Science Magazine Podcast

Transcript, 23 September 2011

http://podcasts.aaas.org/science_podcast/SciencePodcast_110923.mp3

Music

Host – Stewart Wills
Greetings, and welcome to the *Science* Podcast for September 23rd, 2011. I'm Stewart Wills.

Host – Kerry Klein
And I'm Kerry Klein. This week: an Aboriginal Australian genome and what it means for early human migration, an assessment of single-sex education, and the tangled debate surrounding an alleged link between a mouse retrovirus and chronic fatigue syndrome; plus, as usual, a few stories from our online daily news site.

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Host – Stewart Wills
A study published this week in *Science* offers an answer to an important question in the history of early modern humans -- whether Eastern Asia was populated from a single migration event, or multiple events. In the study, researchers used DNA sequence data from a 100-year-old lock of an Aboriginal Australian man's hair to infer patterns of early migrations and population dispersals from Africa. Senior author Eske Willerslev spoke with me about the findings.

Interviewee - Eske Willerslev
This work really deals with the early spread of modern humans outside Africa. And here Aborigine Australians play a key role in the debate because you can say the general notion is that there was one spread eastwards and that gave rise, you know, to Asians and first Europeans Asians, and then later on Aboriginal Australians were kind of diversified from within the Asian cluster. But those other theories mainly based on archeology that suggest that Aborigine Australians actually represent an earlier spread of modern humans into Asia and then first afterwards you can say Asian ancestors came. And so, this is basically what we are addressing in this paper. We have retrieved a genome sequence from a tuft of hair from an Aborigine Australian which is about 100 years old, and we've used this genome sequence to address the origin of Aborigine Australians.

Interviewer - Stewart Wills
So you were trying essentially to distinguish between these two different models of…

Interviewee - Eske Willerslev
Yeah.

Interviewer - Stewart Wills
…initial migration out of Africa. Before looking at the specifics of that, I wonder if you could just give us a quick review of how genomic data – which is what you used – are used to infer things like population dispersions of this type.

Interviewee - Eske Willerslev
Okay, very simplified you can say you're using, you know, the differences in genomes between individuals and also populations to kind of infer, you know, how long has different groups been separated from each other, and when did the separation take place. So you're using substitutions, you know, differences in base composition in the genomes between this Aboriginal Australian genome, Asian genomes, European genomes, African genomes, etc.

Interviewer - Stewart Wills
And, in this study, as you mentioned, you used a 100-year-old lock of hair from an Australian Aboriginal man who lived in the early 20th century. Why that sample, in particular?

Interviewee - Eske Willerslev
It's because today, Aborigine Australians are quite heavily admixed with the other groups like especially Europeans but also Asians, and this makes it very difficult, you can say, to to infer the population history because you have this kind of very severe input of genetic material from other populations. And, by going just approximately 100 years back in time, in certain areas of Australia, you can actually kind of get around that problem. Because southern western Australia, for example, where this sample is from, you know, was populated by Europeans very, very late. So by going 100 years back in time, you know, we are able to obtain, you can say, the genome, if you want, of a full-blooded Aboriginal Australian.

Interviewer - Stewart Wills
Okay. So, in other words, you were trying to kind of screen out certain kinds of I guess contamination…

Interviewee - Eske Willerslev
Yeah.

Interviewer - Stewart Wills
…from the study. But presumably you still needed to verify that the sample was free from that kind of contamination. How does one do that?

Interviewee - Eske Willerslev
Well, I mean we do it in different ways. But I mean first of all we're looking for, you could say, "genetic signals" if you want, that is very abundant in Europeans today and, you know, rare in other populations because Europeans is definitely – in terms of contamination – the very severe problem. I mean this sample has been kept in a British museum almost 100 years, has been handled by numerous Europeans. But also, if we compare the genomic sequence to other populations including the Papuans, the Melanesians, Europeans, Africans, Asians, etc., it shows the greatest similarity to Papuans, which is approximately the same region, which also tells us that it's free of contamination.

Interviewer - Stewart Wills
Okay. So you sequenced the genome and this lock of hair and established the sample was essentially free of contamination from I guess what we'd call more recent sources. How did you move from that to gain these new insights on the early dispersal of humans from Africa? Can you take us through a bit of that?

Interviewee - Eske Willerslev
Sure. I mean if you look very kind of rough on the genome it do show some similarities to Asians, and therefore you can say the first thing we needed to address is is this actually because they the Aboriginal Australians diversified from within the Asian cluster, or could this be due to gene flow, later gene flow, between Asian ancestors and ancestors of Aborigine Australians? And that's the first thing we see – we see actually that there is this ancient gene flow between Asians and ancestors of Aborigine Australians. And, if you actually kind of of remove, you could say, the Asian parts of the genome and look at the rest, then it becomes evident that the Aborigine Australians diversified from the same line as European and Asians but much, much earlier. I mean they diversified from this line about 60 to 70,000 years ago while Asians and Europeans diversify from each other only around 30,000 years ago.

Interviewer - Stewart Wills
And you get those sorts of timings from the rate of, from assumptions about the rate of mutations.

Interviewee - Eske Willerslev
Yeah, you can say it's an advanced way of looking at mutations so you actually get it in generations, and then you can – by assuming a generation time of 35 years – then you can start calculating the time of the split of the different populations. So basically what our data shows is that Aboriginal Australian ancestors diversify some 25,000 years before even Asians and Europeans exist – that they arrived, okay?

Interviewer - Stewart Wills
Before they exist as sort of separate populations.

Interviewee - Eske Willerslev
Yeah, as separate populations, exactly. So they diversified then spread eastwards basically into Australia. But then they leave, you know, they leave descendants, if you want, behind, right – people that didn't go all the way to Australia but were left in various places in Asia. And then, afterwards, some 25,000 years afterwards, you have the Asian migration into Asia. And some of these Asians they meet them – the forefathers of the Aborigine Australians that were left in Asia – and admixed with those, right? And that's the reason why you can say that Asians kind of become Aborigine-like, genetically speaking. That's actually because it's not a primary wind, it's a secondary wind due to a secondary admixture.

Interviewer - Stewart Wills
So you basically established that the Aboriginal line came out earlier, and then by using that timing you could address the admixture between the Aboriginal and Asian lines.

Interviewee - Eske Willerslev
Yeah, exactly. And you can say that, so Aborigine Australians really represent if you want the first modern human explorers. I mean these, while our ancestors in Europe and Asia, you know, were hanging some where around either in Africa or maybe in the Middle East, you know, and didn't really dare to go out and look into the world, Aborigine Aborigine Australian ancestors kind of spread, you know, across into this new country, right, reaching Australia probably about 50,000 years ago, which also makes them probably the oldest continuous population, you know, outside Africa today. Because they have been staying there since.

Interviewer - Stewart Wills
Well, you have a pretty remarkable story here, and I imagine that it's likely to engender some debate. What do you think are the main sources of uncertainty here that might be talked about?

Interviewee - Eske Willerslev
I think there will be two questions that need to be further addressed. One is, "Does Aborigine Australian ancestors, did they actually split of inside Africa or outside Africa?" I mean was it in the Middle East or was it inside Sub-Saharan Africa? And that's something that is very difficult to determine – or actually impossible at the moment to determine. We need to address that, we need more African genomes. The other one is, "To what extent after they reach Australia, about 50,000 years ago, whether they are completely isolated from the rest of the world, you know, or whether there was actually other groups, Asian groups, for example, that kind of make it to Australia and admixed with the Aborigine Australian ancestors?" That's something that also needs to be further addressed.

Interviewer - Stewart Wills
Eske Willerslev, thanks very much for joining us today.

Interviewee - Eske Willerslev
Okay, thank you.

Host – Stewart Wills
Eske Willerslev is a senior author of a new paper, published online this week by *Science*, entitled, "An Aboriginal Australian Genome Reveals Separate Human Dispersals into Asia."

Music

Host – Kerry Klein
This week's Education Forum, entitled, "The Pseudoscience of Single-Sex Schooling," argues that while anecdote seem to supportssingle-sex education, there is no empirical evidence that shows that sex-segregated classrooms improve students' academic performance. I spoke with lead author Diane Halpern about the paper and began by asking her why she chose to use the term "pseudoscience."

Interviewee - Diane Halpern
We call it the pseudoscience of single-sex education because a lot of the rationale for single-sex education is presented as though it's based on sound science, but it really isn't.

Interviewer - Kerry Klein
Okay, so what is some of the science that provides the rationale for single-sex education?

Interviewee - Diane Halpern
Well, we'll often hear things like "boys and girls learn differently". And in fact, boys and girls don't learn differently, the biology of learning is exactly the same for girls and boys. So that's an example where we have something that sounds like a scientific claim, but is not supported by the evidence. Sure, there are some differences in the brains of boys and girls; boys and girls are both similar and they're different. But there's nothing in the differences in the brains of boys and girls that we know that relates to how people learn or in any way provides a rationale for having different kinds of learning experiences for boys and girls. And there's a huge amount of overlap in all the distributions of boys' and girls' achievement and biological factors so that it really logically makes no sense to extrapolate and say, "We have to have one kind of education for boys, another kind for girls."

Interviewer - Kerry Klein
Okay, so let's step back for a second, and can you define sort of the settings in which you're considering single-sex education and and how common is it?

Interviewee - Diane Halpern
In general, we've lumped together all single-sex education because from the perspective of social science, it really doesn't matter where it's done – whether it's in a single-sex school or in classrooms in coed schools. We understand that there are legal distinctions,

but we're talking as social scientists and looking at the data. So single-sex education for us is anywhere where there are only children of one sex learning.

Interviewer - Kerry Klein
And how common is this around the country?

Interviewee - Diane Halpern
That's a very good question, and frankly, nobody has an answer. In 2006, there were changes in the regulations regarding Title IX that under very limited circumstances permitted single-sex classes in what are coed schools. We know there was an increase after that, but no one really knows how many there are. There are people who claim to have data on it, but when others have gone and checked out the data, many of the schools tried it for a semester and went back to coed because they found that it didn't work. And we have lots of schools where that has happened. Others had considered it and never did it. And I'm sure there are many that may have single-sex education but haven't registered anywhere. So no one really has good data on that. But we do expect that it has been increasing.

Interviewer - Kerry Klein
Can you give some examples of the differences in teaching methods for girls and for boys?

Interviewee - Diane Halpern
Sure. And remember, these are not differences that we are endorsing but others have endorsed. And you could really go to any number of websites and show images of, for examples, boys' rooms are under these a lot of the guidelines kept colder than the girls' rooms. Girls are grouped into small, cooperative units where they presumably spend more time discussing, and boys are spending more time actively throwing balls to each other to pass the questions. The point is, you know, I think plenty of girls would love to throw balls to each other when it's their turn to talk, and plenty of boys would certainly benefit from having more small class discussion. And in fact, everyone would benefit from a variety of learning methods because it's wrong to say all boys learn one way, all girls learn another way, or to extrapolate from any "average" to say that "all boys are like this" or "all girls are like that".

Interviewer - Kerry Klein
And you brought up earlier the neuroscientific basis for this. Can you go into any more detail about…

Interviewee - Diane Halpern
Certainly. There are some differences in the brains of boys and girls just as there are some average differences in the achievements of boys and girls. But that in no way means that there are differences in how they learn or they should have different kinds of learning experiences. Several neuroscientists have already pointed this out, and some of the data are just from obscure, you know, isolated findings that have been way over generalized to say, "Boys' brains look like this; girls' brains look like this." Experience

is the greatest architect of the brain, and we know that our brains change considerably. I mean just one experiment, they had girls playing the visual/spacial game Tetris® for several weeks, and you could see differences in their brains, as a result of this experience. So the fact that there are some differences in the brains in boys and girls could be caused by their life experiences and no way supports the idea that boys need one kind of learning, girls need a different kind of learning.

Interviewer - Kerry Klein
So what about standards like test results, graduation rates, college acceptance rates – what do those tell us?

Interviewee - Diane Halpern
Sure. That's really the main issue – is there any evidence that shows that children learn better in single-sex settings? And we can't, you know, there are thousands of studies. Just as one could go online and find a huge numbers of studies that show cures for autism, you could find almost anything if you go looking online. But what we have concentrated on are large-scale reviews that have had reviewed thousands of studies on what's called the meta-analysis or have based on studies that involved hundreds of thousands of children or, you know, large-scale review. And none of those reviews show any benefits of single-sex education. And in fact, the Department of Education itself commissioned a study, and the conclusions from its own study are that, you know, the results are equivocal, but is they didn't find any overall advantages for single-sex education. And you might say, "Well, doesn't that mean that we should try it anyway?" But at the same time, we have a body of evidence that says that it has negative consequences. The negative consequences are increased sexual stereotyping and increased sexism. And we have a huge body of social/psychological research, developmental research, that shows that when we segregate people into groups – could be giving kids in the same class different color t-shirts, it could be on the basis of eye color, classic studies in psychology – it increases intergroup hostility and, you know, really does not encourage a kind of respectful interaction that we want boys and girls to learn while they're in school. Our U.S. Department of Education has said that it is absolutely committed to evidence-based policy making. And it has, you know, very stringent guidelines for what kind of evidence it accepts in order to say that, you know, for basing policies. And clearly single-sex education does not meet any of those evidence-based guidelines.

Interviewer - Kerry Klein
And what do you think is the reason for that? I mean what you're saying is certainly contrary to conventional wisdom. Why do you think that there is still so much favorable information out there, you know, towards single-sex education?

Interviewee - Diane Halpern
Yeah, I don't know about conventional wisdom. I don't know how many people, in fact, endorse the idea of single-sex education. I think there are many well-meaning teachers, administrators who are seriously concerned with achievement of children in the United States, and they're looking for something that will help their children. They see that

there are some on average differences in the success rates of boys and girls in different areas, and they say and then there is also a movement that says, "Well, they learn differently." So I think that it's based on a lot of people who mean well but haven't taken the time to seriously look at the science. And we love stories. Most of the data in support of single-sex education is based on some story where, you know, we tried it, and the kids seemed to love it and so on. But that's not data. And we know that anecdotes – you can find anecdotes on both sides of the issue. So clearly I think as a general public loves these stories. You know, I go to a lot of schools, and this is what I see. But none of that is data, and anecdotes are biased in many ways, and most people don't understand why we need good scientific evidence for basing policies. For sure there are many, you know, really good single-sex public schools, but they're good for other reasons and not because of single sex.

Interviewer - Kerry Klein
Well, Diane Halpern, thank you so much.

Interviewee - Diane Halpern
Well, thank you very much. I enjoyed talking with you.

Host – Kerry Klein
Diane Halpern is a founding member of the American Council for Coeducation. She assesses the outcomes of single-sex schooling in an Education Forum this week.

Host – Kerry Klein

Music

Host – Stewart Wills
For two years, controversy has surrounded a purported link between a mouse retrovirus, XMRV, and chronic fatigue syndrome, or CFS, a baffling, debilitating disease with no known origin. The uproar began in October 2009, when a paper published in *Science* allegedly established an association between the virus and CFS. But a steady assault on the paper immediately followed its publication, as other labs failed to confirm the finding and suggested that the original results were based on contaminated samples. Now, a new study published today on *Science* Express, along with a partial retraction of the original paper, adds another chapter to this tangled story. In a News Focus article this week, *Science*'s Jon Cohen and Martin Enserink write about the history of the research and the implications of the new report. Jon Cohen talked with me about the story.

Interviewee - Jon Cohen
In October of 2009, *Science* published a controversial paper that linked a mouse retrovirus to chronic fatigue syndrome. The paper has been criticized heavily for the past few years. And it all was going to come to a head this next week in Ottawa with a definitive study that would answer the question clearly whether people who have chronic fatigue syndrome indeed harbor this virus, which is called XMRV.

Interviewer - Stewart Wills
And, as I said, this seems like a particularly tangled tale, and one that in some ways isn't getting any easier to understand. Maybe you could just take us through how this situation came about. For starters, just what is XMRV?

Interviewee - Jon Cohen
It's a mouse retrovirus, and it was discovered by a researcher studying prostate cancer. He then collaborated with people studying chronic fatigue syndrome. And they together published the *Science* paper showing that in blood samples, they found the virus in two-thirds of the people with chronic fatigue. Chronic fatigue has a long history of viral suspects being frog-marched out in front of the public only to be dismissed later by scientists who find that they don't have anything to do with the condition.

Interviewer - Stewart Wills
And I gather that the original paper, raising the link between this newest suspect, XMRV, and chronic fatigue, didn't sail through peer review the first time. Could you talk a little bit about that original paper?

Interviewee - Jon Cohen
It was heavily scrutinized by the reviewers and by the advisory board to *Science* when it first submitted, and the researchers substantially rewrote it and addressed some of the serious concerns. And it was not rushed into print by any means; it was first submitted in May, it ended up being published in October of 2009. There were red flags all over the place because of the possibility of contamination. Mouse retroviruses are famous for causing contamination. And furthermore, the study was using PCR, which also has, you know, lots of contamination problems. So everyone was on red alert about that possibility. But the researchers answered the questions that the reviewers put forward, and some very prominent people backed the study.

Interviewer - Stewart Wills
And so the paper is finally published, suggesting this link. What was the reaction?

Interviewee - Jon Cohen
Well, within weeks researchers were criticizing the paper for not using blinded samples, for not being careful enough with the PCR. And then, by the beginning of the new year, there were negative studies in other groups of chronic fatigue syndrome patients that couldn't find any XMRV. And they just started to pile up.

Interviewer - Stewart Wills
I guess, though, one of the interesting, kind of complicating factors here is that quite apart from the scientific debate, there's this very active patients' advocacy community in chronic fatigue that was really pulling for this paper.

Interviewee - Jon Cohen
People who have chronic fatigue syndrome have been accused of having a psychosomatic illness. If there were a clear cause of the disease, it validated their symptoms for years.

Furthermore, it offered the opportunity for treatment and possibly a cure. The most exciting thing to many people who have chronic fatigue is that shortly after the *Science* paper came out, test tube studies showed that antiretroviral drugs that are used for HIV worked against XMRV. And some patients tested positive for XMRV in commercially available tests and started to take antiretrovirals.

Interviewer - Stewart Wills
And so we had the situation where people were actually taking action based on this research that was increasingly being called into question. Then there was at some point apparently a rumor of another confirmation? I mean the story got really tangled.

Interviewee - Jon Cohen
It did get very tangled. There was a group that included researchers from the NIH and the FDA that said they had found a very similar mouse retrovirus, not the exact one but "cousins" of XMRV, in even more CFS patients in the range of 86%. And there's a background here too that the control groups in both of these studies had high levels of finding the virus, on the order of 3 to 6%, which could mean that the entire blood supply was at risk and that the virus was lurking there undetected and infecting people all over the place.

Interviewer - Stewart Wills
So these blood supply concerns kind of set the stage for this most recent study being published today. How did that actually get set up?

Interviewee - Jon Cohen
Well, the U.S. government and the Department of Health and Human Services was very concerned about the blood supply, and so they organized a working group to have nine different labs, including the labs that had found XMRV and its cousins, to blind to study blinded samples and see could they reproducibly detect these viruses in blinded samples from CFS patients, and there were control samples that were negative as well. And what the study has found is that no lab could reproducibly find the virus or its relatives in the blood samples. And given that it included the authors of the original *Science* paper from 2009 and the FDA researcher and the NIH researcher who had found the related viruses, it makes a very strong case that XMRV in the blood is not linked to chronic fatigue syndrome.

Interviewer - Stewart Wills
Well, I guess as you suggested, one of the unusual aspects of this is that one of the lead authors on the first *Science* study connecting XMRV with chronic fatigue, and who has since really been a staunch defender of the work was actually an author on this most recent study, correct?

Interviewee - Jon Cohen
Yeah, this is one of the more complicating factors of the story. The original *Science* paper was, the lead researcher who organized the team was Judy Mikovits from the Whittemore Peterson Institute in Reno, Nevada. And Judy used to work at the National

Cancer Institute with Frank Ruscetti, who is also a co-author of the paper and is also of the original paper and of the new paper from the Blood Working Group. Both Judy and Frank maintain that XMRV-like viruses may well be infecting people with chronic fatigue syndrome and that the new study doesn't rule that out.

Interviewer - Stewart Wills
Well, how can they come to that conclusion?

Interviewee - Jon Cohen
In part, because remember you brought up the contamination. The original *Science* paper focused on one XMRV, one sequence of virus. That, it turns out, is a contaminant. And one of the authors, Robert Silverman, of the original *Science* paper has retracted it and said that is a contaminant. What Judy Mikovits and Frank Ruscetti are saying is, "There are many different sequences, many different XMRVs." And it could well be that there are other XMRVs in people, and they have positive data in their labs that show that those exist. Furthermore, it could be that the virus is in tissue and not in the blood, so blood samples would not reflect what you see. And they looked at antibodies, as well, and the Blood Working Group found nothing, but their argument is antibodies can come and go against the virus. And it could be that the samples that they had just didn't have the antibody level.

Interviewer - Stewart Wills
So it sounds in a way like this story really hasn't come to an end.

Interviewee - Jon Cohen
I think it will have come to an end for most people who have followed this closely. But the way that Judy Mikovits and Frank Ruscetti look at is it's lonely out here, but this is what the world of science is. They realize that the onus is on them to provide positive data, and they say that they will continue to look for evidence to support their original thesis. Now, they were careful all along to never say that XMRV caused chronic fatigue syndrome. They found an association, they found linkage, but they never argued for causation. That's always been something that the community has made much more hay about than they did. So, you know, in their defense that was not their initial argument, and it's not their argument today.

Interviewer - Stewart Wills
But I guess scientists have still been pretty critical of Judy Mikovits.

Interviewee - Jon Cohen
They have, and she has been pilloried in many ways by the mainstream scientific community. She is seen by some as being someone who moves the goalposts, who, whenever there are reports that contradict her earlier report, she comes up with reasons why they don't really apply. And I suspect that with this new Blood Working Group study and her interpretation of it – and Frank Ruscetti's for that matter – it will only further the sense that she's a quixotic figure. But what she says is, "I'm a scientist, and this is how science proceeds."

Interviewer - Stewart Wills
Jon Cohen, thanks very much.

Interviewee - Jon Cohen
Thank you so much.

Host – Stewart Wills
Jon Cohen is co-author, with Martin Enserink, of a News Focus on the controversy surrounding XMRV and chronic fatigue syndrome.

Music

Interviewer - Kerry Klein
Finally today, Daniel Strain, news writer for *Science*, is here to fill us in on some of the recent stories from our daily news site. So in our first story today, we've got one that follows one of the common themes in this segment, which is the mating habits of animals.

Interviewee - Daniel Strain
Right. Yeah, actually today we're going to the always-fascinating world of deep-sea animals. We're going to be talking about squid today – not really your Jules Verne-esque Kracken but these are smaller squid about the size of your hand, reddish colored. They're called *Octopoteuthis deletron*, and they live, among other places, off the coast of California.

Interviewer - Kerry Klein
So how are we able to observe creatures that live basically at the bottom of the ocean?

Interviewee - Daniel Strain
Yeah, these squid do live rather deep. They're found at about 400 to 800 meters below the sea surface, so very dark locations; almost no light is able to penetrate that deep. And it's actually an interesting story about how we're able to see them. Earlier biologists really had no choice but to actually drag them up in nets. Sometimes they were able to find a stray squid in the bellies of dead sperm whales and other marine mammals. But today, institutions like the Monterey Bay Aquarium Research Institute have what are called remotely operated underwater vehicles, or ROVs.

Interviewer - Kerry Klein
So what did these unmanned, these crewless submarines, observe in these squid?

Interviewee - Daniel Strain
Surprisingly, they actually haven't seen them that much. In over just about two decades, they've seen about 108 different squid belonging to this species. What's really interesting in that a small fraction of them, they saw squid that looked like they almost had small blemishes – so, tiny, white polyps that were covering their skin, sometimes

dozens of them, from the head to the tentacles. And these small polyps, it turns out, aren't actually blemishes at all, but they're tiny pouches that once contained sperm, so they're actually very much the remnants of a squid trying to mate with another squid. And they're actually pretty common amongst squid; researchers have found even in these very giant squid that have washed up on shore some evidence of them. What's really interesting in this study is that they didn't just see these polyps on females like you would expect – they also saw them on a nearly equal number of males.

Interviewer - Kerry Klein
So these polyps are the remnants of sperm, but how did they get there in the first place?

Interviewee - Daniel Strain
The squid mating habits tend to not involve a whole lot of courtship. They're actually a bit more like drive-bys. Most of these squid species – and this one, in particular, are no different – have a very, very almost obscenely long organ, which they actually release these giant pouches that are called spermatophores. The squid may be actually placing the spermatophores directly onto females or just sort of nudging them on with different parts of their body. The two squid pass each other, and some time later when the female feels the time is right, she releases some sort of cue, we're not sure what, these sperm pouches burst open and slowly migrate to fertilize the waiting eggs.

Interviewer - Kerry Klein
So this then begs the question, why are these spermatophores being found on male squid?

Interviewee - Daniel Strain
Yeah, and that's a very good question because it seemed like it would be very wasteful for these squid to go around and putting their sperm pouches onto just sort of any squid that happened by. But it turns out that they're not actually all that costly. And there's two sort of reasons to suspect why they're doing this. One might be deep down in the squids' habitat, it gets really dark. They have very sensitive eyes, but it's quite possible that they're just not able to tell a male and a female apart. They're shaped very similar, so it might just be a case of mistaken identity. The other possibility is is that it's actually almost an intentional strategy of the squid. These animals, like many other squid, they tend to live very solitary lives. And the deep sea is a very big place, so they run across other squid, both male and females, very rarely. They also tend to only breed during one period in their life, so they really only have one shot at actually getting their sort of genes out there to the next generation. So the thinking is among researchers that it's possible that they just use this "shoot first/ask questions later" approach to sort of hedge their bets, make sure that they're not missing any potential opportunities to mate. There's also the issue that many squid are, in fact, cannibalistic. So it's quite possible the males too just don't actually want to stay around all that long, so they don't risk becoming lunch.

Interviewer - Kerry Klein
So is this the only species that scientists think exhibit this behavior?

Interviewee - Daniel Strain

Well, there are a number of species that do sort of have what looked to be indiscriminating mating tactics. In the deep sea, they're not sure of any, but it's quite possible. The experts say that we really just don't know that much about the deep sea. So it may very well be a more common tactic than we thought.

Interviewer - Kerry Klein
And now onto a more sober note – deadly volcanoes.

Interviewee - Daniel Strain
Yeah, this story actually, a really fascinating story, takes us all the way back to about 1783. At the time, a volcano called Laki in Iceland – so this isn't the volcano that famously erupted in 2010 with the nearly incomprehensible name – this is another volcano. For about eight months in 1783 and 1784, this volcano sort of just spewed out about 120 million tons of sulfur dioxide, which can be a deadly gas for people. That amount – 120 million tons – is more actually than human industry today produces in a year. So it was quite a big volcanic eruption.

Interviewer - Kerry Klein
So that's obviously a huge amount of sulfur dioxide. What kind of effects were felt in Europe at the time?

Interviewee - Daniel Strain
So Europe at the time was obviously quite a different place than Europe today. It was a lot less dense in terms of populations. But even so, there was actually a really, really big toll of this volcanic eruption; as many as about 10,000 Icelanders, which at the time was about a fifth of the population of the nation, wound up dying due to this volcanic eruption largely because of these noxious gases that were released into the air. And the effects were felt elsewhere, even in Great Britain, where some say the death toll was about 10 to 20% actually higher during this volcanic eruption period. And an estimated 23,000 Brits actually wound up dying. And that doesn't take into any of the other considerations of losses in crop production or any of these more long-term impacts either.

Interviewer - Kerry Klein
But this occurred back in the 1780s, as you said. Why are we talking about this today?

Interviewee - Daniel Strain
So a team of researchers actually went in, and they asked the question, "What would happen if a volcano like Laki from Iceland were to erupt today?" That's actually not really a hypothetical concern the researchers say. In just over a millennia, we've had four similar volcanic eruptions around the same magnitude in the same region. So very much is a concern that's present today.

Interviewer - Kerry Klein
So scientists wanted to sort of figure out the effects of this volcanic eruption. How did they go about simulating this?

Interviewee - Daniel Strain
So they know roughly about the extent of an eruption of this sort. What they did is they looked at current simulations of the weather and to see just where those noxious gases might wind up today in Europe. And for the most part they tend to wind up in southern Europe. Based on sort of how they can judge the airflows, they get a good idea of how much of these gases might be in the atmospheres above major sort of European cities today like Paris or, say, London.

Interviewer - Kerry Klein
And so what were their predicted effects?

Interviewee - Daniel Strain
They were actually quite big and quite worrisome. According to the study, the harmful gas concentrations above much of Europe may increase by as much as 120% in the event of such an eruption. And the resulting sort of illnesses – respiratory illnesses and cardiac illnesses – they estimate would kill about just over 140,000 people.

Interviewer - Kerry Klein
Well, certainly something we hope doesn't happen anytime soon. And in our last story today, it sounds like some astronomers are doing some 65 million-year-old detective work?

Interviewee - Daniel Strain
Yeah, we're actually looking at another, depressingly enough, another mass killing event, but this one came about long before people. So this is actually what killed the dinosaurs. So, as every schoolkid knows, that was a giant meteorite. But a lot of scientists have actually been trying to track where that meteorite came from. Where we start off is a 2007 study that actually thought that they'd pinpoint the exact asteroid or asteroid family that generated this "killer rock". That meteorite, these scientists thought, actually originated from a particular family of asteroids called the Baptistina asteroid family. Baptistina is the largest asteroid in this group, and it's about 40 kilometers wide, so it's a very big asteroid.

Interviewer - Kerry Klein
And what makes the researchers think this asteroid was responsible for the extinction that happened 65 million years ago?

Interviewee - Daniel Strain
It involved quite a bit of astronomical detective work. What happens is is that they suspected some point in the past two very large space rocks crashed in together. This sort of event would likely make a wide asteroid family like the Baptistina family. What happened then is that as the asteroids crashed together all of the fragments would spread out. As solar radiation actually rains down on these particular fragments, they actually absorb heat and then radiate that heat back out. It actually gives them a small almost rocket effect that actually means that once these asteroids have impacted, over millions of years, they slowly spread out like maybe pancake batter on a griddle. What scientists

suspect is that one of these rocks spread out to a certain "sweet spot" near the orbit of Jupiter, which actually then flung the rock directly at Earth. So what these scientists did in 2007 is that they looked at the Baptistina family, they looked at the sizes of all of those asteroids, and from the sizes they could infer just how long it had taken them to spread out to get to the point where they were. That then gave them a bit of time to pinpoint when the crime occurred, so to speak, and where the asteroid that killed the dinosaurs would have originated.

Interviewer - Kerry Klein
So this sounds like they made a pretty convincing case. What new information has led to this reevaluation?

Interviewee - Daniel Strain
So a new team actually came in in this study, and they threw a bit of "cold water" on this old claim, and the researchers suspect that they actually get the Baptistina asteroid family off the hook. What these people did is they came in with new technology that was a little bit more sensitive than the technology the old team had used. This one measures asteroid size using infrared rather than visible light, and that actually gives them a much finer look at just how big these asteroids are. Turns out that this team thinks the asteroids in the Baptistina family are actually quite a bit smaller than researchers once thought. Smaller the asteroid moves faster that means it would take the asteroids in this family less time to spread out to the point that they're at today. And we see that the initial crash that formed this family and potentially sent a meteorite towards Jupiter occurred about 80 million years ago – that's a lot more recent than the 160 million years the previous team suspected. So they think that it was actually too late for that particular crash to have been responsible for basically pelting the dinosaurs.

Interviewer - Kerry Klein
So what are the astronomers, responsible for the 2007 paper, how do they respond to this?

Interviewee - Daniel Strain
Well, that's the great thing. They actually…they're not that upset about it at all. They say it actually makes an even better case for the Baptistina family being the guilty party. In the original scenario, the Earth would have to have been being pelted with basically large rocks for quite a long period of time. But with this new shorter date, that's not the case anymore.

Interviewer - Kerry Klein
Okay. So, what else has been in the news this week?

Interviewee - Daniel Strain
Yeah, so we have a couple of great stories appearing in *Science*NOW. We have a new look at a gene – mutations to this particular gene scientists think may actually contribute both to Lou Gehrig's disease and a very common type of dementia. We also have another story about a paper that actually throws cold water on a claim that there is a

particular gene in worms and mice and people that when overstimulated can actually extend human lifespan – a fountain of youth so to speak. And researchers have now cast doubt on whether or not that can actually occur. And on *Science*Insider we have a nice roundup of the nine MacArthur Fellowships winners this year who happen to have a background in research, like Sarah Otto, who studies why organisms, perhaps like our squid, have evolved sexual reproduction. And today, for *Science*Live we have a very interesting talk on the science of chronic fatigue syndrome.

Interviewer - Kerry Klein
Daniel Stain is a news writer for *Science*. You can check out the latest science 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 – Stewart Wills
And that wraps up the September 23rd, 2011, edition of the *Science* Podcast.

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

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

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

Music ends