space for six frames.

We find the queen and put her into the nuc box to be sold with the bees and brood in four-frame nuc as the breeder queen.

We find two combs of her freshly laid eggs with some already failing, to be our larva graft combs. Each is accompanied by one comb of open honey and one of solid pollen on the other side, filling the six-frame space. Preparing 20 units like that takes the better part of the day. We let the bees do their work for the next day and start the graft the next morning.

The two combs of larva graft are

Rain tent set up.

Grafting house.

handed to the grafter by the helper, and each produces one comb of graft with three bars of 17 cups each. Each bar is grafted from different parts on the comb, if possible also from the other side, to get more ½ sisters for variety of queen's genes. The frames with grafted cups are immediately put in place of where the larva graft was, and the used larva graft is put to incubate on other hives where we incubate the rest of the brood from the starters/finishers.

While the cells are being produced, we make and sell 350-400 Queen-right four-frame nucs, and 200-300 queenless nucs. Our customers either introduce their own queens or use them as boosts to their over-wintered weak colonies.

At the same time, we create 800-1000 mating units. Those on the original location of the old hives are left open and house our mature flying drones. We also make screened nucs, all in standard, deep equipment using our feeder dividers and wintering nuc bottoms. Note the entrances are to the wide side of the box, so moving the feeder can create two to eight-frame units.

We Do Not Move Nucs Into Other Yards.

We screen them and put cells in. Then we leave them in the same yard screened for five days. We open them when checking for virgin emergence; that way we do not leave drones behind and achieve 95+% mating success.

I aim for the cells to be around seven to eight days old when I plan to introduce them to the mating units to prevent emergence when we get delayed by bad weather. However, I have had good results with any age of cells, from four days to caged virgins. The cells are retrieved by taking 10 cells from each master in sequence so a maximum of 50 cell daughters with several half-sister groups from each breeder queen are installed. About 200 cells, 10 from each breeder, are caged and left to emerge as caged virgins; the rest of the cells are sold or terminated.

At the age of 15 days, all cells should be open and the virgins emerged. At this point we open all screened nucs and check all of the mating units. We use JZBZ cell protectors so it is easy to find out if the virgin has emerged. Also in three-frame units, virgins are easily visible, and any bad looking, imperfect virgins or unemerged cells are replaced by a perfect caged virgin.

When the mating weather comes, we have generally 800 - 1000 mating units with virgins of the same age in one gigantic mating yard. Fifty daughters of each breeder are mating with drones mostly from 60 selected drone mothers, and some extra drones are usually left over from 280 pollination units, which we use to produce 500 super nucs for Alberta. At the same time mating units are created and cells put in. This is all done in two to three days.

The Vernon project taught me a lot, but I also added a lot from my own experience over 30 years. The following are the inventions.

1. Queen Rearing

From all different queen rearing techniques, I simplified the methods to the one I just described. It re-queens all my hives while producing a large income from sold bees.

I manipulate breeders only once, and in that configuration I have starter/finisher, cell builder, and virgin incubator all in one.

I do not believe in caging breeder or over-wintered queens which are laying 2000 eggs a day. It wrecks them. Instead we sell them in nucs where they continue laying.

2. Mating Improvement

Contrary to all tradition and recommendations, we do not move mating nucs to other yards for mating. It leaves the drones behind.

- Doing all queen-rearing, nucing and mating in one yard makes it easy and keeps all drones in one place.
- Selection of drone mothers and putting drone combs in them keeps our stock clean on the drone side.

3. Rain Cover

4. Grafting House

5. Bee Glasses

As all old men, my eyes are not that good. I can't see the eggs, but not only is wearing reading glasses uncomfortable but the lenses get dirty easily. BC

Grafting, using glasses and light.

The writer is a professional engineer who, in 1980, became a bee breeder and inventor of many technical innovations. He holds the patent for the discovery of a biological Varroa mite treatment with fungus Hirsuttela Thompsonia *which was passed over to USDA labs hopefully available in the future. Until then use his other patent: MiteGone formic acid treatment on www.mitegone.com. Contact Bill at 1-250-762-8156.*

All The Buzzz in...

Hello Friends,

I'm back. I've missed you.

I'm getting ready for my busy time of year. Of course, I always have time for you!

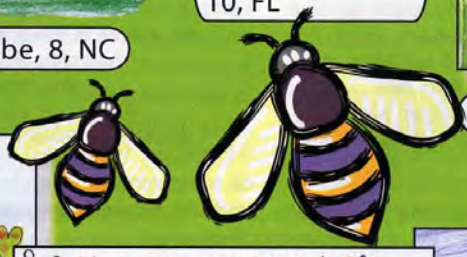
Your Friend,

Bee B. Queen

Maggie Ann McCabe, 8, NC

Zachary Wallace, 10, FL

Bryce Christensen, 8, CO



Isla Wallace, 5, FL

Bees bees honey bees,
they live in hollow trees,
they have zero fees.
Bees bees honey bees,
they pollinate our apple trees
Thank you honey bees!

Curran Christensen, 9, CO

Jack McCabe, 6, NC

Stuck on Propolis

What is Propolis?

Bees collect propolis from plants, especially poplar and conifer trees. It is a resin that helps trees by sealing wounds and protecting them against bacteria, fungi and insects.

People use propolis to help with gum disease, sore throats, and many other things.

The smell of beeswax comes from the propolis.

How Bees Use Propolis

Every once in awhile a mouse or something may creep into the hive and get stuck there. Bees will completely cover and seal the intruders with propolis so they will not get rotting, nasty, gross stuff in the hive.

Propolis is very sticky when warm. The bees mix the propolis with a little wax to seal up the cracks in the hive. The hive stays warmer and the bees can better protect their home.

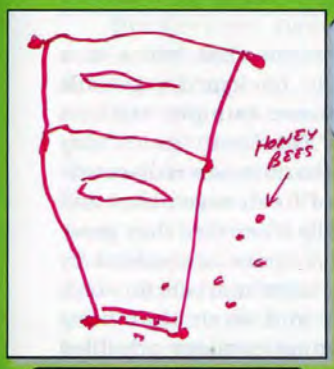
Propolis prevents bacteria, mold, or fungus from growing. The worker bees will line the brood cells with propolis to provide a sterile place for the queen to lay her eggs.

Some people think the famous violin maker Antonius Stradivarious used a propolis mixture as a varnish for his violins.

People in Mongolia and Siberia covered their wooden sleds with a mixture of propolis and oil to prevent cracking and rotting.

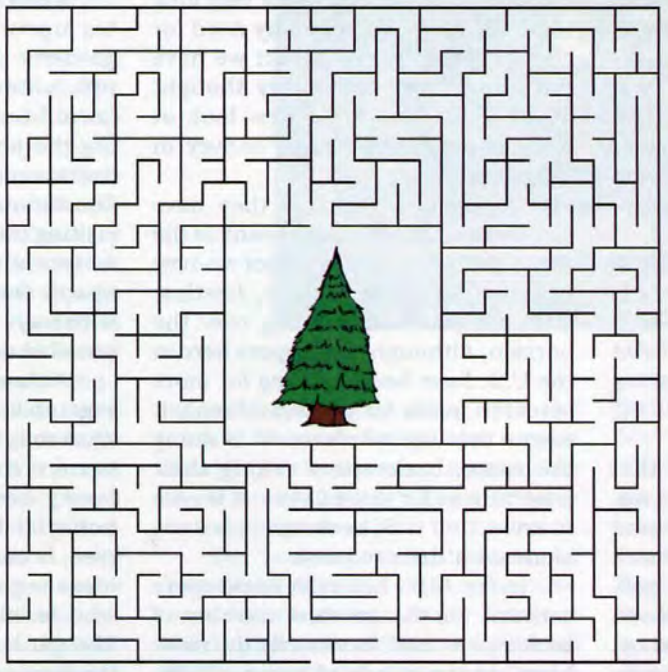
... Bee kid's corner

Produced by Kim Lehman -www.beeladyprograms.com
www.beeculture.com
March 2009



Avery Wallace, 5, FL

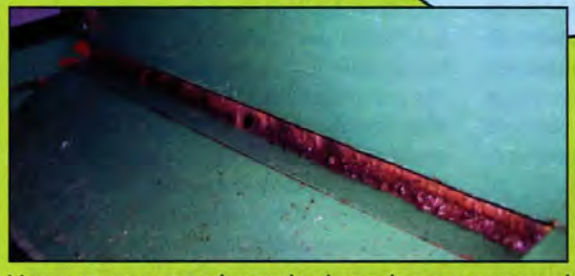
Propolis Hunt



Help Buzzy Bee find the propolis.

Pro polis

The word propolis comes from two Greek words: "pro" which means before, and "polis," which means city. Many people think the word came from Aristotle, a Greek philosopher and beekeeper.



Here you can see how the bees have narrowed their entrance into the hive, or "city", with propolis.

Bee Wind Sock

You will need: poster board, tissue paper, tape, glue, and string.

Directions: Cut poster board in four inch strips about 12 – 15 inches long. Cut out paper bees and flowers. Glue to the poster board. Tape strips of tissue paper along the bottom edge for the streamers. Bend the poster board into a circle and tape. Tape three pieces of string to hang.

Other ideas: Instead of poster board use the cardboard from cereal boxes. Use ribbon for the steamers. Make the bees by scrunching up the tissue paper.

Beecome a Bee Buddy

Send two self addressed stamped envelopes and the following information to: Bee Buddies, PO Box 2743, Austin, TX 78768. We will send you a membership card, a prize and a birthday surprise!

Name: _____

Address: _____

City, State, Zip code _____

Age: _____ Birthday: _____

E-mail (optional) _____

Dear Queen,
Thank you for the Busy as a Bee activity sheet and the stickers. I hope that the hive is well. My dad is a beekeeper. My mom is a chicken keeper. We have a lot of eggs and honey. I help my dad and mama.
Love,
Areanna Schmitt, 10, CO

Send all questions, photos and artwork to: beebuddies@hotmail.com or mail to the above address.

A Defining Moment

Is Hobbyist The Best Description There Is?

Ann Harman

The town council, the state legislators, the federal government and others are always being asked for money. For serious purposes and even some a bit silly. Budgets get scrutinized. Tax here, cut expenses there. Listen to the lobbyists; listen to the people. Listen to the beekeepers.

Dear Senator...I am a hobbyist beekeeper and ... Then you proceed to request money. Money for a perfectly good purpose. Money for the USDA research labs. Money for investigating the problems of beekeepers – CCD and *Varroa*.

Whoops. There is a word that is designed to put any request immediately into the rubbish without going further. *Hobbyist*. Sorry, but it is true. What is a hobby? Well, golf, fishing, stamp collecting. In short, anything that strikes your fancy, something that is fun, something for your leisure time.

Just what do you think a legislator would do with a letter requesting state or federal funds for the improvement of fishing rods? Or for bigger and better jigsaw puzzles?

Yes, we have been using three categories of beekeepers—hobbyist, sideliner, commercial – for a very long time. We have not seen any need for changing the terms. In fact we have not given those terms any thought at all. It is time for a new look at the meaning these terms convey in today's world.

Is this a sideline or commercial operation.

Beekeepers, whether they have two hives or 20,000, have many of the same problems. Mites, a not-so-new nosema, CCD, pesticides, beetles, and new problems waiting over the horizon. Although beekeepers here in the U.S. have been battling for more research funds for years, suddenly it seems that the whole world is doing the same, beekeepers asking their government for more funds. It is nice to know that U.S. beekeepers are not alone with their request.

In the U.S., hobbyist beekeepers account for the greatest number of beekeepers, not necessarily the most hives. In the minds of many legislators those hobbyist beekeepers are having fun with their bees and probably making a little bit of honey for family and relatives. In the minds of legislators – why do those hobbyists want money? Schools and roads affect everyone. They aren't hobbies. So schools and roads get money. None of us begrudges money for schools and roads but we, as beekeepers, know the far-reaching benefit of honey bees.

One good thing arose from CCD. Beekeepers – whether hobbyist, sideliner or commercial – began educating anyone who would listen that pollination, not honey, is the important job of the honey bee. Crop pollination is an important part of our nation's economy.

Let's take a look at the importance of a hobbyist's two hives of bees. These are probably in an urban or suburban location. Isn't it amazing that those bees are the same sorts of bees that the sideliners and commercials use? We don't give any label to the bees, only to the beekeeper. Those hobbyist's bees are cruising the neighborhood looking for pollen and nectar. They will find these in flower gardens and vegetable gardens.

Keep in mind that there is a big upsurge in backyard vegetable gardens. You see bumper stickers proclaiming "Eat Fresh" and "Buy Local." Suburbanites are rediscovering the joys of fresh vegetables and fruits, especially those that they grew. Limitations on space are solved by visiting the farmers' markets for corn, watermelons and such that need space. Gardening catalogs are filled with ways to make vegetable growing possible on decks and patios.

Although tomatoes are a favorite vegetable, urban and suburban gardens may have cucumbers, an apple tree and a strawberry bed. These need honey bees for pollination. So the hobbyist beekeeper, with two colonies, is contributing to the wellbeing of home gardens and hence the family who is enjoying the fresh produce. The gardeners may not know where the bees come from but they do recognize their presence.

It's time to remove that hobbyist label and give those beekeepers the status they deserve!

Now let's take a look at the label "sideliner." Unfortunately I have heard this from some sideliners: "I'm just a sideliner." Whoops, again. The word "just" or "only" conveys some sort of apology. It seems to be saying: "I'm not very big – not very important." Even if we leave both of those two words out, the word "sideline" seems to carry the thought that something else – a full-time job? other interests? – are more important.

We cannot deny that a full-time job brings in the main income of a sideline beekeeper and the beekeeping is a part-time occupation. But those bees are not working part time. The sideliner's main purpose in keeping bees may be moving for crop pollination or it may be for honey production. No matter what, those bees are working full time, just like the hobbyist's bees.

I am certain that the statisticians are happy with the three categories and their labels. After all, if you have 24 hives, 72 hives or 13,658 hives you will fit neatly into a beekeeper catego-

ry and all sorts of numbers can be put into impressive tables. Unfortunately the titles on those tables may contain the words "hobbyist," "sideliner," and "commercial." So there they are for legislators to see. Have we ignored the full-time bees?

Beekeepers need some new terms. Perhaps some new categories. Start thinking.

Recently I was reading an article about beer and beer brewing. The Brewers Association uses some terms for their breweries. Here is a quote from that article. "A craft brewery is one that produces less than two million barrels a year; a microbrewery produces less than fifteen thousand; and a brewpub serves at least a quarter of its beer in house." The labels of "craft" and "micro" certainly sound nice – professional, not demeaning.

As beekeepers we need to keep up with the current fashion in words. An assortment of buzzwords is in use now – "artisanal honey" is one term and "sustainable" is another. Sometimes buzzwords get applied in very strange ways so that they lose some of their original meaning. I heard artisanal being applied to a computer printer. Now there's an interesting thought. Fortunately buzzwords have a lifetime. They appear, get overused, and disappear only to be replaced with other buzzwords. I cannot guess what will come after the two I just mentioned.

For the purposes of beekeeping labels the term artisanal honey applies in the sense that it is produced by an artisan, in this case the beekeeper. However this term does not include the pollination performed by the bees. So perhaps new designations using variations on that term would not be suitable.

The term "sustainable" is being applied to just about everything these days. Can this term be applied to beekeeping and beekeeper categories? You can look in the dictionary for the meaning of "sustainable" but we might consider the definition given by Murray Gell-Mann, a Nobel Prize-winning physicist: "sustainable means living on nature's income rather than its capital."

If beekeeping is to be sustainable it could mean that our income—from honey sales, pollination rentals, queens or nucs would equal our expenses – for equipment, queens, transportation, and bees, among other things. Going along with the current buzzword might be a good idea. But is beekeeping sustainable for all beekeepers or does this term just apply to some?

Is this a side line or hobby operation?

Are beekeepers full-time and part-time? Somehow the part-time term comes out as "well, I'm just working part-time." There's that word "just" again. Perhaps this set of terms is not a good choice.

It has been suggested that the term "small-scale" be substituted for "hobbyist." Certainly the sideliner beekeeper with 700 hives feels small if that operation is compared to a beekeeper with 15,000 hives. The beekeeper with five hives sees those 700 as big.

If we use "small-scale" then would we have just two categories: small-scale and large-scale? Where would the number of hives change from small to large? We need to keep the statisticians happy. Or would it be small-scale, medium-scale and commercial? If someone is "just a sideliner" would that transfer to "just medium-scale?"

What are your thoughts on new terms? Ones that would give importance to all beekeepers.

Ones so that we can present our requests for funding and receive the respect that our honey bees and their keepers deserve.

I would very much like to hear suggestions from beekeepers. Oh dear – now how shall I say this? I would like to hear from all categories. From those with two hives, 200, 20,000. See – I avoided using our current three labels, but I really needed to use some terms.

OK! It's one, two, three – GO! Start using a new set of terms now, even though we're still thinking about what would be best. BC

Ann Harman is a "sideline" beekeeper and regular columnist for Bee Culture.

POLITICAL POLLINATORS

NAPPC has had to step up attention to honey bees because that's where the money is.

Grai St. Clair Rice

In the realm of nature, pollinators go about doing what they do best, whether solitary or social creatures. Their work keeps our world vibrant with an abundance of food and beauty. Pollinators in the human realm have recently taken on an urgent and quite political spin, with the focus of Colony Collapse Disorder putting honey bees in the cross hairs of an impending crisis.

In October 2008, the 8th Annual International Conference of the North American Pollinator Protection Campaign (NAPPC) met in Washington, DC. The Pollinator Partnership (P2)(**www.pollinator.org**) organized the conference, as well as NAPPC generally, by inviting professionals, primarily from government, research and industry. The schedule provided for conference-wide presentations, as well as designated task force breakouts for productive planning. Nine different task forces including "Rights of Way" and "Land Management" all encourage and support a healthier environment for pollinators. Within the task force groups, goals set during the conference are worked on through the year.

NAPPC has made a point of focusing on an entire range of pollinators with their agenda, including native bees, bats and butterflies, at times avoiding the specific subject of honey bees altogether. As national and international attention has shifted to honey bees, NAPPC has had to step up attention to meet the reality that honey bees are where the money and interest is in the current political/environmental climate.

The 2008 conference saw the first reporting of the Honey Bee Health Improvement Project, (HBHI) which was established the previous year with seed money from Burt's Bees. The first morning was full of rapid-fire reports from many of the heavy hitters in CCD research, all but one of whom received some funding from HBHI. The info delivered was intensely encapsulated and dizzying, providing a backdrop for the PR agenda ahead with awards and recognitions. The Honeybee Health Improvement Project continues for a second year, this time with a broad call for research proposals. The goal is to fund targeted, short-term research projects that may provide tangible results that can improve overall honey bee health.

A Pesticide Task Force was convened for the first time, spinning off from previous years' Agriculture Task Force. This is emblematic of the intensifying concerns about pesticide usage and their implications in failing honey bee health. None of the task forces where open to outsiders, and a designated spokesperson from each group delivered a three-minute update of discussions and goals to the conference at large. The Pesticide Task Force was reported to have been a "difficult discussion". Prying loose any details about these pesticide discussions, and gleaning information about the prospect of agreed upon goals, has been an exercise in persistence.

The Pesticide Task Force participants were comprised of three people from Bayer CropScience, five people from the EPA, the P2 Ex Dir, with others from CropLife America, the USDA, the Almond Board, and a number of research faculty, commercial farmers, and one commercial beekeeper. Emotions ran high during discussions with all sides expressing fervent arguments. Pesticides and pollinators are a dangerous mix, with enormous financial stakes and agricultural productivity at risk. An early discussion about creating clear labels warning of the dangers of pesticides was shelved, and the focus turned to pesticide applicator education.

The main goal set was to complete the Pesticide Applicator Training Exam Questions for the American Association of Pesticide Safety Educators (AAPSE), which had kicked around the Agriculture Task Force for a couple of years, and has now been inherited by the Pesticide Task Force. This doesn't sound difficult, especially when there are only about 10 questions involved, however this goes by way of example that finding balance or consensus on issues of pollinators and pesticide safety are nearly impossible.

As a result of previous conferences, NAPPC participants have developed a wonderful network of public awareness campaigns that reach general consumers, as well as land managers and commercial entities, including the first annual National Pollinator Week in 2007, accompanied by a Native Pollinator Postage Stamp. Look for concrete tools on the P2 website, including an impressive collection of downloadable regional guides to forage friendly plantings, as well as their Useful Resources page, which pulls together a diverse collection of links and info.

There is good work being done by P2 and NAPPC, as well as all the dedicated energy provided by the task force members determined to make a difference in our ever more fragile eco-system. These are big issues in critical times, and the work has to start somewhere. There is however no time to waste in protecting our honey bees put to service in commercial agriculture, as well as pollinators in the general environs. Responsibility for the health of pollinators has become political. BC

Grai St. Clair Rice is a freelance writer, beekeeper and is President and Editor of the Ulster County Beekeepers Association in New York.

American Foulbrood – A Review

Ross Conrad

With all the noise about the exotic problems we have, DO NOT overlook the fundamentals. Ignore this disease at your peril.

Few diseases of the honey bee are as deadly and contagious as American foulbrood (*Paenibacillus larvae*). AFB is a challenge to control because in its resting stage, the bacterium form spores that are reported to remain viable for 50 years or more. The spores simply wait in the honey and wax until the environment within the combs will support their growth (germination) and reproduction. *P larvae* spores germinate approximately 24 hours after being ingested by larva. As the disease progresses, the larva changes color from pearly white, to a tan color similar to the color of coffee with milk, before finally turning black in its advanced stages.

A honey bee colony is the only natural environment that will support the growth and reproduction of *P. larvae*. As a result, foulbrood infected honey and pollen can be consumed by people without adverse effects. American foulbrood spreads easily from colony to colony primarily by robbing and drifting bees who inadvertently carry the spores back to their hive along with the honey they pick up. However, beekeepers may spread foulbrood by feeding hives honey or pollen from diseased colonies, or by transferring combs between infected and healthy colonies. Thus it is imperative that beekeepers learn to accurately identify the signs and symptoms of American foulbrood.

Identifying American Foulbrood

The most definitive way for a beekeeper to identify a hive that has been infected with AFB is to conduct a test for stringiness. In its early stages, as the larva turns light brown, a probe such as a piece of straw, small twig, or toothpick, may be inserted into the larval mass and slowly withdrawn. Larva infected with AFB will turn thick and gummy and will stick to the probe as it is removed from the cell forming a rope-like residue that will stretch for typically 1/4-to-1/2 an inch before breaking. Should you encounter brood that exhibits these properties, you can assume that your bees are infected with *P. larvae* as no other condition that I am aware of will create a similar rope-like response within the brood.

Another sign of American foulbrood disease is an irregular brood pattern. Unlike the typical brood pattern of a healthy hive where the brood cells on a frame tends to be filled with young bees that are all about the same age and thus will typically all be capped by workers around the same time, AFB infected frames will feature numerous empty cells among the capped cells. This "shotgun" effect is created when diseased larva fail to hatch, while uninfected larva in adjacent cells successfully emerge, and workers are in the process of uncapping and removing diseased larva that die within their birthing cell. The capped cells on infected combs will often have a sunken or convex shape, a darker color than healthy brood, and a greasy appearance. The cappings will also often contain small pin-sized holes similar to capped brood from a hive that has died from *Varroa* mite infestation.

In its advanced stages, the larva in combs infected with AFB will dehydrate and change from light brown to black as the larval mass shrinks down and the remains adhere to the lower side of the cell wall. These scales contain millions of spores that stick so tightly to the wax comb that they are difficult even for the bees to remove. The final symptom of *P. larvae* to keep alert for, and the one that became its namesake, is the foul smell that the diseased combs emanate. This smell is somewhat similar to a combination of fish and glue and tends to get stronger as the disease progresses.

Conventional Controls

Commercial beekeepers tend to have both the experience and the financial incentive to stay on top of the foulbrood situation in their apiaries. Hobby beekeepers, however are notorious for not effectively dealing with *P.*

It should be noted that for positive confirmation a State Apiary Inspector should be consulted. If one is not available you can send a sample for diagnosis to the USDA Bee Lab in Beltsville, MD for a free diagnosis. Follow the instructions below to do this.

Samples of Adult Honey Bees

Send at least 100 bees and if possible, select bees that are dying or that died recently. Decayed bees are not satisfactory for examination.

Bees should be placed in 70% ethyl, methyl, or isopropyl alcohol as soon as possible after collection and packed in leak-proof containers.

Samples of Brood Comb

A comb sample should be at least 2 x 2 inches and contain as much of the dead or discolored brood as possible. NO HONEY SHOULD BE PRESENT IN THE SAMPLE.

The comb can be sent in a paper bag or loosely wrapped in a paper towel, newspaper, etc. and sent in a heavy cardboard box. AVOID wrappings such as plastic, aluminum foil, waxed paper, tin, glass, etc. because they promote decomposition and the growth of mold.

If a comb cannot be sent, the probe used to examine a diseased larva in the cell may contain enough material for tests. The probe can be wrapped in paper and sent to the laboratory in an envelope.

How to Address Samples

Include a short description of the problem along with your name, address, phone number or e-mail address. There is no charge for this service.

For additional information, contact Bart Smith by phone at 301.504.8821 or e-mail: bart.smith@ars.usda.gov

Send samples originating from the U.S. to: Bee Disease Diagnosis, Bee Research Laboratory, Bldg. 476 Room 204, Beltsville Agricultural Research Center - East, Beltsville, MD 20705

larvae outbreaks in their hives. As a result, timely identification and control of AFB is one of the primary reasons that apiary inspection programs have been established in many states throughout North America. Each state has its own set of laws governing the options for disease prevention and control and consequently, **beekeepers should first establish the legality of any treatment protocol they wish to follow.**

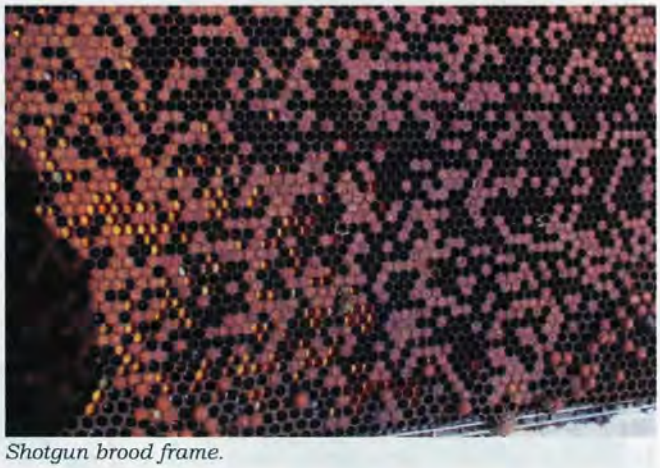
It has been repeatedly demonstrated that destruction of infected colonies by burning the bees, combs, and equipment is a low cost efficient method of keeping AFB in check. Burning a hive infected with *P. larvae* is required by law in some states. The primary objection to this method of control is that it destroys personal property in the form of equipment and bees. Some states allow beekeepers to retain the hive bodies, bottom boards, inner and outer covers and destroy only the bees, honey, pollen, brood, and combs.

When identified early enough, antibiotics are often used to prevent the bacteria spores from germinating and growing. For many years the drug of choice for controlling AFB was sold under the brand name Terramycin™ (ocytetracycline). This antibiotic is typically mixed with powdered sugar and sprinkled over the top bars of the hive, added to sugar or corn syrup during feeding, or blended into a grease patty (a.k.a. extender patty) and fed to the bees in order to control both active American foulbrood outbreaks and as a prophylactic treatment. In recent years however, strains of *P. larvae* that show resistance to Terramycin™ have emerged. Many believe that this is due to the use of grease patties which are consumed at different rates by hives depending on their population strength. Colonies that do not consume the entire patty in a timely manner provide an opportunity for the bacteria to be exposed to sub-lethal doses of the drug, allowing them to build up resistance. For this reason, applying antibiotics in a grease patty is no longer recommended. In order to effectively deal with the emergence of strains of AFB that show levels of resistance to ocytetracycline, a new more powerful antibiotic, Tylan® (tylosin tartrate), has been approved for use in beehives in the United States. Tylan® is only approved for use in active cases of *P. larvae* and is not approved for use as a preventative.

Despite its advantages, there are numerous reasons why beekeepers would not want to use antibiotics to treat hives infected with American foulbrood. Foremost among these are the time involved and the care that must be exercised in applying the correct dosage over a specific period of time. Antibiotics do not "cure" a hive of AFB, they simply mask the symptoms by preventing the spores from blooming. Following treatment, the spores are still present in the honey, wax and pollen waiting to reinfect the hive once again when growing conditions are right. Thus, once antibiotic treatments are used to treat AFB, they will need to be maintained on a regular (typically yearly or bi-yearly) basis in order to keep the disease under control. Over the years the expense and time invested in controlling *P. larvae* will grow.

What is not often acknowledged is that antibiotics will undermine the immune systems of the bees within a hive. Honey bees, like humans, have large numbers of beneficial bacteria that live in their digestive systems that are critical for optimum health. In humans these beneficial bacteria (such as acidophilus found in cultured yogurt) have been shown to have a symbiotic relationship with their host. They produce vitamins that are absorbed into the intestinal walls, they assist in the absorption of nutrients during digestion and they can colonize the small and large intestine to such an extent that there is little room for harmful bacteria, such as those that cause food poisoning, to take up residence. Although it has yet to be thoroughly studied, there is reason to believe that similar symbiotic relationships exist between beneficial bacteria and the honey bee. In addition, such bacteria are required for the transformation of pollen into fermented

A healthy brood frame.



Shotgun brood frame.

The 'rope' test.

bee bread. Antibiotics are indiscriminate; they will destroy the beneficial bacteria along with the destructive bacteria within a colony thus weakening the overall health of the hive in the process of protecting it from foulbrood.

Equipment that is contaminated with *P. larvae* but is not inhabited by bees can be sterilized via irradiation, high-velocity electron beams, or ethylene oxide. Unfortunately, these methods of ridding equipment of American foulbrood tend to be expensive and not easily accessible to most beekeepers. The state of West Virginia has built a unique mobile steam autoclave (made from second-hand navy pressure tanks hooked up to a steam boiler that runs on diesel fuel) and makes it available at no charge to beekeepers in their state for use in decontaminating infected equipment. The autoclave reaches a temperature of 230°F at 30 psi as it destroys the foulbrood spores. This unit has a 12 hive capacity and is available at no charge to West Virginia beekeepers. They will even service beekeepers in the neighboring states of Pennsylvania, Maryland, Virginia, and Kentucky who's hives are within five miles of the West Virginia border. Other beekeepers report dunking infected equipment into a lye bath in order to clean it up. Lye however is extremely caustic and the fumes are very dangerous so full protective gear including gloves, respirator, face shield and appropriate clothing are called for.

Controlling American Foulbrood Naturally

As with *Varroa* control, the ultimate long-term solution to the problem of AFB is the buildup of resistance to foulbrood by the bees themselves. Honey bees that show some degree of resistance to foulbrood can be found. Most notably, hygienic bees are considered to have some degree of resistance to American foulbrood due to their tendency to remove infected larva faster than their non-hygienic cousins. As a result, efforts to breed bees for foulbrood resistance should be incorporated into current efforts that are focused on developing resistance to *Varroa*.

When a feral colony contracts American Foulbrood, its declining population is no longer able to prevent wax moths from gaining a foothold in the hive. Thus nature's clean up crew the wax worm, will destroy the old diseased combs within the doomed hive preventing robber bees from other colonies in the area from picking up AFB spores and bringing them back to their otherwise healthy hive. The naturally inclined beekeeper can mimic the example of the wax worm in destroying the source of AFB infection and yet do so in a way that preserves the life of the bees. This can be accomplished by removing every bit of wax, honey, and pollen from a hive infected with AFB and placing the bees onto frames of foundation. It is best to carry out such a procedure in the early part of the honey season so that the bees will have ample time to draw out the foundation and store honey for times of dearth. However, American foulbrood may rear its ugly head at any time and such ideal timing will not always be possible.

The actual process of eliminating AFB from a hive consists of shaking each frame of bees into a clean hive body filled with foundation. If the queen is spotted during this activity, it is best to transfer her into her new home manually by grabbing her wing and placing her on the top bars of the frames so she can crawl down between them. (To reduce the chance of an injury that could affect her ability to lay eggs, I don't recommend holding a queen by any part of her body other than her wing.) Included in the new hive body of foundation should be one empty frame of drawn comb positioned in the center of the hive body. This frame of comb is left so that the bees have a place to deposit honey they may have engorged themselves with during the process of smoking and shaking them into their new home. The very next day, the frame of drawn comb containing these honey deposits should be removed and destroyed and replaced with a frame of foundation. The colony should then be fed uninfected honey or sugar syrup so that the hive has something to get started on and won't starve should it immediately experience a week of cold, wet weather and not have the opportunity to forage.

This procedure will remove all the beeswax, honey, pollen, and brood that may possibly contain AFB spores from the hive. Once removed, all of the frames and comb from the infected colonies should be destroyed or disinfected, and all hive bodies, supers, inner covers, and bottom boards should be scraped clean of burr comb, which should also be destroyed. Once scraped clean, every square inch of the interior of the wooden ware can be scorched with a propane torch or other device that will heat the surface of the equipment to a high enough temperature to ensure that any remaining AFB spores are destroyed. In this way American foulbrood can be permanently removed from a hive without sacrificing the bees and most of the equipment in the process.

One of the keys to maintaining foulbrood-free colonies are regular hive inspections and careful examination of every colony that dies for signs of disease. Once your apiaries are disease free, regularly removing a couple of the old, darkened combs from the colonies each year and replacing them with frames of foundation will serve to reduce the opportunities for disease spores (or chemical residues) to potentially build up within a colony's drawn comb reserves. Current recommendations are to replace all brood combs on either a five year cycle by replacing two frames every year, or on a three year cycle by replacing three frames every year. Marking the frames with the year they are introduced may help in keeping track of when they are due to be removed. By the same token, one should make it a practice to avoid used frames of comb when purchasing, or inheriting equipment. Unless you know that hard chemicals and antibiotics have not been used on the colony and you have a high level of confidence in the source, accepting used frames is tantamount to inheriting someone else's problems. It is also beneficial to know who has bees in your area, as diseased hives nearby are the most common source of reinfection.

Given the current shortage of honey bees in the U.S., it is my hope that state regulators and apiary inspectors will begin to modify their laws, policies, and procedures to allow beekeepers to use the above method of natural foulbrood control in order to help preserve bees and equipment. BC

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GLEANINGS

FEBRUARY, 2009 • ALL THE NEWS THAT FITS

OBITUARY

Paul Philip Younger passed away on Dec. 10th., 2008 in Queen Creek (AZ). He was a long time member of the *American Honey Producers Association.*

He was born in Arlington, Massachusetts in 1952, to Don and Jean Younger, and he is survived by his two children, daughter PauLeeN, son Philip and Mardonia Petalcorin Younger his wife of 21 years.

He lived in Wisconsin and Ohio as a child and in 1970 he graduated from Kemper Military Academy in Missouri. Paul tested out a few Universities but earned his BS in Entomology from the University of AZ in 1976.

He worked for other beekeepers, at the Tucson Bee Lab with Steve Taber, and started Patagonia Honey, running over 500 colonies. Over the years he worked with *Apis ceranae*

in Sri Lanka, African honey bees in Arizona, and traveled to Argentina and China to study beekeeping techniques in those countries.

He is best known as the inventor of the Younger Smoker, a smoker that used vaporized fluid rather than traditional fuel, the firsst innovation in smokers in 100 years.

CALIFORNIA KEEPS PLANTING THOSE MANDARINS

Mandarin orange plantings in the Central Valley's citrus belt continue to increase to meet growing consumer demand. According to the U.S. National Agricultural Statistics Service, in 2005 there were 24,038 acres planted to mandarins in CA, with 11,834 of those non-bearing. In other words, three years ago nearly half of all mandarins were newly planted.

In 2008, 31,392 acres were planted to mandarins; 5,707 non-bearing. According to the U.S. National Agricultural Statistics Service, in 2005 there were 24,038 acres planted to mandarins in CA with 11,834 of those non-bearing. In other words, three years ago nearly half of all mandarins were newly planted. In 2008, 31,392 acres were planted to mandarins; 5,707 non-bearing.

The fruit has a lot of appeal to people who like their sweet flavor and easy-peeling attributes.

Plant researchers continue to work on developing new varieties of mandarins – not to replace Clementines or Satsumas, but to enhance them. Beekeepers, meanwhile, look on to see if these new plantings are in bee friendly zones, or will be used to exclude honey bee colonies from even more foraging areas. Bees and trees are at the bottom of an ungoing dispute between beekeepers and mandarin growers. The growers want bees excluded from areas too close to their mandarins because bees will visit both mandarins and cross pollinators, enabling the mandarins to produce seeds, reducing their value. Knowingly planting additional trees in areas too close to cross pollinator varieties would certainly be in error, now that the growers are keenly aware of their initial mistake, and would probably weaken their negotiating positions later this season when they want to exclude bees entirely.

UC Riverside scientists have recently released to tree nurseries varieties called Gold Nugget and Yosemite Gold. They continue working on even better varieties of the fruit.

REPORTING PESTICIDE PROBLEMS

Dr. Eric Mussen, at U.C. Davis, puts out a newsletter that is always full of good information. I've referenced it before here, and will again I'm sure. This time he talks about reporting problems with bees and pesticides... worth reading for sure. Thanks Eric.

A group of forward-looking commercial beekeepers took it upon themselves to contact administrators from EPA and asked to discuss their concerns about honey bee-pesticide interactions. Given the history of previous, explosive exchanges, both sides had to take a deep breath and approach the concerns cautiously.

One detail that really caught the attention of the beekeepers was the fact that, at their reporting level, EPA lists only two reports of bee kills in 2006 and none between 2003 and 2005. Therefore, it seemed a bit odd to EPA representatives that the beekeepers felt so strongly about this issue.

In theory, there should be a mechanism by which any person, who believes that an application of pesticide caused a problem, can file an official state document detailing the purported loss. That document should become part of the state's permanent record and should be transmitted to the federal office on an annual basis.

In California, that form is called "Report of Loss, Nonperformance or Damage" (PR-ENF-008). The form can be obtained at the office of any of the county agricultural commissioners or on the Web, if you search long enough. In California, the Reports of Loss are usually taken in to the ag commissioner's office, to become part of the permanent file for that year. The last thing a commissioner wants is a drawer full of loss reports. It suggests that things are not being handled well in the county. It is likely that you will meet resistance to submitting a bunch of loss reports, but this is the ONLY WAY beekeepers can document how much loss actually is being encountered. When asked, I tell anyone that California beekeepers lose, or have severely damaged, an average of 10% of the state's bee colonies. Not everyone suffers losses each year, but some of the losses are very large.

You may have to explain to the ag commissioner that you do not believe that these losses were misuses of the products, but the data is essential to document how much bee loss actually is occurring.

To prove the sincerity of the EPA to collect this data, the following two individuals wish to see copies of the all loss reports as they are being filed in the states:

F. Nicholas Mastrota, USEPA Headquarters, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Mail Code: 7507P, Washington, DC 20460, 703.305.5247, Mastrota.nicholas@epa.gov; Norman Spurling, USEPA Headquarters, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Mail Code: 7502P, Washington, DC 20460, 703.305.5835, Spurling.norman@epa.gov. A third person is interested in keeping track of any possible problems with fungicide applications. If you believe that you have encountered bee problems following a fungicide application next year, report that to your state and to: Tony Kish, USEPA Headquarters, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Mail Code: 7505P, Washington, DC 20460, 703.308.9443, Kish.tony@epa.gov.

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Good News From Lyle

Ed Colby

When I mentioned in the Aspen Mountain ski patrol locker room after work that I was going to the Colorado Beekeepers' convention in Longmont, somebody said, "Beekeepers' convention? What do you do at a beekeepers' convention?"

Scott said, "They dress up in their little black and yellow bee suits, and they have these big antennas that stick out of their eyebrows!"

Everybody on the patrol found this amusing.

Patty said, "And they do their beekeeper dance – like this –" She set down her beer mug and stood up. Then she locked her knees together, splayed her feet, and held her elbows close to her ribs, while she fluttered her hands like little wings and did the cutest wag-tail dance around the room.

She looks fabulous with her new red tint, and she knows it. She blushed when I said, "Patty, when you go by, there's not a guy over 60 who doesn't look!"

I told my patrol buddy Doug about wanting to talk to someone at the convention who goes to California every Spring to buy package bees, except I said "nucs" by mistake. Doug said, "So you want to be like Iran, right?"

"Iran?" I said. What was he talking about?

"Sure," Doug said. "You want *nukes*, like Iran . . ."

Doug obviously thought this was really funny, so I laughed right along with him, because he was doing me a big favor and trading days off with me so I could swing the trip.

I don't often go to the Winter meeting. We hold it on the first weekend in December, in Longmont, which is on the other side of the Continental Divide. And the last five years, we've gotten hammered with snow in early December. This is not my favorite Winter drive, and it's a tough time of the year for me to get away.

In 2005 we had a blizzard the first Saturday in December, so I skipped the meeting and got myself buried four feet deep in an avalanche at work. It's dark down there! And lonely! Just as *Bee Culture* editor Kim Flottum was addressing the Colorado beekeepers, I was looking for a breath of air. You'd think that might have been an omen and a lesson that I ought to figure out a way to get to the winter meeting, but since my patrol buddies found me right away and dug me out, I actually consider December 3, 2005 to be the luckiest and best day of my long lucky life.

This year the blizzard hit a couple of days before the meeting, so on Friday I slipped over Vail Pass under blue skies, with just enough snow left on the road to make you extra careful.

That evening at the convention we had a small roundtable talk with MegaBee pollen substitute developer Dr. Gordy Wardell, who summarized what he would explain in greater detail the following day – that protein supplementation strengthens colonies by increasing the life span of workers. When workers die young – often from environmental and disease-related stresses – immature house bees get tapped to replace them. These bees are physiologically not ready for the job, so they too die young, setting up a vicious cycle that can lead to colony collapse.

Protein deficiency and supplementation were to be major themes at this year's meeting.

Speaker Lyle Johnston from Rocky Ford is a big operator whose family has been in the bee business for 100 years. He runs his own colonies, plus brokers tens of thousands more for almond pollination.

Lyle is a giant of a man. I'm six-foot, and he towers over me. I wouldn't want to speculate on how big he might be. He's also home-spun and self-deprecating. When he was introduced as " . . . someone whom many of you know as a past president of the Colorado Beekeepers Association," Lyle quipped, "I don't know about that. When I was president, nobody came to the meetings."

What's not to like here?

When Lyle talks, beekeepers listen. First he pitched a new beekeeper-funded research program called Project Apis M., which you can find out more about on the Web at www.ProjectApism.org.

Then he gave us the how-to. "Look," he said, "Guys are complaining about losses, but my colonies have never been stronger. I'm going to tell you how to have healthy bees."

You could have heard a pin drop. Suddenly everybody started taking notes.

He said you need to do three key things to strengthen your colonies: control mites, feed fall protein supplement – lots of it – and control *Nosema ceranae*.

Lyle uses Fumagillin for Nosema. I asked him about Frank Eischen's research pointing to pollen substitute alone being as effective, or more effective, than Fumagillin. Lyle said he was familiar with Eischen's study, but he also said he knew that Fumagillin works, and that's why he's stayed with it.

He mentioned three indicators of Nosema that don't require a microscope – spotty brood, drifting, and supersedure. I wondered how he put all this together and came to these conclusions. It made me reflect on how much a really good beekeeper sees in the hive, and how much the rest of us miss.

This was the best bee talk I ever had the pleasure to listen to. You never saw such a beaming bunch of beekeepers coming out of a meeting. Here was a giant of the industry telling us that, yes, we can make it. It's not all gloom and doom. There's a ray of hope.

It's about time.

BOTTOM BOARD