

SCIENCE MAGAZINE PODCAST -- 4th January 2008

Music

Host -- Robert Frederick

Happy New Year and welcome to the *Science* Podcast for January 4th, 2008. I'm Robert Frederick. This week: coevolution between ants and a butterfly species; how the U.S. presidential candidates view science, as well as why that matters to the rest of the world; and quick decision-making by a little fish. All this and more, plus we read from your letters to *Science*.

Promo

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Music ends

Host – Robert Frederick

In parts of Denmark, caterpillars feast within ant colonies, both on the ant brood itself and because the adult ants bring the caterpillars food. That happens because the caterpillar, which later develops into a large blue butterfly, mimics the surface chemistry of the ant brood, so the adult ants think the caterpillar is one of their young. Sometimes, this parasitism by many caterpillars wipes out an ant colony. But other times, ants are able to recognize the caterpillars as invaders and kill them. As David Nash and colleagues describe in a paper in this week's *Science*, the butterfly and ants are engaged in a kind of coevolutionary arms race. Nash works at the University of Copenhagen.

Interviewee – David Nash

One of the, the major problems that people have had with evolution is that if you evolve, always get better and better, then at some point you run out of variations that can be used for evolution because you can become as good as possible. And one of the main cases where this can't occur is when you have parasites and hosts cointeracting. Parasites are always trying to better adapt to their hosts to parasitize them more effectively, whereas hosts are experiencing selection pressures to avoid being parasitized. So it means that there can be an ongoing evolutionary arms race between the parasite and host. There have been some previous studies on microscopic organisms showing that this can occur in the laboratory, but what we have here, I think, is one of the first cases where we have clear evidence that this has been happening out in the field. And what we've shown in this study is that there's a butterfly, the Alcon blue butterfly, which parasitizes two different ant species within Denmark. And it gets into the ant nests by mimicking the surface hydrocarbons, the surface chemicals that the ants have on their own brood.

Interviewer - Robert Frederick

So the wandering ants may pick up a caterpillar and bring it back and start feeding it?

Interviewee – David Nash

Yes, that's right. The caterpillars first start developing on a food plant, but after they reach a certain stage they leave the food plant and wait on the ground to be discovered by these ants, and they mimic the surface chemicals that the ants have on their own brood. So again, they're producing a signal which says, I'm an ant brood. And we've been able to show that the closer that mimicry is, the faster they are picked up by ants and taken back into the ant nest and put amongst the brood. And once they're there amongst the ant's own brood, they become highly virulent parasites; they eat some of the brood, and they will also get fed by the worker ants, and they'll get fed in preference than the ant's own brood. It's been suggested that they might provide some sort of superstimulus as well, but we still need to look into that further.

Interviewer - Robert Frederick

Is any of this chemical mimicry and subsequent adoption of the caterpillar by the ants based on proximity, suggesting that the mimicry has something to do with the diet?

Interviewee – David Nash

Actually we don't think it has anything to do with the diet of the butterfly, or do you mean from the diet of the ant?

Interviewer - Robert Frederick

Either.

Interviewee – David Nash

Yeah, the 2 species of ant that are used as hosts in Denmark, they're actually very closely related to each other, and they, to a large extent, have very similar niches; they feed on similar types of food, they're both scavenger species mostly. It's more in their social structure that they differ. So how the colonies are organized and how they pass on their genes to the next generation is different between the 2 ant species that they use as hosts.

Interviewer - Robert Frederick

Is one social structure more likely to take on the parasitic caterpillar than the other?

Interviewee – David Nash

Well we know that almost any ant within this group, within the *Myrmica* ants, will pick up a caterpillar and take it into the nest. But it's only within these 2 species that it will survive. And what we find in one species is that a certain proportion of caterpillars that are taken in will survive and develop, and that's whatever population you're looking at. In the other species, we find that it's a lot more variable. So there are some populations where caterpillars are taken in, but they never manage to survive or only survive at very low levels, whereas other populations there're very heavily parasitized by the caterpillars. So the caterpillars who will survive very easily, and they'll also have a major effect on those ant colonies. So it's more that one host species is parasitized at a relatively constant rate, whereas the other one is parasitized at a very variable rate. And what I think we've been able to show is, a lot of that variation in parasitism is related to how

common the ant is locally, and that probably is also fed back from the effect of the caterpillar. This is something we still haven't demonstrated yet, but we think in some areas the butterfly can actually suppress that ant colony so much that it becomes very rare and is no longer worth exploiting for the butterfly, and then it tends to use the other ant species as a refuge while that other species recovers. One way you can put it is, if we have one species where the ant is exploited at a relatively constant rate, and we have another species which, when it's common, is exploited even more than you would expect, but when it's rare it's hardly exploited at all.

Interviewer - Robert Frederick

What exactly was your hypothesis?

Interviewee – David Nash

So our hypothesis -- well we had several hypotheses we wanted to test. The first one was whether the degree of mimicry actually resulted in the caterpillars being taken in more readily and exploiting colonies more readily. So that was the first hypothesis, which we found a clear support for -- that the greater the degree of mimicry between the caterpillar and the host ant's own brood, the faster they were taken into to the ants' nests. The second hypothesis was that we were expecting that there may be some coevolution going on between the butterflies and their hosts. So we would get changes in the pattern of chemicals that both the hosts and the butterflies have on their surface as a result of this coevolutionary arms race in mimicry. So in other words, our hypothesis was that in those colonies, or those populations of the ant which were infected by the butterfly, we would get changes in their surface chemistry which the butterflies would then also try to match. Whereas in areas where the butterflies weren't present, we would not get any changes in the surface chemistry of the ants. And what we found for one species our hypothesis was supported; we got arbitrary changes in the surface chemistry and chemicals on the surface of -- or the ratios of the chemicals on the surface of the ant brood. But in the other species, the one that was exploited at a relatively constant rate, we didn't get that pattern. And we believe that's because there is a lot of gene flow in that second species from neighboring colonies, which are not infected, which essentially dilute any adaptation to the butterfly.

Interviewer - Robert Frederick

This was the different social structures that you mentioned?

Interviewee – David Nash

This is the different social structures I was talking about, yes. So, because the second species, the one that's exploited in a more or less constant rate and doesn't seem to adapt to the butterfly, has what we call a panmictic structure, there seems to be a lot of gene flow over even relatively large distances, then we get no local adaptation to the butterfly. The other species, which tends to reproduce by budding -- which means that neighboring colonies tend to be very highly related to each other -- in that species we have a much greater possibility for local adaptations within the ants. And so that is the species in which we find the pattern that they are changing their surface chemistry in response to the parasitism by the butterflies, and in some cases, they seem to be avoiding parasitism

that way. So our third hypothesis we tested, if you like, was that the differences we had in whether the ant species responded to the butterfly or not were because of the social structure and gene flow and the genetic viscosity of the populations, as it's been called. So in other words, how easily genes are transferred over a large distance over several generations.

Interviewer - Robert Frederick

And it doesn't sound as if the ants that are budding are getting much of this gene flow – they're highly viscous?

Interviewee – David Nash

Yeah, so they're highly viscous. So our hypothesis for why we would get local adaptation in one species rather than the other was that species in which we were finding a local adaptation would have much more viscous populations than the other. And that was confirmed when we did some genetic analysis using microsatellite markers to look at the viscosity of the different populations.

Host – Robert Frederick

David Nash is lead author of a paper on a mosaic of chemical coevolution in a large blue butterfly. Read the paper in this week's *Science*.

Music

Host -- Robert Frederick

Also this week in *Science*: the cosmic web. When you look at the night sky, it appears as a vast darkness with stars, galaxies, and enormous clouds of gas. But that picture does not account for what we cannot see: dark matter and dark energy. Tying the seen and unseen all together is a larger, connective structure that astronomers call the "cosmic web." This week, *Science* presents a special issue on the subject, illuminating the efforts of astronomers to untangle the cosmic web and the stars, galaxies, nebulae, and other pieces of the universe embedded within it. Read several perspectives and a news story on the cosmic web in this week's *Science*.

Music

Host – Robert Frederick

In November of this year, the citizens of the United States will elect a new president. While voters rightly focus on mega issues such as war, immigration, and taxes, that does not mean the candidates' views on science should be out of the picture. As *Science's* deputy news editor Jeffrey Mervis explains, how the next U.S. president views such topics as stem cell research, nuclear power, and global climate change will have a profound impact on the U.S. and the rest of the world. Mervis edited a special News Focus on the topic in this week's issue.

Interviewee – Jeffrey Mervis

There are a lot of issues that the president deals with that affect not just U.S. science but international science -- everything from climate change to International Space Station to nuclear-waste disposal to genetically modified crops. Those are all issues that the U.S. takes a policy on but not in a vacuum -- they're done in conjunction with, or in opposition to, the positions that other countries take.

Interviewer - Robert Frederick

So how did you find what the views of the various presidential candidates were in working on this article?

Interviewee – Jeffrey Mervis

Well, that was a difficult process, because science isn't on the front burner for any candidate. That's not new in 2008; that's been true in every campaign. There are fundamental issues -- the economy, taxes, immigration, healthcare -- that take priority. But that's not to say science isn't important. So what we did was talk to the people who knew the candidates, who had worked with the candidates, listen to the candidates on the campaign trail, in their speeches, talked with their advisors, and also looked at their backgrounds, that varied. You have people who are elected officials currently in the U.S. Senate or in the House of Representatives, in the governor's mansions around the country, former governors, former mayors, and to a greater or lesser extent, they've had some contact with the scientific community and have dealt with these issues, although sometimes within a scope that's much more narrow than they would deal with as president.

Interviewer - Robert Frederick

Have any of the candidates come out with any sort of position papers on any of these issues -- even say global warming, which has been really advocated strongly by former Vice President Gore?

Interviewee – Jeffrey Mervis

Well, the candidate that probably has had the most comprehensive position is Senator Clinton from New York. That's not surprising, given that she spent 8 years as First Lady when her husband was president, and as a result she has a network of advisors that is probably much more extensive than any other candidate. That's not to say that she's spent more time as senator on science and technology issues; it's just that the people around her are more familiar with the issue, and she is obviously receptive to those ideas and feels that it's important. She gave a major speech on the 50th anniversary of the launching of Sputnik, back in October, that really, it was a more detailed presentation of the issue than any of the candidates have given. Global warming of course is probably the biggest issue that's science related on the campaign, but even there there is not a lot that you can use to distinguish the candidates within each party. Pretty much all of the Democrats have taken a position in support of large, dramatic reductions in greenhouse gas emissions by some year -- in this case, mostly 2050 -- and also a cap-and-trade system that imposes limits on how much carbon you can emit and charges for it and collects billions of dollars in revenues, which can then be used in various ways to try to come up with alternatives. That's for the Democrats. So the Republicans, pretty much,

they have stayed away from that issue with the exception of John McCain, who for many years has made that one of his important planks. The other candidates -- Rudy Giuliani, Mitt Romney -- have not had a lot to say, and what they have had to say is not much different than the current administration. So within the parties, it's not going to be a litmus test. But that will change in the general election.

Interviewer - Robert Frederick

Well, you mentioned that global climate change is one of the issues in which a Republican differs from his party in how he views it. Is there a issue within the Democrats in which one Democrat differs from all the others?

Interviewee – Jeffrey Mervis

Not really. And I don't mean to duck that question. One issue again that all of the Democrats have mentioned in one form or another is something that goes by the phrase "politicization of science." This comes out in different forms -- on climate change, on endangered species, on other issues that are . . . on use of embryonic stem cells in research -- on issues that are in some ways ethical, philosophical as much as technical and scientific. And the Democratic candidates have all said, in effect, "We won't let this happen." But of course to some extent that's a political football. You can go back to previous administrations and, you know, a favorite campaign tactic is for the party out of office to say, "We won't let this happen -- in our administration things will be different." But that's also an example of how, when someone takes office, that's when the hard decisions have to be made, and that's when scientists want to be involved. But by then it may be too late. So it's important for scientists to keep in mind that while the election is going on, that's an opportunity to have some input into the candidates' campaigns and try to stay up on the issues and be in touch with their advisors. Because once whoever wins in November takes office, then they will bring a whole new set of people into the political arena, and that's when things will actually start happening that affect scientists on a day-to-day basis.

Interviewer - Robert Frederick

Well has there been, in the past, evidence that this kind of "stepping up" by scientists to make themselves and their issues aware to the presidential candidates during the election, had an impact so that scientists doing so this year will have an impact before November?

Interviewee – Jeffrey Mervis

I think -- it's hard to pinpoint a specific issue that where scientists made a difference in what a candidate, once elected, did, but I think that there are some things that scientists can give a slightly higher profile to. The issue of visa restrictions after 9/11 in 2001 is one such issue. I think within the context of homeland security and antiterrorism it wasn't a big concern. But I think the scientific community as a whole, from both spectrums, made a point of telling the policy makers and the powers that be that -- make sure you don't go so far to slam the door that you cut off the inflow of talent that has helped make this country such a strong scientific force. And I think that that had some effect at the highest levels. It wasn't a political issue, it wasn't a partisan issue, so it wasn't something that the policy makers already had a position on. I think that's a case

where there's some fluidity in the system where scientists as a whole can make a case and argue for something that's in the best interests of the country, not just in the best interests of scientists and researchers.

Interviewer - Robert Frederick

What about what the candidates *aren't* saying?

Interviewee – Jeffrey Mervis

Well that's an important question, because there's lots of things that they're not talking about in Iowa, in New Hampshire, and in the upcoming primaries, because they're not issues that candidates are going to make a decision on. But come 2009, they're going to be important. Things like the future of NASA and the role of nuclear power in trying to move away from a fossil fuel economy. How to continue to keep the U.S. economy on the cutting edge, encourage innovation -- not something that candidates are talking much about. But they're going to have to make some pretty important and lasting decisions. It was interesting going back to previous election packages that we have run, and in 2000, when Al Gore and George W. Bush were running, the question of the R&D tax credit, which is meant to foster innovation, was raised, and both of them said they thought it should be made permanent. Well 8 years later you can hear the same thing on the campaign trail because that's something that people agree is important, but somehow when you start to add up the numbers, it doesn't happen. So there are issues that don't go away, and those are going to have to be dealt with. That's why it's important to be familiar with not just the candidate, but who's around the candidate -- because those are the people that are going to get the senior positions. *Science Magazine* also recently took a look at the top science advisors in the Bush administration, and predicted that almost none of them will survive into the next administration. That means, for better or worse, that the positions such as Director of NIH, Director of the Centers for Disease Control and Prevention, the head of the Office of Science at the Department of Energy, in all likelihood the heads of NASA and possibly the National Science Foundation, will have new faces. And who those people will be will go a long way in determining what U.S. science policy is in the next administration, regardless of who the president is.

Interviewer - Robert Frederick

Jeffrey Mervis, thank you very much.

Interviewee – Jeffrey Mervis

Thank you, Rob.

Host -- Robert Frederick

Deputy news editor Jeffrey Mervis edited a special News Focus on how the U.S. presidential candidates view scientific issues. You can read the full set of articles in the January 4th issue of *Science*.

Music

Host -- Robert Frederick

Also this week in *Science*: the biological processes that regulate human growth. Anita Rauch and colleagues have shown that mutations in the centrosomal pericentrin, or *PCNT*, gene cause a rare growth condition known as microcephalic osteodysplastic primordial dwarfism type II. This inherited condition is characterized by a small brain and body size, but near-normal intelligence. The findings may provide researchers with insights into the biological processes that regulate human growth. In addition, the researchers suggest that the *Homo floresiensis* or "hobbit" fossils may have had this genetic condition. Read the paper, "Mutations in the Pericentrin Gene Cause Primordial Dwarfism" at www.sciencexpress.org.

Music

Host – Robert Frederick

When hunting prey, the archerfish makes extremely quick decisions. Understanding that quick process may help researchers in understanding the more complex decision-making of higher vertebrates, including people. In a paper in this week's *Science*, Stefan Schuster and Thomas Schlegel identified what is the minimum input the archerfish needs to make its decisions about catching its prey. The fish sees and starts to move in the direction of its prey in under 40 milliseconds, which is just about the time it takes for a single frame of a movie to flash by. I spoke with Schuster from his office at the Universität Erlangen-Nürnberg in Germany.

Interviewee – Stefan Schuster

What we were most interested in in this paper is to find a system that performs a complex task at a very high speed -- so high that only a very restricted, smaller, compact neuronal circuitry can be involved. And the advantage of having such a system would be, we thought, that you can tackle the complexity of the system much better than, for instance, in the cortex where you can apply functional resonance imaging technology that gives you only coarse resolution and where you have no access to the circuitry at the cellular level. So, what's interesting, in my opinion, about this archerfish work is that here a fish performs a very complex decision, and the fish then must decide what kind of motor outputs to produce. And the interesting thing is that this decision, which is really complex, is made in only 40 milliseconds, or less than 40 milliseconds and can be related, or a large part of it is made by a circuitry that's very nicely accessible that fish do have. So that I think we really have here a handle to study complex decision making at a level of identified and small cellular networks.

Interviewer - Robert Frederick

Why is the archerfish making this decision – what task is it trying to accomplish?

Interviewee – Stefan Schuster

Yeah. Well, an archerfish, very opportunistic hunters that are famous for their ability to shoot down aerial prey, insects, or even up to small lizards from leaves or twigs above the water surface with a precisely aimed shot of water which they release from the mouth. And since they hunt in groups and are surrounded by lots of other surface feeding fish, they must be really fast at the later point of impact of their dislodged prey. And so it's

very important for them to monitor the initial motion of their dislodged prey, and then to be already on the right track towards the later impact point, so to be at the later point of impact at the right time.

Interviewer - Robert Frederick

Why wouldn't this just count as instinct – why is this a complex decision?

Interviewee – Stefan Schuster

Yeah. It's a decision because the combination of variables in order to know how much to turn and at what speed to take off, the fish must take into account, as we now know, four independently varying variables. The initial height of the prey; its initial speed, vertical and horizontal, and the direction -- azimuthal direction of the prey. And these are variables which the fish cannot know before, and in fact as we show in the paper, about which it doesn't have or doesn't use any a priori information. So, the fish just must view the initial motion and take this information about directions, speed, and height, from this initial observation, and then decide on the turning angle. Just one turning angle or just one speed wouldn't do, and the amount of combinations of the initial motion variables are just too many to be stored or to be inherited.

Interviewer - Robert Frederick

Is this a learned response?

Interviewee – Stefan Schuster

Yes, young fish first have to learn to get the response right. And there's a nice finding that shows that it's plastic, because the rapid response of the fish toward the initial motion of dislodged prey goes away when you isolate the group members. It goes away when the competition is taken away from the fish. If you isolate them, then this fast response to the initial motion goes away, and the fish will wait until the prey falls down or splashes on the water and then respond only then. And if you take the isolated fish together afterwards, put them together as a group, then the response, the rapid response and the competition, will come back again.

Interviewer - Robert Frederick

So, your experimental setup then was various targets and things like that for the archerfish to shoot at in groups? How did that work exactly?

Interviewee – Stefan Schuster

So the basic setup was -- our first intention was to show what kind of information the fish really do use or do need to be so rapid. The first idea we had is that because in the natural situation, before the prey moves, there is a shot, one fish will fire its shot of water towards the target, and the other fish, as well as the shooter itself, could use the information. For instance, observing the shot would tell the fish, or could tell the fish, the timing, when motion needs to be observed. It could tell also the fish where motion is going to take place, because the fish know the spot where the insect initially was, and it could even tell the fish perhaps what kind of trajectory, what kind of speed would be most likely given the way the water approaches or the angle from which the water

approaches the fly. So, the first set of experiments we did was just to deprive the fish of this possibility, and this experiment was very simple. We put the fly, a dead fly, immobile, on the top of a nontransparent disc and from which the fly could be blown off with a stream of air at any speed and at any direction. So for the fish in this situation, the fish couldn't see a fly and suddenly this fly started moving at the given speed or direction, which we, as the experimenters, commanded. So in this situation, there was no shot to observe and there were no cues available that the fish could exploit to directing responses. And surprisingly, in this situation where the fish was deprived, there were just as fast and as accurate as in the more natural situation, where they would have all sorts of a priori information available. That was really surprising, because it tells that motion cues were both necessary and sufficient to drive this rapid response, and this is an important step in our chain of argument in this paper.

Interviewer - Robert Frederick

Is that short time of 40 milliseconds that accounts for the number of neurons that must both receive a signal and fire before the fish can act, or is there some other mechanism at play here?

Interviewee – Stefan Schuster

The sort of evidence which one needs to conclude from our findings on the kind of circuitry that is involved in making these complex decisions -- there are two kinds of information we need. First is that the response takes only 40 milliseconds and does not need any a priori inputs. The second piece of information comes from work which we published before, which shows that the responses the fish make to falling prey is just the same as the kind of escapes the fish make when they are startled. And the escape circuitry of teleost fish is very well known....

Interviewer - Robert Frederick

Teleost fish?

Interviewee – Stefan Schuster

Fish that have a backbone.

Interviewer - Robert Frederick

Okay.

Interviewee – Stefan Schuster

...in contrast to sharks and rays for instance.

Interviewer - Robert Frederick

Okay.

Interviewee – Stefan Schuster

And this has been shown by a large variety of wonderful studies to involve the huge Mauthner cells. The Mauthner cells are not shown -- well, we've just shown them to be present in archerfish, but this is not in the paper already. And the fine thing about this

circuitry is that the initial decision is made by a small number of neurons. The Mauthner neurons, for instance, they come in 2 – there are 2 for each teleost fish there are, for most of the teleost fish there are only 2 Mauthner cells per fish. These are huge neurons which you can identify from individual to individual, and there are serial homologous cells to Mauthner cells. And there's this rather small and yet tractable number of reticulospinal neurons probably also involved in the response. Now to the 40 milliseconds, it's known that the fastest goldfish it is known, that the fastest way to a muscle contraction that . . . this takes 35 milliseconds. So the direct path from phototransduction to the tectum of the fish and then down to the fastest way of getting a muscle contraction takes 35 milliseconds. And now if you allow the archerfish only 5 milliseconds to look at the initial motions -- certainly it will need more -- in order to judge what the initial speed and direction and height is, then the time is consumed already, which means that most of the decision must be done, probably the information is provided by the retina and then it's just relayed to the fast output system that fish have.

Interviewer - Robert Frederick

Stefan Schuster, thank you very much.

Interviewee – Stefan Schuster

Thank you very much, Robert.

Host – Robert Frederick

Stefan Schuster is senior author of a paper on high-speed decision-making in archerfish. Read the paper in this week's *Science*.

Music

Robert Frederick

Finally today, we read from your some of your letters to *Science*. Joining me is the journal's Letters Editor, Jennifer Sills.

Jennifer Sills

In December, we published several letters in response to news and editorials. The first we read from today is in response to a September 7th news story on virtual worlds that was part of a special section on social cognition.

Robert Frederick

Greg Miller's news story on how scientists were using virtual worlds to conduct their research prompted Alessandra Gorini to write in from the Applied Technology for Neuro-Psychology Laboratory at the Istituto Auxologico Italiano in Milan.

Jennifer Sills

"Online communities are playing an emerging role in health services.... And recent evidence has shown that reality-based treatments effectively combat anxiety disorders and allow subjects to develop real-world skills starting from virtual experiences."

Robert Frederick

These successes raise the possibility of creating online immersive therapeutic environments for specific disorders, particularly social phobias. For example, Gorini suggests using a virtual pub. In this virtual equivalent of a real-world pub, a therapist can monitor the patient's interactions with the other patrons.

Jennifer Sills

You can read Gorini's letter in the December 7th issue of *Science*. Turning now to the December 14th issue, a response to Donald Kennedy's editorial "Sputnik Nostalgia" from the October 5th issue.

Robert Frederick

In that Editorial, Kennedy, *Science*'s Editor-in-Chief, writes about the positive effects that the launch of Sputnik 50 years ago had on science education in the United States.

Jennifer Sills

But upon reflection about NASA, which also came about, in part, due to Sputnik's launch, Michael Goldstein from Rutgers University in New Jersey says that he is disappointed. Although funding for NASA programs may have increased briefly, it dried up soon after the Apollo moon landing.

Robert Frederick

Goldstein adds, "Lately, NASA has received additional funding to attempt a second series of missions to the moon as a part of the Constellation program, but the long-awaited increase is the bittersweet result of an imaginary space race. It seems that only when faced with the threat of looking stupid or coming in second place does our government open its wallet to science."

Jennifer Sills

Also from the December 14th issue, William Laurence writes in from the Smithsonian Tropical Research Institute in Panama about the relationship between U.S. soy subsidies and Amazonian deforestation.

Robert Frederick

The United States is the world's leading producer of soy. However, many U.S. farmers are shifting from soy to corn or maize in order to qualify for generous government subsidies intended to promote biofuel production.

Jennifer Sills

In turn, this is helping to drive a major increase in global soy prices, which have nearly doubled in the past 14 months. That has important consequences for Amazonian forests and savanna-woodlands, with studies suggesting a strong link between Amazonian deforestation and demand for soy.

Robert Frederick

Laurence writes, "The environmental benefits of corn-based biofuel might be

considerably reduced when its full and indirect costs are considered."

Jennifer Sills

Finally, a reader writes in about a News of the Week story from November 9th, "Postdoc survey finds gender split on family issues."

Robert Frederick

Yudhijit Bhattacharjee wrote that story describing a survey of postdocs at the National Institutes of Health. The survey suggests that the main concern for women is not a hostile environment but insufficient time to juggle the needs of family and career.

Jennifer Sills

From the psychology department at Richard Stockton College in New Jersey, Jean Mercer writes about her own balancing act throughout her career.

Robert Frederick

While special programs came about to encourage women who had delayed professional education until their families were grown, there was little help for those who had been juggling family and career all along.

Jennifer Sills

As Mercer recalls, "Looking back on a career as a professor and a single parent, I missed out on networking with colleagues and on presenting at conferences because of family obligations. I continued to miss out on these aspects of my career for many years, because, as most parents know, children can be too old to be left alone, as well as too young."

Robert Frederick

Now an emerita and consultant, Mercer says the Internet has helped her develop connections, particularly now as her family tasks are minimal.

Jennifer Sills

She adds that young professional women today are more likely to benefit from electronic communication than from changes in social attitudes about family responsibilities.

Robert Frederick

You can read her full letter in the December 21st issue of *Science*. Thank you, Jennifer.

Jennifer Sills

Thanks, Rob.

Robert Frederick

Jennifer Sills is the Letters Editor for *Science* magazine. If you enjoyed this Letters segment of the podcast and would like to hear more, or have other comments about this segment or the podcast itself, please let us know. You can send your comments to our email address: sciencepodcast@aaas.org.

Music

Host — Robert Frederick

And that wraps up the January 4th, 2008, *Science* Podcast. The show is a production of *Science* Magazine and of AAAS, the Science Society. The content is provided by the news and editorial staff of *Science*, and Jeffrey Cook composed the music. I'm Robert Frederick. On behalf of *Science* Magazine and its publisher, the American Association for the Advancement of Science, thanks for joining us.