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Music

Host – Kerry Klein
Welcome to the *Science* Podcast for July 27th, 2012. I'm Kerry Klein.

Host – Edward Hurme
And I'm Edward Hurme. This week: packing nanoparticles into complex structures [00:59], the next steps in planetary exploration [18:13], and a closer look at termites…

Interviewee – Yves Roisin
In social insects, they usually send the older ones outside—to forage, to collect food—and so they are more implied in battles. And when they are old and probably less efficient, they are more likely to sacrifice themselves [11:26].

Host – Kerry Klein
Plus, a few stories from our online daily news site [27:27].

Music ends

[00:59]
Host – Kerry Klein
Back in Chemistry 101, you may remember learning about cubic close packing, hexagonal close packing, and all the other basic arrangements that atoms and molecules can make when bonding with one another. But how would these atoms and molecules arrange themselves if you were to remove the chemical bonds? Seeking an answer to this question, Sharon Glotzer and colleagues investigated the self-assembly of nanoparticles in an environment dominated by entropy. Glotzer spoke with me about the study from her office in Michigan.

Interviewee - Sharon Glotzer
Everyone is familiar with different kinds of chemical bonds that hold atoms and molecules together. And entropy is related to a kind of statistical force. It's not a typical kind of chemical bond, but it's just as important in organizing building blocks like atoms and molecules into structures as chemical bonds. Entropy is a concept that's usually associated with disorder colloquially, but it's not really. Entropy is about options; it's about possibilities. And what that means is that entropy can sometimes order stuff. That seems really counterintuitive, but it's actually been known for about 50 years. What

wasn't known and what's so surprising to come out in this study is just how far you can go with entropy in organizing different sorts of shapes.

Interviewer - Kerry Klein
So you're talking about entropy specifically within the context of self-assembled materials.

Interviewee - Sharon Glotzer
That's right.

Interviewer - Kerry Klein
You say that these kinds of materials are ubiquitous in nature. Can you give a few familiar examples?

Interviewee - Sharon Glotzer
Sure. Broadly speaking, crystal structures can be formed by self-assembly. So if you take water and you put it in an ice tray and put in a freezer, it turns into ice, and what's happened is that the water molecules have organized into a periodic crystal structure. And that's an example of the self-organization or self-assembly process where you didn't go in and place the molecules one-by-one into this ordered structure. The water figures out – during the process of freezing – how to organize all of the molecules.

Interviewer - Kerry Klein
Right.

Interviewee - Sharon Glotzer
So any sort of crystal structure could be thought of an example of that. But you can have other examples like in biology cell membranes are self-assembled structures of lipids. Viruses are a classic example of a self-assembled structure where proteins self-organize into groups, and those groups – that are called capsomers – again self-organize into the virus capsid structure that contains DNA on the inside.

Interviewer - Kerry Klein
All right. So why were you interested in the role of entropy in the self-assembly of materials? What questions were you trying to address, to answer, in this study?

Interviewee - Sharon Glotzer
We want to design new materials. And to design new materials means we want to design new structures, and we want to design new structures in new ways. Structures – for different kinds of materials – can be made out of atoms, they can be made out of molecules. For the past 10 years, nanotechnologists have been making nanoparticles, which are clusters, small clusters, say of atoms, which can be anywhere from a couple of nanometers to a couple of thousand of nanometers across. And those nanoparticles can also serve as building blocks of new materials, like next generation materials, that might have properties that you don't have today in traditional materials. So the goal of our

study was to try to understand some general design rules, general principles for how the shape of nanoparticles can affect what kinds of structures they want to self-assemble into.

Interviewer - Kerry Klein
And, in particular, the nanoparticles that you were studying – or the basically the building blocks for these structures – were a group of 145 polyhedra. So, tell me about these polyhedra.

Interviewee - Sharon Glotzer
So, many nanoparticles are grown in solution as little crystallites. And so they naturally have this sort of faceted shape like the shape of a diamond. So we decided to focus our study on these kinds of faceted shapes called polyhedra. And so we looked at a number of different kinds of polyhedra to see how changing the shape of the polyhedra, which means changing the faceting, would affect how these particles want to self-organize. So we started with the five platonic solids. Those are the five simplest ones. The tetrahedron is the simplest polyhedron of all because it has four sides, and that's the minimum number of sides that you need to form a polyhedron, you know, a three-dimensional shape. There's nothing special about the number 145. We could have studied a few more; we could have studied a few less. These were some polyhedra that are highly symmetric.

Interviewer - Kerry Klein
So your next phase of work was to determine the structures that these polyhedra would form when self-assembled. But you weren't actually working with these materials. You were just running computer models of of how they would all fit together. Is that right?

Interviewee - Sharon Glotzer
Yes. We don't make anything. We just do it all in the computer. And so we use computer simulation to solve the laws of thermodynamics. And when there are no chemical bonds, no interactions between particles other than they can't sit at the same spot – think of them like billiard balls – thermodynamics dictates that the stable structure that will result will be the one that maximizes entropy. And then, what we do in the simulations is we just start the simulation out with just a few particles in the box so they have lots of room, not very crowded, and then we start throwing more particles in, more particles in or making the box smaller for the same number of particles so that they start feeling more crowded. And at some point, they get crowded enough that the system realizes as a whole that if the particles start to align face-to-face there are more ways for the particles to arrange themselves than if they stayed disordered. And that's the part that's usually counterintuitive to people.

Interviewer - Kerry Klein
Indeed. So is there a way for you to then test these models and to confirm whether or not they're accurate when you're outside of this hypothetical computer scenario?

Interviewee - Sharon Glotzer

Sure. Well, first there are different kinds of rigorous tests that can be done to ascertain the stability of the kinds of structures, the correctness of the structures that you get. And then, we work with a number of experimental groups here at the University of Michigan and at other places who can make the kinds of particles that we're simulating. And so they can test our predictions.

Interviewer - Kerry Klein
So in the end, what did you learn from modeling the self-assembly of all of these different polyhedra? How much are you now able to predict about the final structure knowing the the particular sizes and shapes of the building blocks going into it?

Interviewee - Sharon Glotzer
Well, we learned quite a few things. The first thing that we learned is that there is an incredible diversity of crystal and crystal-like structures possible with just shape alone and no chemical bonding – no other interactions. And that was surprising to us. The second thing we learned is that one can control all of these types of crystal structures just by controlling the shape of the particle and that some of the structures that you get are incredibly complex. For example, we found some crystal structures that have 52 particles in the repeat unit, which is extraordinary complex structure even for atoms to form, let alone nanoparticles like this with no chemical bonding. So structures like that with 52 or 20 or even 8 particles in the unit cell are to date the most complex ordered structures that we're aware of from entropy alone from just hard particles. Of course, structures of that level of complexity are known in classic materials, but it's not been found before with say nanoparticles that have no such metallic bonding.

Interviewer - Kerry Klein
So within your field and beyond, what's sort of the greater significance of this work? And what are some applications?

Interviewee - Sharon Glotzer
So it allows us for the first time to predict the category of structure that will come out by just looking at a particle's shape. Without having to do an experiment or do a simulation, we can take a particle's shape and predict whether or not it will form say, a very simple type of crystal with a very small repeat unit, or a much more complex crystal with a much more complex repeat unit, or whether it will form a liquid crystal like the kind that you might find in a liquid crystal display. Not made out of the same molecules, of course, but the same sort of structure. Or we can tell whether or not that shape is likely to self-assemble into a structure called a plastic crystal where the particles are free to spin in place. There are many types of crystal structures that nanotechnologists would like to be able to obtain through self-assembly because it's just not practical to build them by placing every nanoparticle where you want it in some mechanical process. So you just want them to self-assemble by the bucket. And so now we can tell them, "Well, if you want this particular kind of structure, then your nanoparticle should have this kind of a shape." That was not possible before. So the greater significance is that we now understand that entropy can get you a lot in the way of complexity and so that we can go back and look at many of these types of self-assembled materials especially in biology

and think about what the role of entropy might be there. It also has applications in the field of granular matter – processing of particles of sand grains, packaging of pharmaceuticals. M & M's packed in a package or diamond-shaped Skittles – how you might design the package to fit the most number of Skittles in a in a box.

Interviewer - Kerry Klein
So whenever I'm looking to design the preferably shaped candy for packing purposes, I will consult this paper.

Interviewee - Sharon Glotzer
Yes, absolutely.

Interviewer - Kerry Klein
Sharon Glotzer, thank you so much.

Interviewee - Sharon Glotzer
Thank you very much.

Host – Kerry Klein
Sharon Glotzer and colleagues write about entropy in the self-assembly of nanoparticles in this week's *Science.*

Music

[11:26]
Host – Edward Hurme
Would you support sending our elderly out to the front lines of the battlefield? Evolution seems to favor this decision -- at least in one species of termite, in which elderly individuals take on sacrificial roles in battle. As the termites age and can no longer serve the colony by chewing wood, pouches containing a deadly mixture of chemicals begin to grow on their backs. When disturbed, the chemicals mix together and erupt to trap surrounding attackers in toxic goo. Senior author Yves Roisin spoke with me from his office in Brussels, where he began by describing these toxic pouches.

Interviewee - Yves Roisin
Water is the carrying kind of backpack, which allows them to explode, and they release a sticky and toxic substance. And so, it's actually a two-component system. The backpack is actually a pocket outside of the body, which contains a pair of blue crystals. And then, within the abdomen, there are stores of secretions from the salivary glands. And so, when they explode, the two mix together, and they produce the toxic secretion.

Interviewer - Edward Hurme
So, what can you tell me about this species of termite?

Interviewee - Yves Roisin

Well, they are social insects, of course, so there must be a queen in the colonies, a king then lots of brood, the young ones, and then soldiers, then also workers. And among the workers, we have distinguished white ones and blue ones – the blue ones are the ones with the blue crystals, of course. And actually those blue workers are old ones – they are older workers – and we could tell this because their mandibles get worn when they chew on wood; they are wood feeders. So their mandibles get worn, and we can tell they are the older workers.

Interviewer - Edward Hurme
And how do you measure how worn the mandibles are?

Interviewee - Yves Roisin
Oh, we have to dissect them and measure the length of the edge of the mandible. If they are sharp, the edge is longer than if they are blunt – just a microscopic technique.

Interviewer - Edward Hurme
So how did you test whether these backpacks were helpful in battle?

Interviewee - Yves Roisin
Well, actually we we observed, of course, the termites explode when they are grabbed by another termite or a predator or by ourselves. And then, we tested by removing the crystals, since they are outside of the body. They can be removed. If you cool the termite, you can remove the crystals without making it explode. So you can remove them and then test if they are toxic without the crystals or transplant the crystals to a white worker and see if that white workers become more toxic with the crystal. So it can make transplantation experiments.

Interviewer - Edward Hurme
So what did you see when you transplanted the crystals?

Interviewee - Yves Roisin
Actually, we showed that the two components are important – the crystals and the secretion of the labial glands. And actually, when they explode, then they release some toxic substances. The blue color disappears indicating the reaction.

Interviewer - Edward Hurme
So getting into this blue color, what what exactly is it?

Interviewee - Yves Roisin
It's actually a protein containing copper. So there are, what, several kinds of copper-containing proteins in animals and arthropods so we are now trying to find out exactly what kind of proteins this is. Many have an oxidizing action.

Interviewer - Edward Hurme
It's pretty much these termites are sacrificing their their older individuals for a suicidal battle.

Interviewee - Yves Roisin
It's quite common in in social insects because they usually send the older ones outside to forage, to collect food, and so they are more implied in battles, encounters with enemies or predators. And such insects, of course, the individual doesn't really count or it counts by the work it can actually do for the colony. When they are old and probably less efficient, they are more likely to to sacrifice themselves. Now, in non-social animals, of course, they tend to be more selfish always.

Interviewer - Edward Hurme
Yeah, of course.

Interviewee - Yves Roisin
So probably they won't do that.

Interviewer - Edward Hurme
So, this this chemical toxin – is this similar to sort other insects that have venom in their stingers?

Interviewee - Yves Roisin
Well, this is very original because it's a two-component system. And this is not common at all in insects. So there are a few ants that also possess a two-component system – they have two glands side to the sting. They can also mix the two substances. But it's really, really uncommon. So many of them carry venom, of course, in their poison gland. Many ants do. It's also exceptional to have the animal really carrying one component outside of the body. I don't know of any other animal doing this.

Interviewer - Edward Hurme
Since this seems to be a highly evolved defense, are there non-blue workers hesitant to engage in battle with a blue worker? Do they seem to be wary of individuals that are older and likely to explode?

Interviewee - Yves Roisin
Well, I don't think so. I don't think they can identify the opponents like this. When they get to know the opponents too late, so they not have the opportunity to learn, at least for insects. So maybe for other animals such as vertebrates, I don't know lizards, that could be predators then probably they could identify the exploding worker. We are now interested in the evolution of this kind of defense because, of course, it's a two-component system. So it doesn't evolve so easily because one component alone is probably not really efficient. And so we are trying to see what's happening in related species. So this species well it's a genus *Neocapritermes*, which comes from South America, and there are quite a lot of species in this genus. But so far we observed this behavior only in one of them. So we will try to check what's happening in the other species and where this differences divide can come from.

Interviewer - Edward Hurme

So, trying to find the origin.

Interviewee - Yves Roisin
Yeah. Trying to do the phylogeny of the group and so seeing if there are adaptations in other species that could explain the evolution of the two-component explosive system. The other thing we are doing with this termite is now try identify the biochemical mechanisms – so exactly what the secretion of the salivary glands and how does it react with the blue crystals; what's exactly the protein. So, that's what we are studying now.

Interviewer - Edward Hurme
Thank you, Yves Roisin.

Interviewee - Yves Roisin
Thank you.

Host – Edward Hurme
Yves Roison and colleagues describe exploding backpacks in a neotropical termite in a Brief in this week's issue.

Music

[18:13]
Host – Kerry Klein
When first approaching another planet we play it coy by doing a simple flyby--just a day or so to examine one side of a planet. Next comes the orbiter, circling and collecting data on the whole planet. Step three: send in the rovers to do some on-the-ground reporting. That's the normal progression of planetary exploration in our solar system and NASA is itching to take the next step--returning samples from the surface of another planet. Sarah Crespi spoke with *Science* News Writer Richard Kerr about who will be making the next trip to Mars, humans or robots?

Interviewee - Richard Kerr
There was a Natural Resource Council Committee, which last spring came out with what's called the Planetary Decadal Survey. It's a consensus document. They've essentially polled the planetary community and come up with a list of what are the most desirable missions for the next decade. They come up with a list – it's three tiered – several small missions, a couple of medium-sized missions, and then one multibillion-dollar so called flagship mission. And in this last Decadal Survey, the top priority for flagship mission was to collect and return samples from the surface of Mars.

Interviewer - Sarah Crespi
And so this is something that you called an aspirational mission. What does that mean?

Interviewee - Richard Kerr
Well, maybe that's a a NASA term. NASA is very interested in inspiring everyone to greater ambitions – whether it's elementary students to take an interest in science or

Congress to fund space exploration – the idea is to set high, challenging goals that will deliver great science but also will inspire and egg people on to even greater achievements.

Interviewer - Sarah Crespi
And so one thing that seems aspirational to me is to put a person on Mars. And that that does come up in your story, but that may not be the goal that the scientists want who want to do this sample return mission.

Interviewee - Richard Kerr
Well, NASA's most aspirational endeavors definitely involve humans. Human exploration – it is NASA. Planetary science has usually been on a parallel track. They have come together on occasion. The Apollo astronauts returned almost 400 kilograms of precious rock samples from the Moon. But, it doesn't always turn out well for the scientists or not as well as might have been hoped.

Interviewer - Sarah Crespi
Is that because they have to take their focus off of some of the analysis equipment or…

Interviewee - Richard Kerr
Well, there's always a tension between robotic science exploration and human exploration. Their interests overlap, but the overlap is not always that great. And the human exploration program is much more expensive – maybe 10 times, 100 times more expensive. And so it doesn't always work out the way the scientists would like. They were very pleased with the Apollo rock samples, but they were expecting a more thorough investigation of the Moon. And then again, in recent years, NASA was working under President Bush's directive, was going to return astronauts to the Moon. And the scientists were onboard – they got several missions, successful missions that returned terabytes of data. But President Obama changed the vision that NASA is operating under, and now NASA is going to be sending astronauts to an asteroid so that eventually someday they can get to Mars. The ultimate destination has always been Mars, but we're just shifting the pathway. And when the pathway gets shifted, one group of scientists lose out, maybe another one gains.

Interviewer - Sarah Crespi
Well, let's talk about the sample return mission a little bit more. So the idea is to to send something to Mars that can pick up some soil there and bring it back, right?

Interviewee - Richard Kerr
Right.

Interviewer - Sarah Crespi
Can you talk about how that would work?

Interviewee - Richard Kerr

Well, there is a very general concept that people have in mind, but everybody sees it as a three-step process. The Decadal Survey recommended taking the first step in this decade. And that would be a mission to Mars – a rover that could rove around, see what looks really interesting, and pick up some rocks. But that doesn't get them back home. So, you need a second mission, a second multibillion-dollar mission – goes down, lands very close to that first rover, takes on its samples and blasts them up into Mars' orbit. Then, you need a third multibillion-dollar mission, and you need to have them all work. The third one rendezvous in Mars' orbit and brings the samples back to Earth.

Interviewer - Sarah Crespi
You sure it wouldn't be cheaper just to send a person up there?

Interviewee - Richard Kerr
Well, sending humans to Mars has its own challenges. And there's actually some on-going discussion about do you have the robots bring the samples back first, or do you send the humans and have them bring them back? The thinking seems to be going toward robotic return of samples first. Humans – they're very expensive – they're also fifthly dirty. You want to know more about Mars before you send the humans there. I mean, what's lurking in that Mars soil might be something living, maybe not. There might be something that would be unhealthy for the astronauts. The scientists see that as a driving force to get their samples even before the humans get there.

Interviewer - Sarah Crespi
So you mentioned the Decadal Survey – it lists out some of the main missions, priorities for the space program. What were some of the top contenders?

Interviewee - Richard Kerr
Well, the committee did prioritize four or five missions. Mars sample return was a top one; next was sending an orbiter to the Jovian moon Europa. Once again, there's potential life involved. Europa has a a deep ocean beneath its icy surface. And scientists are very interested in the nature of that ocean and the possibility of life there. The next one was sending an orbiter to Uranus. It's one of the outermost outer planets. It's had only one mission – a flyby – and it's an interesting planet, gassy on the outside and a lot of ice on the inside. It's the sort of planet that is turning up around a lot of other stars. And then, the last priority was an "either/or" deal – a mission to study Venus' climate, or the alternative there was a mission to Enceladus. This is a small, icy moon of Saturn. It's spewing tiny ice particles kind of like icy geysers. And scientists are coming to believe that there's an ocean under there, too, which they're interested in for astrobiological purposes, as well.

Interviewer - Sarah Crespi
So those are all pretty interesting options if the Mars' sample return mission doesn't work out. But, kind of before any of that happens, we need to see how the funding shakes out. How is that playing out right now?

Interviewee - Richard Kerr

Well, NASA failed to sell Mars' sample return to the Obama administration – it was a bit too much for them to swallow apparently. So in this budget round, it looks like there's going to be some alternative means proposed. And whatever that alternative pathway is is going to involve human exploration. President Obama has directed NASA, said it should send humans to Mars by the mid-2030s. Now, that's to orbit Mars. But he did say that will be followed by a landing on Mars soon enough that he will be able to witness it. So, we're talking the 2040s. So NASA is reformulating the Mars' science program in some way that they can still get Mars' sample return at some point in the future.

Interviewer - Sarah Crespi
Well, Richard Kerr, thanks so much for talking with me.

Interviewee - Richard Kerr
My pleasure. Thank you.

Host – Kerry Klein
Richard Kerr is a staff writer for *Science*. He writes about planetary exploration in a News Focus this week.

Music

[27:27]
Interviewer - Isabelle Boni
Finally we have Nicholas St. Fleur to give us a rundown of some of the stories from our daily news site. First off, we have a pretty interesting story about artificial jellyfish. So these researchers created a sort of "Franken-jelly." What does a real jellyfish have to do to move?

Interviewee - Nicholas St. Fleur
So jellyfish move rather rhythmically. What they do is they flex their muscles, and then they expel water, taking on a dome shape as they glide through the water.

Interviewer - Isabelle Boni
So how on earth do you make a fake jellyfish?

Interviewee - Nicholas St. Fleur
Well, what these scientists did was – after analyzing how the jellyfish moves and how the jellyfish acts and more of its mechanics – they took silicone and transplanted cells from a rat's heart to make the shape of the jellyfish. So it's a silicone schematic powered by rat DNA.

Interviewer - Isabelle Boni
Okay. That's really cool. But I know the scientists went through a lot of trial and error to get the Franken-jelly to actually swim. So, what were some of the problems with their design, and how did they overcome their obstacles?

Interviewee - Nicholas St. Fleur
Some of the different problems they faced were designing the correct type of silicone layers to best mimic the different types of movements that this jellyfish creates. Another problem that they had was actually bringing it to life. So, what they did was they put the Franken-jelly into some saltwater; they ran an electric current; and then, boom it's alive – it's like Frankenstein straight out of the the classic.

Interviewer - Isabelle Boni
So Frankenstein has his new pet.

Interviewee - Nicholas St. Fleur
Exactly.

Interviewer - Isabelle Boni
Okay. But this all goes beyond fake jellyfish. What are some of the more practical applications of this technology?

Interviewee - Nicholas St. Fleur
So the main application of this activity is in creating new heart devices, artificial heart devices. The synthetic jellyfish comes into play because the motions that the jellyfish uses to move are comparable to the same motions that the heart valve uses to pump. When the heart's beating it has a valve, and the valve lets blood come in and go out, much in the same way that the synthetic jellyfish moves. So by applying this type of technology to future heart valves, they may be able to make better heart valves, and they could also use this technology to test out different types of heart medicine, heart drugs, by testing it on the actual synthetic jellyfish to see how it makes that jellyfish react.

Interviewer - Isabelle Boni
That's great. So jellyfish may end up saving our life someday. So next stop we move to what seems like a scene from a teenage horror film, as you put it. In our next story, we have bats preying on copulating houseflies. Now, we know that bats typically find their prey through echolocation, but the situation is a little bit different here, isn't it?

Interviewee - Nicholas St. Fleur
So, typically bats use echolocation to find their prey. With echolocation, the bat sends out signals that bounce around the surrounding environment and send back echoes that the bat can pick up. It's like looking into a dark room with a strobe light. So this is normally how bats find their prey. But that wasn't the case in this instance. So, what you have here is a cowshed that's covered with about 9,000 flies. It's a pretty stinky area. The flies are just buzzing around during the day. But at night, they fly to the ceilings, and they go to sleep, or they do other activities.

Interviewer - Isabelle Boni
Like what?

Interviewee - Nicholas St. Fleur
Like copulation. So when the flies rest on the ceiling, they're actually protected from the bats' echolocation. So when the bat sends out his signal and it hits the ceiling, well this ceiling is covered with a bunch of tiny bumps, which are about the same size as the flies. So when that signal comes back, instead of seeing where the flies are, the bat gets a message of full of bumps – little tiny bumps – that it can't discern whether what it's seeing is a bump or a fly.

Interviewer - Isabelle Boni
So if they're invisible, how are the bats able to find them?

Interviewee - Nicholas St. Fleur
That's exactly what the researchers were trying to find out. The bats were able to pick up on a certain noise that the flies made while they were mating. It was a clicking noise, which to us sounds more like a buzz. But to the bats it was more of a signal telling them that there's something going on over here. So what the researchers found is that the bats would hear this noise, home in on it and then fly to the copulating flies, swoop them up in a process known as "gleaning", which is when a bat takes a prey off of a surface. So they'd swoop in, grab the flies, and head out with a two-for-one dinner.

Interviewer - Isabelle Boni
How did the experimenters actually confirm that it was the buzzing noise that attracted the bats?

Interviewee - Nicholas St. Fleur
Well, that's a great question. So what the researchers had to find out was whether it was a clicking noise that the flies were making that cued in the bats, or if it was just having two flies on the ceiling, which created a larger target for echolocation. So what they did was they set up four speakers hanging from the ceilings that would play recordings of the copulating flies. So, it would play that clicking noise. So when the researchers played this noise, the bats would come in and attack the actual speakers thinking it was prey.

Interviewer - Isabelle Boni
So if buzzing can get them eaten up, then why don't the flies keep the noise down?

Interviewee - Nicholas St. Fleur
So what the researchers found is that it's actually the male housefly that makes this noise – this clicking noise. So looking at previous studies, what different researchers found is that the clicking noise is part of the male flies' courtship ritual. So the male fly will click his wings to show the female that he's, basically, worthy to mate with. The female would only allow the male fly to mate with her after he produced these sounds. So no noise, no mating.

Interviewer - Isabelle Boni
From houseflies dying in the throws of passion to Neandertals perishing in central and Eastern Europe. But for Neandertals the reason seems a bit less certain. So there's a

long-standing debate over just why the Neandertals disappeared. What are people saying about this? What are the two sides?

Interviewee - Nicholas St. Fleur
So right now scientists are aren't too sure why the Neandertals disappeared. There is a theory that the Neandertals were killed off by humans, *Homo sapiens*, who were emerging around the same time period. There's also the theory that climate change may have led to their demise. And there's another theory that a super volcanic eruption helped cause their ultimate destruction.

Interviewer - Isabelle Boni
Okay. So we have a lot of things going on here – the presence of modern humans, the eruption, the cold spell, and the disappearance of the Neandertals. So what was the solution the scientists came up with to find the correct, sort of order, the timings?

Interviewee - Nicholas St. Fleur
First is the idea that this super volcanic eruption occurred around 40,000 years ago. So recently scientists found out that this particular eruption was actually two to three times more massive than they had thought. With the explosion comes up massive amounts of volcanic ash, which was thought to be linked to a climate change that happened at that period in which globally the temperatures were cooled by two to three degrees. What these scientists tried to discover was whether or not this massive explosion happened before the Neandertals disappeared or after the Neandertals disappeared. So what the scientists investigated was a different type of volcanic glass. So this type of volcanic glass was much smaller and easier to detect at a wider range than the previous study that looked at this.

Interviewer - Isabelle Boni
So it spread out to sites that had previously been inaccessible to them?

Interviewee - Nicholas St. Fleur
Right. They looked to see where those glass pieces were in relation to Neandertal tools and human tools. So by looking at the sedimentary layers, they found the time period when Neandertal tools were no longer used, and *Homo sapien* tools started taking over. So, this time period signified when Neandertals died out and when *Homo sapiens* came to predominate. So after looking at this region, they found that the glass particles were on top of this region, meaning that they were younger particles than the layer at which *Homo sapien* tools predominated over Neandertal tools. So what this means is that this volcanic explosion happened after the Neandertals died out.

Interviewer - Isabelle Boni
So what does this tell us about the climate change theory?

Interviewee - Nicholas St. Fleur
So this finding isn't conclusive in completely ruling out that climate change may have had a hand in the Neandertals disappearing. So basically that adds stronger evidence that humans – not volcanic explosions – were the cause of the Neandertals dying out.

Interviewer - Isabelle Boni
So, what are some other stories we have on our online daily news site?

Interviewee - Nicholas St. Fleur
One story we have on the website is about selfish sheep and the reasons why they stay in the herd. Another story we have is about how scientists recreated mother of pearl, which is the mineral material inside of shells. So from *Science*Insider this week we have a story about conflicts of interest and fracking. And in this week, in *Science*Live, where we chat about the hottest topics in science, we have a discussion on invasive species and whether or not they're misunderstood. For next week's *Science*Live, we have a chat about the landing of the Mars rover. Be sure to check out these stories and more at news.sciencemag.org.

Interviewer - Isabelle Boni
Thanks, Nick. Nick is an intern at the *Science* news site. You can check out the latest news and the policy blog, *Science*Insider, at news.sciencemag.org where you can also join a live chat, *Science*Live, on the hottest science topics every Thursday at 3 p.m. U.S. Eastern time.

Music

Host – Kerry Klein
And that concludes the July 27th, 2012, edition of the *Science* Podcast.

Host – Edward Hurme
If you have any comments or suggestions for the show, please write us at sciencepodcast@aaas.org.

Host – Kerry Klein
The show is a production of *Science* Magazine. Jeffrey Cook composed the music. I'm Kerry Klein.

Host – Edward Hurme
And I'm Edward Hurme. On behalf of *Science* Magazine and its publisher, AAAS, thanks for joining us.

Music ends