Science Magazine Podcast

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Music

Host – Robert Frederick
Hello and welcome to the *Science* Magazine Podcast for April 8th, 2011. I'm Robert Frederick. This week: the connection between physical disorder and stereotyping; keeping genetically modified and organic crops separated; and new insights into the internal structure of distant stars. All this, plus a wrap-up of some of the latest science news—including a story about how sex led to a scientific first—from our online daily news site, *Science*NOW.

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Music ends

Host – Robert Frederick
Stereotyping and the discriminatory behavior it leads to is not always such a bad thing. It can keep you from walking alone down a stereotypical "dark alley" where trouble may await. But, discriminatory behavior *among people in public situations* can actually cause trouble, inciting riots and other kinds of violence. Now, research in a paper in this week's *Science* suggests that one stimulus that prompts people to stereotype is disorder—whether clutter in a room, cracks in a sidewalk, even geometric shapes arranged haphazardly. Siegwart Lindenberg and Diederik Stapel report that people stereotyped more and even exhibited more discriminatory behavior when in a disordered environment, and it made no difference what mood these people were in, whether they were distracted with some other task, or were male or female. I spoke with Lindenberg from his office at the University of Groningen in the Netherlands.

Interviewee – Siegwart Lindenberg
Very little disorder already in the environment can make people discriminate more than an orderly environment, so that the stereotypes that underlie discrimination become activated just through, let's say, a garbage bag or garbage on the ground, and that is the upshot of what we have found.

Host – Robert Frederick
What, if any, prior research prompted you and your coauthor, Diederik Stapel, to test this idea that physical disorder leads to increased stereotyping, and so, even discriminatory behavior?

Interviewee – Siegwart Lindenberg
Well, we had some prior research by Stapel himself that showed that people do not always stereotype to the same degree, and that it looked as if, indeed, a need for order may be connected to stereotyping, but we weren't quite sure of the causal connection, and we weren't quite sure whether, indeed, it is just any kind of disorder, or whether it is a particular kind of disorder, or what. But we had some hint that there may be a connection, and so we went to explore that in a number of experiments in the field, and then in the lab. And, in the lab, we did experiments that really focused on the mechanism behind this effect.

Host – Robert Frederick
What happened in these field experiments, first?

Interviewee – Siegwart Lindenberg
Well, we had two field experiments, one in a station – we were lucky enough that the garbage men were on strike for quite a while, and the station in a Dutch city became very dirty and covered with trash – a very busy train station. And so there, we took the opportunity to use that as our condition of disorder. And we had six chairs lined up, and we asked people to fill in a questionnaire, and this questionnaire was about their opinions about minorities – Muslims, homosexuals, and Dutch—or, I should say, three groups, two of which were minorities. And, in order to fill that in, they had to sit down, and we had placed a stooge – so, a stooge is a person who works with us, so seems to be just like another person that is asked to fill in a questionnaire – and that person sat already on one chair on one side, and the question now was how far away would a person who sits down to fill in a questionnaire, how far away from that person already sitting there would the person be seated? And our hypothesis was that in a clean condition, there isn't much difference between a white and a black person for white people, and in a dirty trash condition, people—white people—would sit significantly further away from the black person than from a white person.

Host – Robert Frederick
So, the confidante—the stooge, as you say—was either a white person or a black person, and…

Interviewee – Siegwart Lindenberg
Was either a white person or a black person. That's right.

Host – Robert Frederick
… and then you tested people who were in the train station, and these were all white people?

Interviewee – Siegwart Lindenberg
We tested only Caucasians.

Host – Robert Frederick
Okay.

Interviewee – Siegwart Lindenberg
Yeah, and the reason that we assumed that they would sit further away is that we hypothesized that the disorder would increase their tendency to stereotype – to stereotype all sorts of groups. And stereotypes about minorities are—and especially in public places—are, by and large, negative, so they may have some stereotypes that are positive, but in general, there's also a stereotype, "this may be dangerous," and sit further away. And, indeed, this is exactly what we found. There was a significant difference in the two conditions; in the orderly condition, they sat equally close to a white or a black person, and in the disorderly condition, they sat significantly further away from the black person than from the white person.

Host – Robert Frederick
And you said there were two field experiments?

Interviewee – Siegwart Lindenberg
Yes. The second field experiment was in a very prosperous neighborhood in another Dutch city, where we did the following: Dutch sidewalks are often tiled with concrete tiles, and we took a number of these tiles out and just put them in a very disorderly fashion – let them lie there – then we parked a car with a front wheel on the sidewalk, and we had a bicycle lying there, half on the sidewalk, half on the street, to create the impression of disorder. And then as people were walking by, we asked them to fill in the same questionnaire about stereotypes about Muslims, homosexuals, and the Dutch, and this time, we would give them five Euros in small coins as a reward. And at the end of filling in the questionnaire, we asked them whether they would like to donate some of that money to a fund for the improvement of the condition of minorities in the Netherlands, and that was our behavioral measure for discrimination. So, we had predicted and we found that in the disorderly condition, people did not just stereotype a lot more, they also gave a lot less. So, just as we found in the train station, stereotyping went up and discrimination also went up. And, mind you, in the train station, it was clear that the questionnaire was about different groups than blacks, so it just spreads the prejudice – or, I should say, the stereotyping – spreads to all sorts of groups, so it's a general stereotyping effect.

Host – Robert Frederick
So, with these field experiments, you got at this apparent connection between disorder and stereotyping, and, so, even discriminatory behavior. Back in the lab, you said, there were a few more experiments. What questions were you trying to answer with these experiments to really try and show that it was physical disorder leading to the stereotyping?

Interviewee – Siegwart Lindenberg
Yes, right, so, first of all, we wanted to be sure that it is indeed not dirtiness, so I should just add that; that's why we did the second field experiment. The first field experiment was messy, but it could have been simply the dirt, that people get disgusted by the dirt rather than the sheer disorder, so that's why we did the second field experiment with the

tiles. In the lab, we wanted to go further to find out about the mechanism by testing whether it is indeed true that, as we surmised, that the disorder increases a need for order, and it is the need for order that is satisfied by thinking more in black and white terms—in stereotypes. These are very simplifying categories that you then think in about other social groups, and that creates a certain degree of order. And we wanted to see, first of all, is it true that the need for order goes up with disorder around you? And it does. We measured the need for order, and we compared then the conditions with regard to the need for order, and, indeed, the need for order increases through disorder, just as discrimination and stereotyping does. And then we wanted to find out whether, indeed, it is the need for order that really is the causal mechanism behind it, or maybe it just also goes up like the others, or maybe it's really the causal factor. And we found out that, indeed, it is the need for order that creates this effect; we could show that after discriminating, the need for order went down. So, first of all, the need for order really mediated the effect. There are some statistical techniques to find out that you have disorder leading to heightened need for order, and that leads to more stereotyping, and so that the direct link between disorder and stereotyping vanishes if you put in the need for order, because it runs via the need for order. There are some statistical techniques to use that to find out that, indeed, this is the causal link. And we, indeed, found out that stereotyping is a way of dealing with disorder; it's an effective way of dealing with disorder, because the need for order is reduced after one has just stereotyped. So, this is what we did in the lab experiments.

Host – Robert Frederick
You said in the train station experiment that you only tested white people. Did you repeat these experiments and find similar results with different ethnic or cultural groups?

Interviewee – Siegwart Lindenberg
No, no we did not. This was a unique opportunity by the strike of the garbage men, and we had not another such occasion to test this, so the tests were done only with whites, also in the lab.

Host – Robert Frederick
You mentioned one of your conclusions, this need for order goes up with disorder around you. What, if any, evolutionary selective pressure is there for coping with physical chaos by stereotyping?

Interviewee – Siegwart Lindenberg
Well, of course, we are not sure whether there were selective pressures with regard to that, but one could imagine that once you go to a mode where you use very simple categories, that you will act much faster – so, is that person dangerous, or is that person not dangerous, that you will cut out a lot of detail, a lot of possibilities – well, let's see, let's find out more. We believe that, indeed, there is an evolutionary explanation in the sense that situations that are unstructured that increase the need for order have often been dangerous situations, situations that you couldn't quite structure right away what is going on. And in such situations, it is survival value to use very simple categories that cover

basically not the individual before you, but the cue you have about the membership of that individual.

Host – Robert Frederick
Siegwart Lindenberg, thank you very much.

Interviewee – Siegwart Lindenberg
Well, okay, thank you very much for calling.

Host – Robert Frederick
Siegwart Lindenberg of the University of Groningen is co-author of a paper in this week's *Science* on how disordered contexts promote stereotyping and discrimination.

Music

News Writer – Erik Stokstad
This story is about the tension between organic farmers and biotech farmers, how research can help the two coexist side-by-side, and some of the political difficulties that remain in working out all the differences.

Host – Robert Frederick
Science's Erik Stokstad reports in this week's issue on the co-existence of organic and biotech farms and keeping the crops separated.

News Writer – Erik Stokstad
Coexistence is an old idea; it's about how farmers who are doing different things in the same area can both grow their crops and thrive without one adversely impacting the other, so that's the principle. Farmers have been dealing with this issue for a long time – pesticide drift, livestock that gets out of one field and tramples your neighbor's alfalfa field. What's different about biotechnology—about genetically-modified crops—is, one, that there's a lot of consumer reluctance out there in some places, in some communities. So, if genes from a genetically modified crop drift from one field where you're growing biotech corn over to the neighboring organic farmer, and those transgenes end up in his corn, the concern is that that corn might not be able to be sold as organic to a buyer who doesn't want transgenes in their Corn Flakes. And the other thing that's slightly different now is that it's pretty easy to test for these transgenes. You can test a sample, and you can find very low concentrations of these transgenes. And they find them – these genes spread around and they are found in organic fields, they're found in shipments that go to Europe.

Host – Robert Frederick
And right now, who pays to keep the organic produce organic – free from transgenes?

News Writer – Erik Stokstad
Right now, in the U.S., it's the organic farmer, and the reason is our de facto policy in the U.S. is that it's the responsibility of the organic farmer to keep out the transgenes – it's

not the responsibility of the biotech farmer to keep them in. So, essentially, the organic farmer has to find a way to fence out the transgenes. The problem for the organic farmer who finds transgenes when they show up in that field is not so much the organic label, because in the U.S., what the label means is that the organic farmer has followed a set of rules, and the rule is—for genetically modified crops is—you can't plant them. So, if you're growing organic corn, you can't grow genetically modified corn, but if transgenes from your neighbor's biotech corn drift into your field, that's not your fault. You can still label that corn as organic in the United States – that's what our label means – but if you want to sell that corn to Europe – and their policy is "no transgenes in our corn" – then you have an export problem. So, you might lose your market, you might not be able to sell that corn as premium to a buyer in another country, or to a buyer in this country that says, "No transgenes, please. We're going to test you." You have transgenes in your corn, you can't get that premium to that discriminating buyer.

Host – Robert Frederick
At present, how are genetically modified and organic crops kept from mixing?

News Writer – Erik Stokstad
There are several things that organic farmers do. One is that they plant a buffer strip so that their field is edged with corn that they're not planning as organic, so if transgenic corn pollen drifts 10 meters into their field, no problem. They're planning on selling that as regular corn, not as premium organic corn. The other thing that they can do is plant their crop at a slightly different time, so the corn next door is putting off pollen at a time when your corn is not ready to receive pollen, so you have a difference in planting times. Another thing that sometimes happens is, you may have your farm in a place where not much biotech corn is grown, so you might grow your organic corn in a part of the state which isn't great for growing corn, and that's why there's not a lot of biotech corn around – so, I mean, you have geographic isolation.

Host – Robert Frederick
So, at least with corn, the concern is pollen, and, I imagine with other crops, even seeds might transport long distances with the wind – 10 meters, 100 meters, another state, I mean, don't pollen and seeds sometimes travel across oceans even?

News Writer – Erik Stokstad
You're absolutely right, and there are a lot of ways for genes to get mixed up. One is with pollen, so if you have a genetically modified crop, the pollen from that plant with those transgenes can drift in the wind, or be taken by your friend the honeybee, depending on the crop, and transferred into a field of organic crops. The other thing that can happen is, you grow your biotech corn and you harvest it. You now have a truck, and then a silo full of biotech corn. Next door, the organic farmer is also harvesting corn, and those kernels end up in a truck and go to a silo. You can have mixing along the way. If you have a farmer who's doing both, growing biotech corn at some times and organic corn at another, they're using the same equipment, perhaps, things can linger in the combine, there's a lot of way that seeds can get mixed up. And a really dramatic example of that is when you have experimental varieties of a crop – corn, rice – that

haven't been approved yet, only experimental, and then you find them in the food supply. And that happened 10, 11 years ago with what was called Star-Link corn, a corn that was approved for animal feed, but not for human feed, and even though there were processes in place to keep those separate, they got thoroughly mixed – found in taco shells, found throughout the food supply – and it happened just a couple of years ago with a biotech rice that wasn't approved yet. Millions and millions in dollars of lawsuits over that mix-up.

Host – Robert Frederick
So, it sounds like zero tolerance for any mixing is pretty much out of the question.

News Writer – Erik Stokstad
Zero is really hard. Most scientists say it's pretty impossible. You can imagine that if you're growing a crop in a country where there are no approved varieties, that you might be able to get pretty close, but seed moves around the world, so zero is pretty hard to achieve.

Host – Robert Frederick
So, what, if any, future plans are there for keeping genetically modified and organic crops from mixing?

News Writer – Erik Stokstad
One idea is to give organic farmers plants that can't be pollinated by a biotech crop.

Host – Robert Frederick
So, breed them in traditional ways?

News Writer – Erik Stokstad
In fact, there are plants like that already, and this is where the idea comes from. Decades ago, scientists noticed that some varieties of corn had a very special property. They could only be pollinated by the same type of corn – that same variety. This has been used in popcorn. So, popcorn is a special type of corn, it's a specialty corn – if you're growing popcorn, you don't want it to be pollinated by dent corn, by other field corn that's going to be fed to animals, because you lose the special properties that makes popcorn pop. So, the genetics are fairly complicated about why this is, but researchers have taken those genes from those varieties of popcorn and bred them, using traditional breeding techniques, into varieties of corn, regular corn, that organic farmers would grow to serve an organic market. The neat thing is, you plant these types of corn, they're not going to be pollinated by biotech corn, even if it's across the fence.

Host – Robert Frederick
But it works both ways, right? I mean, these plants could pollinate the genetically modified plants.

News Writer – Erik Stokstad
That's right, and when they do, that special gene ends up in the biotech corn.

Host – Robert Frederick
And, so, it could pollinate, essentially, back.

News Writer – Erik Stokstad
That's the potential weakness, exactly. So, it's not a permanent solution, but that hasn't stopped researchers from working on this approach. And the first commercial varieties of this corn is going to be available to organic farmers this fall.

Host – Robert Frederick
So, will the idea be, then, for biotech crop farmers to keep this gene essentially out of their biotech crops? Or there's no incentive for that?

News Writer – Erik Stokstad
There's no incentive for them to do that.

Host – Robert Frederick
So, you've given me one example with this pollen and the gene in corn. Is there any consensus that any of these types of future techniques—real or imagined—for keeping genetically modified and organic crops from mixing will work long-term?

News Writer – Erik Stokstad
It's very hard to imagine that you'd come up with a perfect solution, and a perfect solution that would last forever. That's why researchers keep coming back to this idea of having a threshold for acceptability of saying we can't promise zero transgenes, so come up with an amount – a small amount, 0.1%, 1% – that everyone will agree is acceptable, and when you do that, then you can start to figure out isolation distances and other recommendations that will make that possible almost all the time.

Host – Robert Frederick
And, until that agreement, more lawsuits, at least here in the United States?

News Writer – Erik Stokstad
Yes, that's very likely, because there are still groups that are very passionately, philosophically opposed to genetically modified crops, and they'll keep suing.

Host – Robert Frederick
Erik Stokstad, thank you very much.

News Writer – Erik Stokstad
Thank you, Rob.

Host – Robert Frederick
Science's Erik Stokstad reports in this week's issue on the co-existence of organic and biotech farms and keeping the crops separated.

Music

Host – Robert Frederick
Also in this week's *Science*: Happy 100th, superconductivity! In a special section in this week's issue, read about 100 years of research on superconductivity since it was originally discovered in April 1911. Two review articles look at exotic superconductors, and two news articles make clear that superconductivity and the theory behind it have enriched basic science in ways that nobody could have foreseen. A century on, for more reasons than ever before, physicists and materials scientists remain enthralled with the observations of disappearing electrical resistance. Read about it in this week's *Science*.

Music

Host – Robert Frederick
Scientists use NASA's Kepler space telescope to look for Earth-like planets by recording tiny changes in the brightness of stars as objects pass in front of them. But many of the brightness variations measured by Kepler represent variations in the stars themselves rather than any passing planet. Our Sun, for example, has a million or so of these periodic variations, perhaps the best-known of which is the solar maximum that happens about every 11 years. Now, there are many different mechanisms that drive these solar oscillations, with the bubbling, convective motion of the plasma perhaps the most important in understanding the structure of our Sun. Those oscillations shake the Sun like a bell that never stops ringing, and analyzing them allows researchers to study the interior of the Sun in much the same way that seismic waves allow geologists to study the interior of the Earth. Of course, scientists cannot get the same kind of data from other stars as they can from our Sun because of the vast distances the light has to travel and because Kepler is sampling light from 100,000 stars. But with the data Kepler has, three teams report in this week's *Science* results that provide new insights and raise new questions about the internal structure of distant stars. Michael Montgomery writes a Perspective in this week's *Science* about all three papers, and I spoke with him from his office at the University of Texas at Austin.

Interviewee – Michael Montgomery
We're able to make a lot of these same inferences for other stars. We can get out several aspects, like what their real age is, what their real composition is, what their rotation profile is like, things like that.

Host – Robert Frederick
So, Kepler is sampling these stars often enough, and has for long enough, to pick up the variations—at least some of them, hundreds of them—that are observed in our sun?

Interviewee – Michael Montgomery
Exactly, and the technical term is asteroseismology, and that means you're making a match between models of the stars and the stars themselves, so you build a model of the star, you know, numerically, and then you say, "Okay, well, this particular model, what frequencies would it pulsate with?" And you calculate a whole list of ones that it could

pulsate with. And then you look at the actual star, and you say, "Okay, what frequencies is it pulsating at?" And you have a list, and you simply try to match those two lists together. And when the frequencies are off a little bit, you go back to your model and you say, "Okay, well, maybe I can change something in my model, like make it slightly more massive, or slightly hotter," and that'll bring the frequencies into agreement. And so it's kind of an iterative process between you build a model of the star, and you try to explain the data that you're looking at.

Host – Robert Frederick
To what extent are the observations in these three papers matching the models?

Interviewee – Michael Montgomery
Well, in the paper by Chaplin *et al.*, they took a large sample of stars, which really allow you to do much better statistics, you know, because not all stars are the same, but what you really want to know are what are the group properties of the stars? And so, what they did is they looked at the pulsations of 500 stars, and they applied what I would call some—gosh, I don't want to use the word "heuristic"—but some simpler criteria, which are reliable, to derive the masses and the radii of these objects. And, I want to emphasize that these masses and radii come from the pulsations themselves; they don't come from taking a spectrum of the star and trying to figure out how hot the star is, and then using a stellar model to say, "Oh, this star must be this mass and this temperature." It really is just using the pulsation data and saying what you can say with just the pulsation data – so, it's an independent technique of getting masses and radii. So, what they found by using this technique is that the distribution of radii for these 500 objects was what they expected, but that the distribution of masses was not. Now, when we say distribution of masses, what we mean is, you know, stars form from collapsing gas clouds, and there's a distribution of masses; some are 0.5 solar masses, some are 1, some are 2, 3, 4, 5. As you go to higher masses, there are few stars; most stars are low mass, around 0.8 or something. And so, then, you're going to have a distribution, and we think we know what that distribution of masses is because we've independently measured it for a large set of stars. What these results find is a slightly different distribution of masses, more weighted toward the lower mass side than the higher mass side. The strange part is, is that the radii of this sample of objects is what you would expect, is what has been measured before. You know, if that were different, too, then you'd say, "Okay, well, maybe there's just some systematic difference here," but if you take both of these sets of data at face value, it says, "We predict the radii of stars correctly, and yet we predict their masses wrong." And what that would mean is that the mass-radius relationship for a given star would be different than what we think theoretically, and that would actually be a rather big deal.

Host – Robert Frederick
Say, and because it says also something, perhaps, about the composition of the star, or…

Interviewee – Michael Montgomery
No, what that would really say is that our main models of the stars – you know, if you give us a mass, the radius we calculate for our models is wrong. Now, I personally don't

think the answer is quite that simple, but it definitely points in the direction that, yes, maybe there is something missing from our models. And, you're right, one of the things could be composition; it could be the way we treat convection in these objects, because convection is sort of a free parameter; it could be composition, or mixing, in these models. I'd have to say, at this point, that it's really kind of unknown what the source of this discrepancy is.

Host – Robert Frederick
Okay. How about the other two papers, then?

Interviewee – Michael Montgomery
Okay. Let's see, the second one – so this paper by Beck *et al*., what they found is the normal pressure mode oscillations that we see in the sun, they found in red giant stars. Then they found other frequencies that didn't really fit the pattern very well, and they were able to make a very good argument that those additional frequencies were due to gravity modes and not pressure modes. So, they are fundamentally different processes; having both in the same star allows you to learn different things about the interior of the star. And, it turns out in these stars, we think that the gravity modes, their vibrations go way down into the core, deeper than the pressure modes do, so by having these gravity modes in addition to these pressure modes, one can potentially measure things about the red giant core which one couldn't measure otherwise. The red giant structure is very unconstrained, and so measuring things about the core will really be valuable in the future.

Host – Robert Frederick
And, so, for this final paper, what do the pulsations observed by Kepler say?

Interviewee – Michael Montgomery
Well, the surprising thing about this third paper by Derekas *et al*., they observed a rather exotic system that, again, does have a red giant in it, but, surprisingly, in this case, no pulsations have been found. And this is really quite a mystery; however, it's not the most remarkable thing about this system. This system that they looked at is actually a triple star system with a red giant, and then orbiting that red giant is a pair of stars that you can think of as a tight binary. So you have a tight binary composed of two stars orbiting each other, and that binary itself orbits the red giant, and so it's a triple star system. And, okay, so that's very interesting, but that's not unique. The thing that makes this really unique is that every component in this system is eclipsing. So the two stars—the binary—pass in front of the red giant and behind it, and the two stars pass in front of each other, so they eclipse themselves and they eclipse the red giant. And so this sort of, you know, multi-component, multi-eclipse system is really quite unique.

Host – Robert Frederick
And you said the red giant doesn't have any pulsations. Are they being potentially canceled out by the pulsations of the others?

Interviewee – Michael Montgomery

That is a very interesting question. They're probably not being canceled out by the pulsations of the other stars, but I think they must be being suppressed somehow by being in this strange orbital setup. It's certainly the smoking gun, I mean, when you look at isolated red giant stars, they pretty much always pulsate at this level, and here we have one that isn't isolated that's in a rather, you know, strange orbital configuration. It's certainly natural to think that it has something to do with the fact that it doesn't pulsate, but I'd also be lying if I told you I knew exactly why that was the case. Since these stars are so close to each other, there may well have been interactions in the past that involved transferring mass between different components in the system, and so this red giant might not be like other red giants for which that hasn't occurred. But, again, I can't say for sure. It is a bit of a mystery, and I'm quite puzzled by it.

Host – Robert Frederick
So, with continuing observations helping to learn more, capturing pulsations, oscillations on a longer timescale, or is what's needed a future space mission or a ground-based project?

Interviewee – Michael Montgomery
Yes, you mean, where do we go next after Kepler?

Host – Robert Frederick
Or, just with Kepler itself, having a longer timeframe of data.

Interviewee – Michael Montgomery
Yes. It's a good point. So, Kepler has been in orbit for about two years, but, you know, the first part of its mission was, you know, calibrating the spacecraft, making sure everything was working perfectly. And so, we're hoping to start to be able to see things that only become apparent when you have multi-years of data on single objects. You know, for instance, the Sun has a solar cycle of 11 years where the magnetic field reverses and you get more sun spots and then fewer sun spots. We hope to see evidence of this in the pulsations of some of these stars, to see solar cycles that we can tease out. Now, obviously, that requires a longer time baseline, but Kepler has more years that it'll be up, and I'm quite hopeful that its mission will be extended beyond the initial 3-1/2–year phase. I don't know what that would be, but I know that NASA will be thinking along these lines and will want to extend the mission. Plus, you know, Kepler is also looking for planets. And, you know, if you're looking for a planet that takes three years to go around its star, then you need a three-year mission so that you're sensitive to timescales that are longer. And so, by extending its mission, I think we will get out much more science than we've even gotten out so far. It really makes sense to continue these observations for the coming years.

Host – Robert Frederick
Mike Montgomery, thank you very much.

Interviewee – Michael Montgomery
Well, thank you very much, Robert.

Host – Robert Frederick
Mike Montgomery of the University of Texas at Austin and Delaware Astroseismic Research Center, on observations with the Kepler space telescope and what they reveal about the internal structure of distant stars. Find Montgomery's Perspective and the three papers he mentioned in this week's *Science*.

Music

Host – Robert Frederick
Finally today, David Grimm, *Science*'s Online News Editor, is here with a wrap-up of some of the latest science news from our online daily news site, *Science*NOW, including a story about how sex led to a scientific first. Are we talking about the first time there was sex, Dave, or something else?

Online News Editor – David Grimm
No, Rob, we're talking about sex between two people, namely, two of the authors on this new paper, and how that has led to a new understanding about how mosquitoes can transmit disease.

Host – Robert Frederick
You've got a lot to clear up here, Dave. What does that mean?

Online News Editor – David Grimm
This is a pretty complicated, but very fascinating, story. What happened was that a few years ago, a couple of researchers went to Senegal to study malaria mosquitoes there, and when they came back to the United States, they came down with some pretty unpleasant symptoms. They had a rash on their torso, extreme fatigue, headaches, swollen, painful wrists, and they weren't really sure what was going on. And before they could figure it out, one of the researcher's wife also came down with those symptoms, and she hadn't gone to Senegal. None of the researcher's children developed the symptoms – it was just him, the person he went to Senegal with, and his wife, who developed it a few days after he returned. And this became a really big mystery, and the researchers went to have themselves tested; they wondered if they had malaria, or something else. And they had their blood tested, and when the results came back, they suggested that the two researchers had dengue fever, which can cause similar symptoms, but that the wife didn't. So this was still a mystery. How could the wife have developed it? There's, really not mosquitoes that spread dengue in this part of the U.S., which is in Colorado. So, this remained a mystery for a few years. The researchers really weren't sure what they had; they weren't sure what the wife had; they weren't sure how she got whatever she had. Their symptoms had long gone away, but the mystery persisted, and then a chance meeting between one of the researchers—the one who didn't have a wife that came down with the infection—and somebody else who was an expert in a disease known as Zika resulted in a retesting of their blood samples, which the researchers had actually saved, and, lo and behold, all the blood samples came back positive for this Zika virus, which is this really rare virus that can cause very similar symptoms. The reason the researchers

think they initially tested positive for dengue is because some of the antibodies between Zika and dengue can cross-react. So, this solved part of the mystery—what they had—but it still left open the question of how did the wife get the Zika virus, which is even more rare, and clearly not the kind of thing that you would find in Colorado.

Host – Robert Frederick
So, the idea is that the researchers picked it up, not by sex in Senegal, but by mosquito transmission, and then the researcher passed it on to his wife when he got home via sex?

Online News Editor – David Grimm
Right, that's the implication of this new study, that the researcher passed it on to his wife via sex. Now, they don't have proof of this, but there's very strong circumstantial evidence. The first thing is that Zika is just not common at all in Colorado. Also, the wife developed symptoms very quickly. If she had been bitten by a mosquito, or if she had been bitten by a mosquito that also bit her husband and transmitted the disease to her, it probably would have taken about two weeks for her to develop symptoms, but she developed symptoms in just nine days, so the math didn't add up if it was anything other than sex. And yes, the researcher confirms that he did have relations with his wife very soon after returning from Senegal. So, although it's not direct proof, there seems to be strong evidence that the researcher passed the Zika virus to his wife. And so, what's exciting about this paper, besides from the fact that it was this really interesting mystery, and it's a bit of a racy topic, what's really exciting is that researchers have never seen evidence before that disease passed on from a mosquito can be sexually transmitted between people, and that's actually very important to epidemiologists. There was actually a Zika outbreak in 2007 in Yap, which is an island in the Federated States of Micronesia, and the disease spread a lot faster and hit people in a younger age bracket than researchers would have originally suspected. It also infected a lot more women than the researchers would have thought. And if the virus was actually sexually transmitted, it would explain a lot of what epidemiologists saw in this outbreak, and it could help them understand future outbreaks as well.

Host – Robert Frederick
Now, you said this transmission from mosquito to human, and then from human to human, is new. Have researchers identified mosquito to another host, and from that host to one of its own species before? Or is this completely new?

Online News Editor – David Grimm
Well, this is the first evidence in humans, but actually researchers have seen something similar in boars, where the males were infected with a virus, and they transmitted it to females via sex. So, that means that this type of transmission could be more common than we thought.

Host – Robert Frederick
Okay. Thanks, Dave. So, what other stories have you brought with you this week?

Online News Editor – David Grimm

Well, Rob, from mosquitoes to another annoying insect – lice. This next story is about what lice can tell us about the evolution of birds and mammals.

Host – Robert Frederick
When they began feeding on us, or what?

Online News Editor – David Grimm
Well, it's a little bit more ancient than that. This story has to do with a mass extinction known as the Cretaceous-Tertiary extinction, or the K-T extinction, that happened 65 million years ago, and this was the big extinction that wiped out nearly all of the dinosaurs. And after this happened, mammals and birds really began to flourish, and we're probably here today because of that mass extinction. But there's been a big debate among scientists about whether the ancestors of these early mammals and birds actually survived this K-T extinction, or whether they really just started to arise after the extinction had taken place. And the reason lice enter the picture is because lice have been around for over a hundred million years, and if researchers could show that there were lice around at this time that were adapted to feeding on birds and mammals, that would suggest that there were birds and mammals around at this very early period in history.

Host – Robert Frederick
Because the lice themselves hadn't evolved in 100 million years to feed on something else, or what?

Online News Editor – David Grimm
Well, it's a little bit more complicated. Basically, what the researchers did in this study was they took two fossil lice; one that was 44 million years old, and the other that was 100 million years old, and they did something called creating a molecular clock, trying to figure out how they evolved over time, how they changed. Now, some of these early lice did not feed on other animals, so the trick was figuring out when this adaptation to feed on animals, like birds and mammals, evolved, and it theoretically only would have evolved if these animals were around because otherwise why would lice have adapted to feeding on these animals? And what the researchers found was that these parasitic lice—the lice that feed on other animals—arose about at least 115 million years ago, which means that it's very possible that the ancestors of birds and mammals were also around at this time, and that they, indeed, were around to survive this K-T extinction event.

Host – Robert Frederick
But weren't the ancestors of birds dinosaurs?

Online News Editor – David Grimm
That's a very good point, Rob, and, as you know, scientists think that some of these dinosaurs had feathers, much like birds do, and the evolutionary analysis of these lice suggested that the earliest lice to feed on mammals probably fed on a bird-like creature, which could mean that dinosaurs, or at least these bird-like dinosaurs, may have helped spread lice to mammals.

Host – Robert Frederick
So, what's the broader picture here? What are researchers really going for?

Online News Editor – David Grimm
Well, they're really trying to figure out how birds and mammals evolved, and because there was this really dramatic event – this K-T extinction – this could have played a very big role in their evolution, so trying to figure out exactly when these animals came on the scene can tell us a lot about how we got here.

Host – Robert Frederick
Okay. So, last story. What's this last one about?

Online News Editor – David Grimm
Well, Rob, this last story, we're also going to be going back into the past, but not so far back into the past. We're going to be going back to ancient Egypt about 3500 years ago, and this story is about the development of atherosclerosis, which is the hardening of the arteries, in ancient Egyptians.

Host – Robert Frederick
Written about in hieroglyphics, or what?

Online News Editor – David Grimm
Somewhat written about in hieroglyphics. In fact, some hieroglyphics suggest that some of the ancient Egyptian nobility had not the healthiest diets. They seemed to have fed on calorie-rich fare, like cakes sweetened with honey, and because they had these kinds of diets, researchers have long wondered, did they have the same type of heart disease that we have? Now, the ancient Egyptians didn't have a lot of the ills in their society that we have today – things like smoking and air pollution, which can also contribute to atherosclerosis – but diet plays a big part, and, so, in this new study, researchers wanted to figure out how prevalent was atherosclerosis in these ancient Egyptians. And so what they did was they conducted the broadest and most detailed study yet of atherosclerosis in Egyptian mummies. They performed CT scans, which is a kind of medical scan, which really lets you peer inside the body, on 52 mummies, and what they found was that 45% of these mummies exhibited definite or probable hardening of the arteries, which is a really high percentage.

Host – Robert Frederick
These are soft tissues, and they could still see this thousands of years later?

Online News Editor – David Grimm
They can, they can with the CT scan technology.

Host – Robert Frederick
So, could the researchers puzzle out that it was the diet, or something else?

Online News Editor – David Grimm
Well, they couldn't puzzle out that it was the diet, although they suspect that definitely played a role, but the ancient Egyptians had another problem, which we don't have as much today, or, at least, we in developed countries don't have as much today, which is they were dealing with a lot of bacterial infection and infectious disease which they couldn't treat. And these kinds of diseases cause inflammation in the body, and doctors today know that inflammation can contribute to the development of atherosclerosis, so even though the ancient Egyptians didn't have all of the ills that we deal with in society today, they had their own problems, and those ills seemed to have contributed to many of the same health problems that we have today.

Host – Robert Frederick
At least among the nobility who were mummified.

Online News Editor – David Grimm
Exactly.

Host – Robert Frederick
Any reason to think these people might have all been related to one another, and there was a genetic component?

Online News Editor – David Grimm
That's possible, but the other thing about nobility is they probably had access to a lot more of this high-calorie food than people that weren't in the nobility, so that might be further evidence that diet played a large role in the atherosclerosis that the researchers saw.

Host – Robert Frederick
Okay. Well, thanks, Dave.

Online News Editor – David Grimm
Thanks, Rob.

Host – Robert Frederick
So, what other stories are you looking into for the site?

Online News Editor – David Grimm
Well, Rob, for *Science*NOW, we've a story about how genetics may influence how much caffeine you drink, and also a story about growing eyeballs in the laboratory. Now these aren't full eyeballs, but they're enough of an eyeball that they could be used to treat blindness and other ailments in the future. And for *Science*Insider, *Science's* policy blog, we're continuing to follow the debate about the U.S. budget in Congress and what effect that could have on scientific research in the U.S. And, also, we're continuing our coverage of the disaster in Japan, some new insights into how the radiation is spreading, and what impact it's having on the soil in Japan and the surrounding ocean. So, be sure to check out all these stories on the site.

Host – Robert Frederick
David Grimm is the online news editor of *Science*. You can check out the latest science news, plus all the stories on the *Science* policy blog, *Science*Insider, at news.sciencemag.org.

Music

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Host – Robert Frederick
And that wraps up the April 8th, 2011, *Science* Magazine Podcast. If you have any comments or suggestions for the show, please write us at sciencepodcast@aaas.org. The show is a production of *Science* Magazine. Jeffrey Cook composed the music, and I'm Robert Frederick. On behalf of *Science* Magazine and its publisher, AAAS, thanks for joining us.

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