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Science AMA Series: We are Dr. May Berenbaum and Dr. Gene Robinson, University of Illinois entomologists. Our genomic research efforts go together like bees and honey, and we're here for some sweet science discussion for Valentine's Day! AUA!

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As a science communicator, discussing neonicotinoids is difficult. There seems to be conflicting views on the role these pesticides play in pollinator declines. What are your opinions on neonics? Should they be relabeled, banned, kept the same? If they were banned, would whatever replaces them (practices or chemicals) be better for bees? How do you all approach neonic communication to the public in a way to cut through the misinformation and disinformation? I know honey bees are not all bees, do you have any comment on our native bees and the role neonics play in their status?

[albopictus](#)

Hi, this is May Berenbaum; thanks for the question (which I guess is inevitable these days in any forum about bees these days). Neonicotinoids are designed to be toxic to insects--that said, there are multiple neonics and they're not all devastatingly toxic to honey bees (acetamiprid, e.g., is less toxic to honey bees than spinosad, which is approved for use in organic agriculture). What's most problematical about neonics, in my opinion, is how they're delivered; using seeds pre-treated with neonics and fungicides so that they are incorporated into plant tissue systemically, even before insect pest problems materialize, violates decades of IPM practice, selects for resistance, and contaminates soil and water (which presents a threat to ground-nesting native bees). There's some evidence (at least one EPA analysis) that, in some parts of the country and for some crops, the pretreatment is a needless expense for growers. So, beyond pesticide identity as a concern, there's pesticide delivery. Were neonics to be banned, other old-school systemics, which are also harmful to bees, might come back to replace them. So--it's complicated. That's what makes discussions about neonics so fraught--black and white would be nice but pest management is by its nature gray...

Thank You so much for doing this AMA. Bees are really awesome, it must be so fun to study them.

My question; What are your thoughts on the population of honey bees? Some Scientists are sure the population is in grave danger, while others believe this is untrue.



If you believe they are in danger, what are basic things average folks can do to help protect the bees?

Thanks again!

[kleinerschatz](#)

This is May--short answer is that *Apis mellifera*, the western honey bee, isn't in imminent danger of extinction. The honey bee is native to the Old World and there are between 10 and 20 races, of which only a handful are used for apiculture. In terms of managed honey bees, there are clearly problems--the phrase that comes to mind is "death by a thousand cuts". Every aspect of modern life seems to affect bees adversely--global warming contributes to frequent droughts, which reduce the availability of flowers; international trade has increased the global distribution of pathogens and parasites; widespread use of pesticides has exposed bees to unprecedented levels of toxins in a seemingly infinite number of combinations...If there's an up-side, it's that we're now far more aware of the diversity of stressors to which bees are exposed and beekeepers are better equipped to deal with them than they were even ten years ago...How to help? Plant more flowers, for one thing (particularly those that provide quality nectar and pollen for pollinators)--every kind of stress is easier to cope with if you've been eating right!

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Thanks again!

[kleinerschatz](#)

You're welcome, our pleasure.

Scientists now understand the contours of the bee problem. It involves the "4 P's"--pesticides, parasites, pathogens and poor nutrition. Plus a key insight: That these 4P's interact in unanticipated ways.

The general public can help by planting flowers and when using pesticides, following the instructions on the labels.

Is bee intelligence entirely genetic or does there appear to be a learned component also?

Is bee communication restricted to the location of food sources or do they also communicate about other things (such as danger)?

[halborn](#)

Bee intelligence has both innate and learned components. Bees are born with the instinct to learn many different things, and then they proceed to do just that. It's a classic case of nature AND nurture. And the reason I did not use the word "genetic" is that both nature and nurture affect "genetic" in the sense of affecting the activity of genes.

Best, Gene

Do you think drone like bees (robots) will eventually reduce the population and pollination situation?

[JintoBenie11](#)

This is a topic of increasing focus because of the strong interest in robotics in general, and the concern about declining populations of bees, and what this means for pollination. I think it is a very worthy topic of study, but the real honey bee is a formidable model to emulate. In addition to possessing specialized structures to collect and hold pollen, the honey bee also is able to learn how best to handle flowers to obtain nectar and pollen.

Best, Gene

I know bees are great pollinators, but someone told me recently that mosquitos actually pollinate more. Is this bollocks?

[crushedsombrero](#)

Not to diss mosquitoes but great pollinators they're not. Bees have the advantage over mosquitoes in terms of size (so they can carry a lot of pollen), electrostatically charged fuzziness (so that pollen clings well), flower fidelity (in part due to an efficient communication system, they are more likely to visit individuals of the same species of flowers, which is the only way to effect fertilization), and learning behavior (so when they encounter novel flower types they can learn how to find and collect nectar and pollen). Mosquitoes do pollinate a few species (including some orchids) but if pollination were an Olympic event, honey bees would be gold medalists and mosquitoes would be the Jamaican bobsled team (no offense, Jamaican bobsled team)

So great to see you here Dr. Berenbaum! You did a seminar for my department as a visiting professor and I have to say it was one of the best talks I went to all year.

My question is a bit out of the realm of your actual research. I find myself talking to a number of people regularly who are not educated on the current research behind CCD but are aware of it being a thing. What do you normally say to someone who is say a home beekeeper or average citizen concerned about honeybees? What research do you try to convey to them as being most important?

I really wish I just had a pre fabricated 5 minute talk I could give to anyone who asks me about CCD and what is "actually going on" that was informative without going over the top.

[dradwithaC](#)

This is May--thanks for the kind words! I actually get the CCD question a lot; my prefab five-minute talk is that bee researchers today collectively consider CCD to have been a phenomenon isolated in time--a specific and still unexplained phenomenon. Beekeepers today continue to experience significant losses, both over the winter and during the "field season", but the nature of the losses is different from what was experienced ten years ago. There are multiple explanations for losses, which vary with time and place. As Dr. Robinson wrote earlier, the four Ps--pesticides, pathogens, parasites, and poor nutrition--are paramount.

Hello! Where is the best honey you have had where did it come from? Thanks!

[BassHeadVet](#)

For me, "best" for honey, like "best" for wine, needs to be qualified. I have different favorite honeys for

different purposes, like putting in tea, or putting on toast, or marinating, etc. Like many bee lovers, I host honey tastings that feature different floral types, from water white acacia to deep black buckwheat, and everything in between. This is a great way to introduce people to the remarkable diversity of honeys that exist. Notice how I didn't answer the question? I just can't! Best, Gene

I had no idea bees could have "complex social lives"! Could you summarise what you mean by that though? I mean do bees have complex enough brains to have friends and enemies for instance?

Also, if a sitcom starring bees was created, what would you name it?

[gurugeek42](#)

It's May--I'd love to see a bee-themed sitcom! "Bee-witched" doesn't quite work.. How about "Bee's Company"? "The Honey Mooners"? Hey, wait--I know! "The Golden Girls"!!

I had no idea bees could have "complex social lives"! Could you summarise what you mean by that though? I mean do bees have complex enough brains to have friends and enemies for instance?

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[gurugeek42](#)

Complex social lives means that they use multiple forms of communication and a division of labor to guide and coordinate their activities. They do this for the welfare of their colony.

The bee brain is complex, with different regions that specialize on coordinating different functions. Bees show aggression toward intruders to their hive, but there is no evidence of personal friends and enemies. As to a sitcom title, I will leave that to my colleague and Insect Fear Film Festival creator, Dr. May Berenbaum.

Best, Gene

Asking as someone who knows very little about bees, what is the coolest fact about bees and honey that you know? (Besides the whole vomit -> honey thing)

[imnothappyrobert](#)

The coolest thing I've learned recently about bees is that nurse bees who are infected by a fungal parasite (Nosema) selectively choose honey that has greater antibiotic properties (Gherman et al. 2014 <http://link.springer.com/article/10.1007/s00265-014-1786-8>). So they self-medicate! That's more than I can do and I can read labels!

Hello. When buying honey there are many different types that have different colors. What makes the different kinds of honey? And which kinds would you recommend we look for that has better quality and more benefits when eaten? Thanks.

[mistymountainz](#)

Honey's taste, aroma, color, consistency, and physical properties (e.g., tendency to crystallize) directly reflect the nectar (or other sugar source) that went into making it. Some of the attributes of honey reflect the types of sugars (e.g., the ratios of fructose to glucose and the relative sucrose content) but

most of the attributes are due to the presence of phytochemicals in nectar--the flavonoids, phenolics, alkaloids, terpenes and other "secondary metabolites" plants make to mediate their interactions with other organisms. By the way, honey bees can exploit any sugar-rich material for honey-making; favorite types of honey in parts of Europe include "pine" honey or "fir" honey. Pine and fir trees are conifers, which don't produce any nectar; they do, however, harbor populations of sap-sucking aphids or scale insects that produce a sugar-rich form of excrement called honeydew, which bees avidly collect and process into honey! In terms of "more benefits", I'll put in a plug for buckwheat honey; here at UIUC we published a paper about 20 years ago showing that buckwheat honey is rich in antioxidants (equivalent to some fruits and vegetables). If you're looking to boost your antioxidant intake, try buckwheat honey (although in the interests of full disclosure I have to say not everyone is enamored of its taste. Personally, I love it!)

Hello there! This is actually kinda surreal for me because I live in Champaign and use to work in the IGB! I'm not a student anymore but I recently started my own business to help save the bees. What I'm finding is that it's hard for people of non educated backgrounds to grasp how serious it is that bees are dying off. Could you recommend a reliable source/website that explains it plainly with clear data? I know there are lots of YouTube videos that do a great job explaining the situation but I'm more looking for hard data that's easy to analyze to back up said videos.

[greenstatic92](#)

"Welcome home!" I'm glad to hear about your business--innovation and entrepreneurship are certainly important in addressing the bee problem. For good information on the situation I'd recommend the Honey Bee Health Coalition. <http://honeybeehealthcoalition.org/>

Best, Gene

I've always had that one question.. so if bees die we die?

[hitcherr](#)

Actually, that's a lot of questions. Do you mean if honey bees die we all die? No, not likely--even the biggest honey bee booster must admit that only about one-third of our diet (an old estimate, by the way) is dependent on managed honey bee pollination. If all 20,000 species of bees die? Also probably not likely--although bees collectively pollinate a vast diversity of flower species, there ARE other pollinators so it's unlikely we'd lose all access to fruits, nuts, and vegetables. Hey, even flies are pollinators--blow flies can pollinate carrot and onion flowers, and tiny midges are entirely responsible for pollinating flowers of cacao, from which chocolate is produced. A future without bees might be grim, but chocolate will be there to help us cope!

Hello! My question is: Have you looked into the social behavioral changes of bees when they are stressed, excited, etc as a community? How similar are there behavioral changes to humans under similar circumstances?

Thanks for all your contributions to science!

[haamrtme](#)

Yes we have, and we do find similarities to humans, at both the levels of behavior and brain gene expression. Here are two examples.

First, when bees confront an intruder they respond aggressively and show large changes in brain gene

expression. These changes are similar to the gene expression changes that occur in mice and stickleback fish. This suggests some universality to social responsiveness. Here is a link to our paper on this topic: <http://www.pnas.org/content/111/50/17929.full.pdf>

Second, when "baby" bees (larvae) grow up in a colony that has a more aggressive temperament, they themselves grow up to be more aggressive than if they grew up in a less aggressive colony. This kind of "early life" effect also has parallels in human society. The link is:

<http://www.nature.com/articles/srep15572>

This does not mean that bees are little people or people are little bees. Rather, there are genetic "toolkits" for social behavior that are used over and over again in social evolution, apparently because they work very well.

Best, Gene

A more personal question from me, I have been fascinated by bees throughout my degree course and would like to go a little further and assist researchers where I can. My degree is only a BSc and I'm burnt out on education, I just want to get involved where I can.

Is there any schemes for observers with a distinct fascination, places that findings can be reported etc, anything for just a simple biology undergrad looking to save the bees

[MrForeshadowing](#)

There are many citizen-science projects that could use your help! Here at UIUC we host Beespotter, <https://beespotter.org/>, which is a place for citizen-scientists to help us keep track of the status of bumble bees and feral honey bees here in the state by uploading photos. At the national level, there's Bumble Bee Watch, for bumble bees in the USA and Canada <https://www.bumblebeewatch.org/>. The Great Sunflower Project based at San Francisco State needs citizen scientists to plant sunflowers and monitor visits by all kinds of pollinators <https://www.greatsunflower.org/>. At Ohio State, Reed Johnson is recruiting citizen scientists to help with evaluating larval honey bee development at Broodmapper <https://scistarter.com/project/1767-Broodmapper%3A-Honey-Bee-Development-and-Citizen-Science>. And Zombeewatch, www.zombeewatch.org, is asking citizen scientists to be on the lookout for honey bees that are acting oddly, abandoning their hives at night, because they're parasitized by a phorid fly that alters their behavior.

Dr. Berenbaum, I took your 'intro to insects' class at UIUC around 1998/1999 (almost 20 years ago! yipes!). You won't remember me as I only really interacted with my TA. I just wanted to say that I've carried your enthusiasm for all things insects ever since I took your class. I still have lepidopteras, apis melliferas, true bugs, etc. flying around in my brain. I'm still upset though that I didn't get any honey bee powers when I got stung in the scalp by a bee when my group visited the apiary on campus. Anyway, thank you for being an awesome teacher!

[owenburnett](#)

Thank you--so good to hear!! If being stung by bees gave you honey bee powers, then Gene Robinson would be able to fly but he's just sitting across the table from me, so I guess it doesn't work that way!

Thanks for doing this. What was it about bees specifically that drew you into devoting your career to them? With so many types of flora and fauna, what single (or a couple) distinguishing characteristics got you hooked?

[phd_dude](#)

Actually, I'm not technically speaking a bee expert-- at least in contrast with Dr. Robinson, who has three degrees based all or in part on honey bees and at least 300 papers on honey bees. I'm interested in how plants and insects interact, so only part of my career has involved honey bees. My first foray into honey bees was a result of reading papers in the human nutrition literature that dismissed honey as nothing but sugar water--and knowing what I knew then about nectar, phytochemicals, and bees, I was offended on behalf of the bees. That was the motivation behind my work on honey and honey bees twenty years ago and my admiration for honey bees and honey (and beebread and wax and propolis and royal jelly and everything else they make) just keeps increasing!!

Thanks for doing this. What was it about bees specifically that drew you into devoting your career to them? With so many types of flora and fauna, what single (or a couple) distinguishing characteristics got you hooked?

[phd_dude](#)

I fell in love with honey bees over 40 years ago, the first time I walked into an apiary. At first the scene appeared chaotic, with hundreds of thousands of bees flying around. But when I looked more closely at the honeycombs inside the hives, I saw the first glimpses of colony organization --many different activities taking place, and different bees doing different jobs. Understanding the mechanisms that govern bee society continues to captivate me to this day.

Best, Gene

As I understand some honey producers feed their bees corn syrup bc of lack of flowering plants; corn syrup is known to be quite unhealthy for human consumption and as a person w a corn allergy I have to be careful w honey... Can you see a difference in bee behavior/production of honey etc w use of corn syrup?

[crushedsombrero](#)

Corn syrup is definitely NOT the same as honey--in addition to having a different sugar composition, it's entirely lacking in phytochemicals that honey bees evidently depend on for dealing with dietary toxins and pathogens. In Mao et al. 2013, we showed that phytochemicals in honey turn on immunity and detoxification genes (and that eating honey increases the ability of honey bees to metabolize a pesticide) <http://www.pnas.org/content/110/22/8842.short>. In 2015 we showed that one phytochemical in particular may play a role in determining whether a female grub becomes a worker or a queen <http://advances.sciencemag.org/content/1/7/e1500795>. My colleague and reddit partner showed that honey and corn syrup differ in their effects on gene expression in the honey bee fat body, which is involved in lipid and carbohydrate metabolism <http://www.nature.com/articles/srep05726>

Why is it said it should be impossible for bees to fly when obviously the physical world is proving the bees right everyday?

[filxyz](#)

Actually, the saying is that bumble bees theoretically shouldn't be able to fly, and it goes back to the 1930s, apparently resulting from a conversation among scientists at a cocktail party and a few hastily scribbled equations. As it happens, there were faulty assumptions underlying the calculations (notably, the fact that bee wings have a rigid leading edge and flexible trailing edge that create "dynamic stall"--in

other words, they're not airplanes). I tell the whole story in my book *The Earwig's Tail*, available on Amazon in hardback or Kindle...

Hi May! Have you seen Black Mirror season 3 episode 6, Hated in the Nation? It could make for a good addition to a robot insect themed IFFF.

[LepLarva](#)

I have not! Well, that's my homework from this AMA session--thanks for the tip!

How similar is your research on the complex social lives of bees to human social behavior? Do you believe your research can translate over to Sociology, Social Behavioral Psychology, I/O Psych maybe? Or are they two different entities? Thanks for taking time out of your day to answer our questions. :)

[BlackBurton](#)

Let me begin by emphasizing that bees are not little people and people are not little bees. Their last common ancestor lived over 600 million years ago; it is thought to be a marine flatworm, with only a rudimentary nervous system --no brain-- and no social life to speak of. However, our genomic research has revealed that there are genetic "toolkits" for social behavior that are used over and over again in social evolution, apparently because they work very well. An important challenge for the future is to use these findings to develop new ways of integrating the social and life sciences. A new synthesis, based on this integrating them as true partners promises a deeper understanding of human nature.

Best, Gene

Good day and thank for answering our questions.

I was just listening to a news topic that mentioned the link between fungicides and the slowing metabolism off honey bees. It didn't go into any detail, just that a concern has been raised. Can you provide anything more informative about the link and what is being seen in bees?

[HockeyBein](#)

Actually, it sounds like you're referring to our just-published paper in PNAS (<http://www.pnas.org/content/early/2017/02/07/1614864114.abstract>). We showed that honey bees rely on enzymes called cytochrome P450s to metabolize a phytochemical called quercetin that is abundant in honey and pollen. If unmetabolized, quercetin can interfere with the production of energy in the mitochondria (the "energy factories" of cells). Certain fungicides are inhibitors of these enzymes and, when they're present in the diet, they can slow down the rate at which bees detoxify quercetin and evidently, as a consequence, they produce less ATP (cellular fuel). What's particularly worrisome about this finding is that we tested only one fungicide but molecular models of the detoxification enzymes suggest that this ability to inhibit P450-mediated metabolism is characteristic of many of the pesticides that have been found in hives. The article just came out yesterday--thanks for asking about it!!

Dr. Berenbaum, is the fictional entomologist [Dr. Bambi Berenbaum](#) from the X-files episode 'War of the Coprophages' named after you?

[logos](#)

Yes and no--the screenwriter Darin Morgan used some of the popular books I've written as background research for the character and, when he had to come up with a plausible name for an entomologist, "Berenbaum" fit the bill. We did indeed show "War of the Coprophages" along with the "X Files" movie at our Insect Fear Film Festival, and Darin Morgan and Chris Carter, writer/producer/director/creator of all things X File, were our honored guests!

Hello Dr. Robinson,

I was an undergrad in your lab a few years ago, and I want to say thank you for giving me the opportunity :) You were an amazing advisor, and the work I did actually got me a job working in pharma. Thank you for all you do for UIUC and IGB.

[masha13](#)

Thank you for the kind words, and I'm very glad to hear you're doing well. Feel free to get in touch through the IGB so I can hear more about what you're up to!

Best, Gene

Dr. Berenbaum and Dr. Robinson, thanks so much for answering our questions!

For Dr. Robinson: When studying bee behavior do you or others working in the lab have to watch bees in a "natural" habitat? Is there information that you could benefit from by looking at behavior in the field vs the lab?

For Dr. Berenbaum: When looking at the different Cytochrome P450's, is there a limit to how many insecticides an insect can become resistant to? At what cost would metabolizing many insecticides have on an insects body?

For both: Is there one very large question that you wish to answer? What is it?

[entomo](#)

The study of behavior benefits both from studies in the field and studies in the lab. The studies in the field are more natural and so it is easier to draw conclusions with ecological and evolutionary relevance. The studies in the lab are more controlled and so it is easier to perform sophisticated manipulations that are designed to reveal causal mechanisms. Both are important!

Best, Gene

In your opinions, what are the most interesting and/or surprising social behaviors with honey bees?

[mmm_butters](#)

A relatively recent finding is that bees that have unpleasant or dangerous experiences while foraging can communicate this in the form of a "stop" signal, a new addition to the remarkable dance language of the honey bee. Here is a link to this work, from the lab of James Nieh at UCSD.

[http://www.cell.com/current-biology/pdf/S0960-9822\(10\)00075-8.pdf](http://www.cell.com/current-biology/pdf/S0960-9822(10)00075-8.pdf)

Best, Gene

Can each of you give an example of how next generation sequencing and/or big data computing advances have benefited your research, or entomology in general?

[mix_feedback_repeat](#)

Using next-gen sequencing we sequenced the genomes of several different bee species that range in levels of social complexity, from those with solitary lifestyles to honey bees and stingless bees, who live in some of the most complex societies on earth. We used these species and a few that already had been sequenced in big data computing analyses to look for molecular signatures of social life in the genomes of a total of ten different species. One key result is that it appears that social evolution is associated with an increase in the complexity of gene regulatory networks. The paper that describes this work can be found at: <http://science.sciencemag.org/content/348/6239/1139>

Best, Gene