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Who killed the honeybees?

A round table of experts answer all our pressing questions about the sudden death of the nation's bees. What they have to say has a bigger sting than we ever expected.

By Kevin Berger

May. 29, 2007 | The buzz about the alarming disappearance of bees has been all about people food. Honeybees pollinate one-third of the fruits, nuts and vegetables that end up in our homey kitchen baskets. If the tireless apian workers didn't fly from one flower to the next, depositing pollen grains so that fruit trees can bloom, America could well be asking where its next meal would come from. Last fall, the nation's beekeepers watched in horror as more than a quarter of their 2.4 million colonies collapsed, killing billions of nature's little fertilizers.

But as a Salon round table discussion with bee experts revealed, the mass exodus of bees to the great hive in the sky forebodes a bigger story. The faltering dance between honeybees and trees is symptomatic of industrial disease. As the scientists outlined some of the biological agents behind "colony collapse disorder," and dismissed the ones that are not -- sorry, friends, the Rapture is out -- they sketched a picture of how we are forever altering the planet's delicate web of life.

The scientists constituted a fascinating foursome, each with his own point of view. Jeffrey Pettis, research leader of the USDA's honeybee lab, told us the current collapse is one of the worst in history. Eric Mussen, of the Honey Bee Research Facility at the University of California at Davis, maintained that it may only be cyclical. Wayne Esaias, of the NASA Goddard Space Flight Center, an amateur beekeeper, outlined his compelling views about the impact of climate change on bees. And John McDonald, a biologist, beekeeper and gentleman farmer in rural Pennsylvania, reminded us, if at times sardonically, of the poetry in agriculture.

First things first. The Internet, as you know, loves a rumor. Are cellphones killing the bees?

JEFFREY PETTIS: All the explanations that bees became disoriented by cellphone radiation, or this, that and the other thing -- there is zero evidence for any of it. All we know is we lost the worker population and they died away from the hive. What's unusual is they died over a short time period. Are they flying off to Nirvana? Who knows where they are? They are just dying away from the hive, which is normal.

ERIC MUSSEN: It's important to look at what's normal. In the summer, bees go through a six-week life cycle: three inside the hive, three outside it as foragers. Then they die of old age. When bees are coming to the end of their life for whatever reason, they just fly off and don't come back. They fly out to die because flying out and dying is what they do. The question is, Why are we seeing bees with such a shortened life cycle? Well, now we're talking about winter bees. As you move into fall, the colony is supposed to be rearing bees that have a long life expectancy -- from about October to March of the next year. The problem is the winter bees aren't making it. Everything just sort of fell apart near the end of this summer and those bees that were supposed to live up to six months didn't come close.

JOHN McDONALD: That cellphone thing is a major source of irritation to me. If it were true, I suspect about 10,000 people at Penn State would be lying on the street dead now. And yet you see them walking around and talking on cellphones. My son explained to me that cellphone radiation puts out a wavelength of about three inches. A honeybee is three-quarters of an inch long and so the bee is going to create virtually no shadow in that wavelength. That's one reason why I look askance at that theory. The other is where I live, in the middle of Appalachia, the bees are disappearing and there are virtually no cellphones.

One scientist has said solving the bees' disappearance is like "CSI" for agriculture. What's the latest word from the lab?

PETTIS: The latest word is we're working on a lot of different samples we've collected throughout the year. We're working under the idea that bees have suffered a one-two punch. The first is a primary stressor -- poor diet, mites, or low-level pesticide exposure. That puts them in a compromised or weak state, and then a secondary pathogen takes over. Because of how quickly the bees are dying, it seems most likely a pathogen would be involved. So we're looking for a secondary pathogen that might be unique or novel.

Are pesticides a major culprit?

MUSSEN: Perhaps 10 percent of commercial bee colonies in any given year are either severely damaged or die on contact with agricultural pesticides. But there's no reason to believe the exposure this year is any different from last year or any other year.

John, you wrote a pretty strong opinion piece that fingered Bt crops, which have been genetically modified to control insect pests. Based on your experiences as a beekeeper, how did you come to that conclusion?

McDONALD: My first collapse started last summer when a powerful colony, in a manner of a week, went downhill. The drone cone sort of cascaded down over the foundation like ice on a mountain. In another hive that was equally strong, the bees ended up lying dead on a mat that extended about six feet. That didn't happen with the other hives, which is indicative of agricultural poisoning. Also, the drones hung around until snowfall, which is unusual, indicating some kind of kind of behavioral dysfunction with the worker bees.

I did a little research and found two studies about the Bt phenomenon. When you look at the action of Bt gene proteins taken up in the gut of insects, including bees, you find an enzyme that gobbles its way through any protein there and affects the insects. And bees are known to forage on corn flowers to get pollen to rear their young brood. I'm not saying Bt is the sole cause of collapse, only that I would like to have it investigated.

Is there any evidence, Jeff or Eric, of Bt crops killing bees?

MUSSEN: When Bt crops were being used in the fields to control lepidopteron insects, or butterflies, there were a significant number of studies run to try to determine whether or not incorporating Bt into the food of the adult bees, or the larvae, would hurt the bees. And the answer was no.

PETTIS: I contributed to a recent study where we directly fed the Bt toxin to whole bee colonies and could demonstrate no effects on them.

MUSSEN: There was a study, and perhaps this is the one John is referring to, that showed the active

chemical in these Bt cultures is a protein crystal that develops in organisms. For four years in a row, an institution fed that protein to honeybees at 10 times the amount that they would ever encounter in the field if they were feeding on pollen. In three of the four years, they saw nothing out of the ordinary. In the fourth year, a parasite showed up, and the bees that had been consuming the protein appeared to suffer more. The experiment didn't say the Bt protein gave the bees the "disappearing" disease, or that it killed all of them; it just said the bees that came in contact with the crops appeared to be more negatively affected by the parasite.

Can you tell us about your experiences with colony collapse, Wayne, and your studies to understand wider ecological causes?

WAYNE ESAIAS: Sure. I'm a small beekeeper. I have about 15 colonies and have experienced some loss. I realize there are many symptoms involved. Still, there are one or two I'm puzzled about. I keep records of when my bees collect pollen and nectar in my backyard. I weigh the hive and I have a time series that goes back to 1992. What I've seen over the course of that time is due to local warming: The pollen and nectar flow come almost a month earlier than they did in the 1970s. This is coincident with the urbanization of the D.C.-Baltimore area, causing temperatures to rise.

I'm also using data from NASA satellites to address how global warming or environmental change might be impacting our honeybee populations, and even the spread of the African honeybee. We see plants blooming at different times of the year, and that's why the nectar flows are so much earlier now. I need to underscore that I have no evidence that global warming is a key player in colony collapse disorder. But it might be a contributor, and changes like this might be upping the stress level of our bee populations.

One new study suggested the collapse might be the result of a rare spore called Nosema ceranae.

MUSSEN: If you get enough Nosema ceranae, yes, a colony will die. If you get enough viruses, the colony will die. If you get enough mites, the colony will die. If you get exposure to insecticides, the colony will die. So all these things that we are looking at are capable of doing in a colony. There's no doubt about it. So could a true lack of food. Literally, you could starve the bees to death. Beekeepers have accidentally done that many times. What you're going to find is that in most cases there is not going to be one factor that did them in; it's going to be a combination. This is the perfect storm for honeybees.

Millions of bees in California alone are trucked around from town to town to be used as pollinators on farms. That's got to be awfully stressful on them, right?

MUSSEN: Yes, it's a stress. But commercial beekeepers have been moving substantial numbers of colonies on trucks for decades. I'm not convinced that they're being moved more, or that it beats them up any worse that it did ten years ago. California beekeepers have told me that in a course of moving the colonies around in the back of the truck, they tend to lose 10 percent of the queens with each move. Some feel it's that high. But that doesn't meant that 10 percent of your bee colonies died; many of them will come back and you will still have a colony.

One researcher has said that the competition for food among the millions of bees used to pollinate almond trees in California could, essentially, be working them to death. Do you agree?

MUSSEN: Almond trees aren't the problem. It's what happens after the bees are done with the trees and are brought back to the holding yards. In late fall, there is basically no food -- after the almonds -- so the bees have to fend for themselves. Besides eucalyptus trees, there's a bunch of weeds that the

bees can feed on. They don't get heavy and fat but they've got some food available.

PETTIS: Beekeepers are always looking for what they call "good pasture," places they can put the bees and not have to feed the bees themselves. Florida has an abundant and diverse set of floral plants, so the bees are not suffering. What's interesting is that there's a number of government control programs for invasive weeds. Beekeepers love invasive weeds. Most produce a lot of nectar for the bees. So there's been competition in some cities over getting rid of the noxious weeds and keeping them for beekeepers. But California is unusual in that beekeepers are doing what we are starting to call "feedlot beekeeping," where we are having to provide resources because there is just not enough food out there. And this is just to meet the almond-pollination demands.

MUSSEN: The real problem in California is that we've only had half a normal rainfall this year. So after the almonds, when the bees went out to find other things, there was barely anything there. What was really interesting was some of the bees looked like they were well on their way to establishing good colonies. They looked like they could live on the stored almonds they had picked up in the late summer and fall. But this time they collapsed. So that's the question: Why?

And what's your answer?

MUSSEN: I'm probably the strongest advocate in the United States suggesting that malnutrition was the underlying thing that set up our bees to be whacked by everything else researchers are looking at. Honeybees rely on pollen for protein, vitamins, fats and minerals. That's where their major "health food" comes from. If we are having a typical year, and the rains come, there aren't too many places in the United States where the bees cannot find their mix of pollens to meet their dietary needs and get them through a normal life cycle.

The question is, What happens when things don't go like that? Well, you get this blast of hot temperature, which is about the time the flower buds are forming and the pollen grains are beginning to form. What does that do? You get sterile pollen. A beekeeper could look into the hive and say, "I've got all kinds of pollen in there and the bees disappeared." Well, right, you've got pollen grains, but do they have any nutrition in them?

Anything that interferes with the availability of food, or the quality of the food, is going to be detrimental to the bees. They don't have much of an immune system, so the only way that they can resist being infected by a lot of things is when they have their innate resistance up, and the best resistance is when they're best fed. So my feeling is that their nutrition just wasn't what it was supposed to be, and they were susceptible when they should have been resistant. I think something happened at the end of last year in many places in the temperate climate around the world, not just here, and fouled up the bees' food supply. Unless somebody tells me differently, I'm blaming it on the weather.

ESAIAS: One of the things that I've noticed in my short little time series in my backyard is that I could pick out every El Niño and La Niña effect. These are normal. These short-term climate changes are normal, and our bee population and our natural pollinator population have seen them, and they can probably handle them. What is disturbing is the long-term trend. Maybe years of severe climate impact are going to be more frequent and it's going to be really difficult to pick them out as causative factors unless we have a coherent way of studying each one.

Could the bees be dying because once they are sent out to do their work as pollinators on farms, they can't find their way back to their colonies? Sometimes it seems like there are more mini-malls in America than flowers, and maybe the bees can't navigate urban land patterns.

MUSSEN: Land patterns would be the least of their problems. When a honeybee transitions from an in-hive bee to an outside bee, it flies back and forth around the hive for a few minutes. Then it backs off and goes further away. In the process, it is taking a bunch of snapshots. That's how it's going to navigate from that time on -- through those snapshots. It's going to learn the roads, the trees, the houses, and the part of the hive with the entrance it uses. Bees use those landmarks to determine where they are and where they are going. That's another reason why cellphone communication is not going to rattle them unless it completely fries their brains so they can't see anymore. But when you put them into the environment where they have been flying, they'll follow their landmarks home. So I don't think we have to worry about that.

McDONALD: I'm not sure. I've been thinking about the size of the current soybean and corn crop, which I think impacts on this. When we fly over the fields in a jet, we look down and think we see some pastoral idyll. But the truth of the matter is, we may be looking at a slow-motion ecological train wreck. I made some calculations, and the total soybean and corn crop, including genetically modified seeds, is in a neighborhood of 102 million acres. After a little basic arithmetic, that would be a strip of crops running from Pennsylvania to the Rocky Mountains. It would be 100 miles wide, and if you were flying over in a plane, it would take you four hours. When you look at that thing at that magnitude of disruption, you can't help but suspect that maybe there's more to the picture than meets the eye, when you consider the absolute scale of things, compared with natural environments where you still have weeds and flowers.

ESAIAS: Land use has changed drastically in the past 100 years. There's no question that urbanization is increasing at a fantastic rate. I was thinking, as I was listening to John, that a lot of these concerns apply to our native pollinators -- the things that live in the hedge rows and the woods -- much more so than to our managed bee colonies, which are generally cared for by beekeepers. Crops are a significant source of pollen and nectar for our bees and our pollinators, and there is no doubt in my mind that the flora quality is changing, even if we can't say whether it's for the better or worse just now.

McDONALD: You know, I was looking at my flowering trees the other day. I have a beautiful weeping crabapple, and my grandson, while standing under the tree, which was just heavy with blossoms, said spontaneously, "Last year that tree was humming with bees." Now there was one bumblebee on it. The small nascent bees and other little bee types are absolutely missing. Near that tree I've got acres of dandelions and you cannot find one of the native pollinators. And it's not just the honeybees; it's other pollinators like moths and butterflies. In many ways, their loss is probably more alarming or indicative of a deep problem.

PETTIS: We rely on honeybees for agriculture because we can move them in large numbers. And we know how to manage them. But the National Academy of Sciences recently published a study that showed that all pollinators -- which rely on a diversity of flowers -- are in decline. Whether it's urbanization, habitat fragmentation, or an increase in agricultural land use, something is severely impacting the native pollinators.

Colony collapse disorder was reported by commercial beekeepers. Is it also happening to bees in the wild?

PETTIS: There's very few places where we actually monitor the feral population. I know of a group in Texas that was following some wild populations of bees, and a Cornell researcher has found a group around Ithaca, New York. But it's often hard to sample those bees. We know that wild bee populations were decimated by parasitic varroa mites over time, and they've rebounded, probably due to natural selection for natural resistance. But I'm not familiar with data coming in from feral populations.

McDONALD: A few years ago, in a very remote part of the state, I found thriving bee populations that I assumed were feral. To help them along, I set up bait boxes and put in anti-mite strips. I slipped them in seed oil and made little puddles so the bees had to walk through the oil in this experiment I called "remote medication." But as the summer went on, the bees collapsed in spite of my attempts to help them. The feral population is just getting so hard hit that I suspect it's virtually gone by now.

Are scientists looking at how the climate affects the bees' favorite flowers and food sources?

ESAIAS: That's a good question. Most of the nectar sources in Maryland, my state, come from trees -- tulip poplar, black locus, and holly trees. There has been a great deal of research on plants and increased CO_2 and warming. I tried to find out how temperatures would affect blooming dates, and there is virtually no information in the literature on how temperature affects blooming dates of our trees and how increased CO_2 concentrations affect blooming dates. There's lots of research that says it makes plants grow faster, and some of them, like poison ivy, become more toxic. But ecologists in general have not paid attention to the timing of blooming and nectar availability and quality of pollen.

McDONALD: That is so true. The only number that I go on is that an apple tree will bloom after 40 days in 40-degree temperatures. That boils down that simple formula.

ESAIAS: As a kind of a climatologist, I'm getting paid to study the impact of potential global warming scenarios on our ecology. There's a lot of research being done on carbon cycling, but without information about when the plants bloom and how the quality of the flora changes, we are in a poor position to asses the effect of changes in temperature and rainfall on our ecosystems.

Can bees survive climate changes?

MUSSEN: I can tell you that beekeepers take their honeybees north to the upper Canadian border and all the way down to the equator. If they're warm, they cool themselves by evaporating water, and if they're cold, they heat themselves by sucking up a little bit of extra carbohydrate and rattling their muscles.

So they're great adapters?

MUSSEN: They're going to handle it. The honeybees are not the ones I'm concerned about. I think Wayne will back me up on this: Historians have said that thousands of years ago, there were some pretty nasty fluctuations in the earth's weather. And through this period of time, we became and continue to be very good farmers. But for whatever reason, we are beginning to kind of move into a cycle where we are going to find more extremes than we used to have. The droughts may be hotter and longer, the storms and floods may be more severe. Things aren't going to be so nice in the future. But again, I think the honeybees are more likely to handle that as long as they've got some food available to them. But with some of these other pollinators, which we rely upon to keep the environment going for us, well, if they get knocked around too much by the weather, then that's going to be really consequential.

What do you think the disappearance of the bees teaches us about ecology?

ESAIAS: If I can go back to what Eric was saying, I too don't doubt the survivability of the honeybee. On average, it's going to do fine. But what we are dealing with now is a series of local effects. That doesn't mean we aren't going to see an average global increase of temperature in the future, if you believe the predictions.

What does it tell us about our native pollinators and ecology? That's such an exceedingly complex question that I don't know. It just puts me in awe of earth's complexity. If you ask scientists to predict what global warming will do to an ecosystem, and they don't throw up their hands and say, "Beats me," then it shows we have a lot of work to do to understand the complexity and responses of all of these insect and plant interactions, when they occur, and will they get out of phase.

McDONALD: I think there is a cautionary tale here. Look at the progenitors of the maize, the corn which was developed in Mexico. It took a long time for environmental researchers to find the original plant because as the maize became dependent upon cultivation, a lot of those genes from the wild corn had died off. There used to be 1,000 small meat-packing plants, and if a problem arose at one, it was not particularly important to the other 999. But now with all these together as one vast factory, any problem that arises has instant implications everywhere. We're at the mercy of assembly-line farming and high-speed distribution, and maybe no accountability as far as the quality of the food. But I don't know how you do it. How do you get more people to go back to smaller farms? It's practically utopian to bring that up anymore.

It's amazing that an esoteric subject like beekeeping has erupted in the mass media. Do you think that's been beneficial?

ESAIAS: I think the media coverage is wonderful. I think we are facing a series of problems like this, problems that are environmental in nature, and this has been a real eye-opener for me as to how poorly prepared this country and countries around the world are in taking note of how climate change or global change will impact our ecosystems. Humanity is affecting our ecosystems, and it's very complex to determine whether this is due to environmental change or some disease. You can see now that it is very difficult to pull these things apart.

McDONALD: The media has done a very good job of telling all sides. But the problem is, how do you motivate people to change the way they are? Where I live, I try to live pretty low on the food chain and avoid the temptation of most of the things that people have. People are just incredible consumers and runners of fuel and buyers of gadgets. How do you change that? It's as if there's an ethical or a moral blank spot there. I don't like to preach, but it's pretty obvious: When you're killing the corn belt by growing fuel to run SUVs, there's a very bad disconnect somewhere along the line.

MUSSEN: Bees are a necessary part of our food production. If we don't grow our own cherries and apples, can't we just buy them somewhere else? The answer is yes. But do we want to become as dependent on foreign nations for our food as we are dependent on them for fuel? I would certainly hope the answer is no. I believe that the amount of food we exported to other countries last year was less than the amount of food we imported for our consumption. We use to be the breadbasket of the world. Now we're just one of the breadbaskets.

McDONALD: The basket case.

MUSSEN: [Laughs.] So to keep our industry healthy, we certainly have to keep our pollinators healthy.

In the end, are we the people the ultimate cause of the bees' collapse?

PETTIS: We're the ultimate cause in that we've changed the planet to suit our needs. We're running it to suit our needs and not the benefit of all the organisms around us. Honeybees aren't totally domesticated, but we have tried to domesticate them. We've tried to make bees more gentle and make more honey. In enhancing certain traits, we make the bees more susceptible to other things.

Do you think the bees will be back?

PETTIS: I do. I don't think we've gone *that far* in domesticating them. The bee population is very diverse and can withstand an onslaught of different things -- including beekeepers.

Research assistance by Jonathan Vanian.

-- By Kevin Berger

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