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Music

Host – Edward Hurme
Welcome to the *Science* Podcast for June 29th, 2012. I'm Edward Hurme.

Host – Kerry Klein
And I'm Kerry Klein. This week: plant biodiversity and modern pharmaceuticals [00:58], the elephantnose fish's peculiar vision [10:29], and…

Interviewee – Richard Stone
You really have to give a lot of credit to the Chinese space program because despite the sanctions, despite the fact that they have to reinvent a lot of technology, they are now counted among the elite of space-faring nations [19:43].

Host – Edward Hurme
Plus, a few stories from our online daily news site [29:21].

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Music ends

[00:58]
Host – Edward Hurme
For millennia, plants have been used to treat a wide variety of ailments. As human societies have moved away from their ancestral roots, they've also moved down the path of synthesizing single-chemical drugs in the lab, rather than relying strictly on natural sources. In a review from this week's special section on Plant Metabolism, Vincenzo de Luca argues that there is still much to be gained from looking for new, more complex drugs and pathways within the vast library of plant biodiversity. I spoke with de Luca from his office in Ontario. He began by explaining the evolution of plant-based medicine.

Interviewee – Vincenzo De Luca
For most of human history, all drugs were natural. For example, human ancestors discovered that cinchona bark cured intermittent fevers; that ergot triggered abortions in farm animals; or that tea leaves awakened and energized individuals. Throughout the twentieth century, the trend has been to produce single-ingredient drugs from natural extracts, and inevitably these were replaced by synthetic molecules if it was possible to do this cheaply. These single-ingredient drugs are those that are predominantly used in wealthy societies around the planet. In developing countries where about 80% of the

world population lives, they rely primarily on these traditional ethnobotanical remedies for some of the diseases that they have.

Interviewer – Edward Hurme
And this kind of plant-based medicine is tied up with metabolites in these plants. And could you describe what exactly are plant metabolites?

Interviewee – Vincenzo De Luca
The term metabolite is usually restricted to small molecules that are found in living systems. They are usually organic compounds. For example, glucose is a six-carbon molecule that when broken down to its six single-unit carbon dioxide components using a process that generates the energy that's required to drive biological processes, and, in fact, life itself. That's an example of a metabolite. Glucose is classified as a primary metabolite, since it's important for performing primary housekeeping processes common to all living organisms, including plants. In contrast, other chemical entities that are responsible for particular biological activities, such as their toxicity inhibition or their stimulation of cellular processes, may make them valuable for medicinal uses. These small organic molecules have a more restricted distribution, and they're often made in a limited number of plant species: a genus, a single family, or in a few plant families. The fact that most individual molecules are restricted in their distribution to particular taxonomic groups has led to their traditional classification of secondary, or more recently, special metabolites.

Interviewer – Edward Hurme
So can you give us an example of the differences between these chemicals? Between the ones found in plants and the chemicals we can synthesize in the lab?

Interviewee – Vincenzo De Luca
Well, about two-thirds of the new drugs that were discovered in the past 25 years really originated from the discovery of particular secondary metabolites derived from nature. The success of nature to give us these new drugs seems to be attributed to the remarkable structural complexity of molecules that we find inside these living organisms. They have an average of 6.2 chiral centers per molecule, as compared to an average of 0.4 chiral centers that are found in the large combinatorial libraries that were produced by chemists over the last 20 years or so.

Interviewer – Edward Hurme
Can you describe what a chiral center is?

Interviewee – Vincenzo De Luca
A chiral center is defined as a carbon atom associated with four different atoms so that their mirror images cannot be superimposed. So these chemically complex molecules are really very difficult to make.

Interviewer – Edward Hurme

Why does it matter if we accidentally have the mirror image of the chemical we're trying to make?

Interviewee – Vincenzo De Luca
Remarkably, the chiral center is really important, because if you have one type of chirality, you produce a molecule that may be totally ineffective or inactive in terms of the target that it's affecting. And therefore, the need to produce molecules of the appropriate chirality that gives them their biological reactivity is essential for creating the drug of interest. And this is something that is extremely difficult to do. It's very easy for living organisms to do, because they have biocatalysts that act as scaffolds to produce the molecule with the right orientation. So one of the things that's been happening is chemists have been actually turning to enzymes from plants or other organisms to actually facilitate performance of the actual chiral reaction. And this is an area that's going to be very actively explored in the future. Because of the fact that these enzyme reactions can be taken place in aqueous solutions, the process is much greener than synthetic organic chemistry approaches.

Interviewer – Edward Hurme
So that would be an example of using plants or microbes as chemical factories.

Interviewee – Vincenzo De Luca
Well, this is why plants are really the source of such biodiversity, that your chances of identifying a biologically relevant molecule are greatly increased over the combinatorial approaches that have been tried now for the last 20 or so years and have not been terribly successful in creating, or discovering, new drugs. And so it tells us that plants and other organisms are going to continue to be very important in the discovery of new drugs.

Interviewer – Edward Hurme
Could you describe some of the new ways of synthesizing drugs from plants?

Interviewee – Vincenzo De Luca
The trend today really involves the identification of biosynthetic pathways and trying to harvest all the genes involved in a relevant pathway and then transferring the pathway from the plant of origin to a host that may be an industrial bacterial strain, a yeast strain, or maybe even another plant. Now, in the past, the identification of pathways was kind of slow and tedious. It involved protein purification, and once protein was pure, sequencing of the protein, and going backward with that to identify the gene itself, followed by verification of gene function by expression in microbial hosts to show the biochemical reaction. If we look at the important biosynthetic pathways – for example, the biosynthesis of the anticancer agent vinblastine – a number of genes in those pathways have been identified, but many more remain to be identified in order to have the whole pathway. Much of the morphine pathway is known. The identification of those genes has taken 20, 25 years of hard work by biochemists. And while this has yielded information on sequences and the development of homology-based cloning approaches, this is still relatively slow. And one way that this is being improved is the fact that we have large-scale, inexpensive sequencing technologies that have appeared in

the last 5 to 6 years. We do very large amounts of sequencing to obtain transcriptomes. And all that data is integrated into databases for searching for relevant gene sequences, or relevant candidate gene sequences.

Interviewer – Edward Hurme
I guess a lot of this research really depends on there being plant biodiversity, and that's really in some danger right now. Could you talk a little about that?

Interviewee – Vincenzo De Luca
Well, indeed, one of the important problems that we face is what are we doing to not only the plant biodiversity, but all the organisms on the planet are being modified to some extent, in terms of which ones are disappearing from the planet forever. And, of course, one could say, well, why don't we sequence them all, right? That way even if we lose them, we have the genetic information. In fact, there's some level of truth to if you're simply gathering information. But we don't know what those organisms are going to do in the future and how they might help the planet or ourselves if they were to disappear. This is really important, for example, if an important biosynthetic pathway is within an endangered plant species. If there's a medicine in that endangered plant species, the risks are that the plant species will disappear because of over-harvesting. And the mobilization of these biosynthetic pathways to a common system, like tobacco or yeast or microorganism, means that you don't have to harvest the plant, and, therefore, the pressure to eliminate it because of the needs of the medicines that have disappeared.

Interviewer – Edward Hurme
Vincenzo De Luca, thanks for talking with us.

Interviewee – Vincenzo De Luca
Thank you.

Host – Edward Hurme
Vincenzo de Luca and colleagues report on plant based pharmaceuticals and enzyme pathways this week in *Science*.

Music

[10:29]
Host – Kerry Klein
Not all eyes are created equal: cats are famously adept at night-time vision, while a hawk's survival depends on being able to spot motion from extreme distances. The ability of these animals to detect motion and light outside of the human experience is due to special light collection techniques and different arrangement of photoreceptors—or rods and cones—in their retinas. Now, add to this list the elephantnose fish, which lurks in the murky depths of African rivers. According to neurophysiologist Andreas Reichenbach, this fish's visual acuity is the result of unique crystalline parabolic "mirrors" in the fish's retinas that reflect and concentrate light onto photoreceptors. Reichenbach spoke with me about the findings from his office in Leipzig.

Interviewee – Andreas Reichenbach
We studied the visual capabilities of a certain fish that's called the elephantnose fish. This is a weakly electric fish often used for behavioral studies of this electric sense, but thought to be blind, or almost blind, until a couple of years ago. And then we realized that, indeed, the fish is able to see something. And we saw also very astonishing morphology of its retina and eye, and so we started to study what this special structure of the retina could mean. And, in fact, the visual capabilities of this fish are pretty poor. It's colorblind. It cannot see anything that is not bigger than six times the size of a full moon. But surprisingly, it's optimal for his environment. The fish swims in so-called black waters. It's turbid water of some African rivers. It's pretty dark. And so the special structure of the retina of the fish enables the fish to see large moving objects more reliable than any other fish, and this makes him thrive under these conditions.

Interviewer – Kerry Klein
Alright. So this is all about eyes and retinas. But before we get into how this actually all works in this fish, first I just want to ask how do you even determine the functions of eyes of other creatures? What's your methodology here?

Interviewee – Andreas Reichenbach
Yeah, of course you need a couple of methods, because you cannot ask the fish what it sees.

Interviewer – Kerry Klein
Right.

Interviewee – Andreas Reichenbach
And so it starts with microscopy. This shows you something about the structure of the eye and of the retina, and you can have some ideas about the function. But to check the function, of course, you need different methods. One of them is the measurement of the absorption spectrum of light of isolated photoreceptor cells. Another method is to do electrophysiology. That means there are stimuli applied to the retina, or to the entire fish. And you go with electrodes into the retina and record the electroretinogram, or go with electrodes into brain and record the responses of brain cells to these stimuli. And then, of course, we needed behavioral tests. So the living fish, freely moving, were subjected to stimuli, and then we recorded the behavioral responses.

Interviewer – Kerry Klein
So for comparison, how do the eyes of humans and other vertebrates work?

Interviewee – Andreas Reichenbach
There are two general specializations of the vertebrate's retina. Either the eye or the retina is specialized to see many, many details and colors, so this is high acuity vision. And a good example for this is our central area in the retina, the so-called fovea centralis or macula. You know, everybody can read very small letters or see lots of colors, and maybe the best example of this is a hawk eye, or something like this. On the other side,

we have animals living in the darkness, and usually they have a high density of specialized photoreceptor cells, the so-called rods. They are of a higher light sensitivity and can nicely detect even very small amounts of light. It's about a few light quanta which can be detected by such retinas. And the astonishing thing is the elephantnose fish is not specialized for either of the two functions, and this was a surprise for us as we first started to look at this eye.

Interviewer – Kerry Klein
Right. Yes, as you mentioned earlier, it was initially thought that this fish was blind. So what did you discover about their eyes?

Interviewee – Andreas Reichenbach
The very special thing is that behind the eye in the so-called retina pigment epithelium, there are huge cells, which form kind of parabola mirrors reflecting the light. They have a diameter of about 50 microns. We even measured this, or showed this, in the living retina. From outside, you can see that light is reflected, like in the cat's eye, but it is focused on a certain level in this case. The astonishing thing is that within such a parabola mirrors, there are about 30 cone photoreceptors, which are responsible for high acuity vision in our case, but not in this case, and a couple of hundred rod photoreceptors. And all sees the same part of the image because they are all illuminated by the same structure. That means visual acuity must be very, very bad because we are proud of using a single cone for detecting a single small pixel of the image. So they don't see small particles and can only detect the big ones. And under their conditions, this is advantage. They see the big moving predator coming, but they don't see all the dead worms falling down or the bubbles of air going ahead. And the other thing is you have a huge light amplification by these mirrors. This amplifies the lighted intensity by a factor of 6 to 10. This is much more than any other eye can do of vertebrates. Even the famous cat eye, it has other mirror behind the retina, but a plane mirror, and it can only provide for a factor of 2 or less. And so we have a huge amplification for the light for these cones which normally are the light-insensitive photoreceptors. So the fish can use all day long both rods and cones, and takes information together. We cannot do this, with the very exception of maybe five minutes at sunset, also in the rest of the day we have either cones or rods vision.

Interviewer – Kerry Klein
Right. Well so, as you said, this kind of vision is an advantage for this fish because it lives in such dark, murky, turbid waters. But there must be some disadvantages as well.

Interviewee – Andreas Reichenbach
Yes, of course. If the fish swims in an aquarium together with other fish under normal laboratory conditions, it's almost blind. And this was the reason why the fish had been considered to be blind for many years. There was research in the behavior of this fish for more than 50 years, and all the time people thought the fish is blind because at bright daylight it cannot see anything; it just hides in a dark corner of the environment.

Interviewer – Kerry Klein

So what's the greater significance of this? What's the future of this kind of research?

Interviewee – Andreas Reichenbach
I mean, there is two things we could say about this. The first, this is a novel principle of retinal organization and retinal function. So it's not only highly acute vision at daylight, and not only highly sensitive vision in dark environments. This is a third principle: a filtering retina filtering out small details and just leaving the most important facts. And the second thing is this principle might even be used for future technical sensors or something which ought to be built to see, or to detect something, under similar conditions if you have fluids which are turbid or much signal noise, then you could use a similar principle, such small parabola mirrors and collecting the information for couple of small sensoring units to achieve the same advantage for technical reasons.

Interviewer – Kerry Klein
So this research team that put together this report, as you alluded to earlier, is just huge and extremely interdisciplinary. You have physicists; you have biologists and neuroscientists. What's the greater significance of this study for, you know, for this whole team?

Interviewee – Andreas Reichenbach
I mean, it was just fun. It was all very bright and intelligent people, and it was just highly interesting to meet their methods and to see their ideas and to work together. And of course, all of us learned much about the fields of the other specialists. And so I think we all had big advantage from this study.

Interviewer – Kerry Klein
Wonderful. Well, Andreas Reichenbach, thank you so much.

Interviewee – Andreas Reichenbach
I thank you.

Host – Kerry Klein
Andreas Reichenbach and colleagues discuss the unusual eyes of the elephantnose fish in this week's issue.

Music

[19:43]
Host – Edward Hurme
China's space program has had a lot of firsts this month: the docking of its first manned spacecraft to a space station, with the first female "taikonaut" aboard for the journey. But China hasn't always been an active competitor in space exploration. *Science's* Sarah Crespi spoke to Asia News Editor Richard Stone about China's burgeoning interest in space research.

Interviewee – Richard Stone

This is a really important milestone for the program, because this was the first time that astronauts performed a manual docking, and it was between the Shenzhou craft and the Tiangong space module. It's important because this is going to be crucial to building a space station. Being able to dock is pretty critical to being able to function in space.

Interviewer – Sarah Crespi
Well, this is a pretty technical feat. Can you tell us some of the history of China's space program? How did they get here?

Interviewee – Richard Stone
It's a pretty long story, and it starts with their most prominent scientist from the 1950s. His name is Qian Xuesen. He was one of the founders of the Jet Propulsion Laboratory back in the 1940s. He was working in the U.S. at that time. During the Red Scare of the early 1950s, he was placed under house arrest for the next 5 years. And then 1955, he was allowed to return to China. He was given a hero's welcome. And he promptly proposed to the Chinese government that they start a space program. It took a long time from that point from 1955. China was pretty poor at that time. They didn't make much progress until the mid-60s; they really got serious, and they developed their first satellite, Dongfanghong-1, which was launched in 1970. Years passed and they had the idea to have a crewed space mission in the mid-1980s: 1986. Finally in the early '90s, they started pouring significant resources into the development of a manned space program. Shenzhou-1 lifted off in '99. They had their first astronaut in space in 2003. And what's really significant about this is that China has been under sanctions for about 20 years.

Interviewer – Sarah Crespi
Can you just briefly say where those sanctions come from?

Interviewee – Richard Stone
The sanctions began basically after the Tiananmen Square crackdown in 1989. And these were sanctions that the U.S. imposed on the export of use of dual-use technologies. In 1999, there were longstanding rules – the International Traffic and Arms Regulation – that applied not just to China. But enforcement of these rules was strengthened around 1999. The two sets of sanctions – the sanctions that were China-specific, and then the so-called ITAR sanctions – they really dealt a pretty heavy blow to China's space program, their limited possibility to import high technology. So their space program is largely based on their own research.

Interviewer – Sarah Crespi
Right. One of the things that you mention in your paper is that China's space program has really been led by engineers and the generals. But in the coming years, the space scientists will take center stage. Can you tell us about some of those upcoming projects?

Interviewee – Richard Stone
This is pretty exciting, because for years the only space science mission that China had pulled off was Double Star, which was a project with Europe. In the coming 5 years, they have plans to launch 5 missions. And they have 4 more, which are likely to go in

the following 5-year plan. So we're talking about at least 9 missions – major missions – in the next 10 years, as well as some missions on the Tiangong space module, and the space station, which they plan to build by 2020. There is a dark matter satellite that is going to be launched in about 2015. They have the Hard X-ray Modulation Telescope, the HXMT, which is going to be probably the first of 5 missions launched as early as next year.

Interviewer – Sarah Crespi
And what does that do?

Interviewee – Richard Stone
It was planned back in 1992. It is going to observe black holes, neutron stars, and other objects, based on their X-ray and gamma-ray emissions. So this will be China's first astronomy satellite. It's actually the first of 3 instruments that are part of China's Black Hole Probe program. There are a couple space weather missions, including one called Kua Fu, which has also been planned for quite a long time now. That's being done with Canada.

Interviewer – Sarah Crespi
A lot of these projects have been in the planning stages for a really long time. What's turned the Chinese government's attention to space? Why are they spending so much time and effort on it?

Interviewee – Richard Stone
The space science community in China for quite a long time has been unhappy because when they see all the knowledge that has built up – when they open up any given textbook, they see wonderful astronomy discoveries that were sometimes made by Chinese scientists, but always overseas. And the Chinese Academy of Sciences was successful in proposing this major program to launch these upcoming 5 scientific satellites. It's a pretty big-budget item. You're talking about $550 million for these missions. It's really the first time that the central government has acknowledged that the space program is more than simply technology. So they're really going to try to make a difference, in terms of acquiring basic fundamental space knowledge now.

Interviewer – Sarah Crespi
But there is a blurring of the lines between the military and civilian programs there. How does that affect their international collaboration?

Interviewee – Richard Stone
Yes, that is a long-time concern, because space is essentially 95% dual-use. Any particular technology, any particular feat which can be performed in space can be put to both civilian and perhaps military uses. In other countries, for example, in Europe and in the United States, they've established civilian space research agencies. They have tried to differentiate between peaceful space activities and activities in space which are more for defense purposes. So the fact that China has not really differentiated its space program has made it difficult for other countries to easily cooperate. But there are efforts

to try to close this gap. The Chinese Academy of Sciences through its National Space Science Center is having discussions with the U.S. National Academy of Sciences about trying to create a forum for space researchers from both countries who are engaged in purely civilian research to find a way that they can meet and talk. There's not going to be an easy way to get around the challenge of cooperating, for example, on scientific payloads because there's a lot of technology transfer issues, and there are these sanctions, and it makes it very difficult for the scientists to work together on hands-on projects.

Interviewer – Sarah Crespi
It seems like China's really fighting through. How does it compare to, you know, what the U.S. space program's going to look like in the next decade?

Interviewee – Richard Stone
You really have to give a lot of credit to the Chinese space program, because despite the sanctions, despite the fact that basically they have to reinvent a lot of technology, they are now counted among the elite of spacefaring nations. They're not maybe not at the same level in terms of the technology that the U.S. uses right now, but the fact is they can carry out crewed missions. And you just saw with the docking mission that they can carry out the basic functions necessary to have a sustained human presence in space. I think that even though they may lag a bit in some of the space technology, I think they have drive. They have a lot of big plans. They are going to be going to the moon with a lunar rover in the next few years. They are going to bring samples back to Earth. And they're even contemplating a human landing – a moon landing. There's a lot of debate in China about, you know, what would be the aim. But they have also talked about the possibility of having a moon base after 2035. They're thinking big, and they have the financial resources to take on this high-profile kind of space mission. And the question is whether they really will want to do this purely by themselves, or whether they are going to seek out more cooperation. The scientists here do talk a lot about the fact that they want to cooperate. And the question is at what point will the United States and Europe feel that the sanctions are inhibiting what could be a very fruitful cooperation to real ambitious space exploration at a cost which could be shared?

Interviewer – Sarah Crespi
Well, Richard Stone, thanks so much for talking with me.

Interviewee – Richard Stone
Pleasure, Sarah.

Host – Edward Hurme
Richard Stone is the Asia News Editor for *Science*. He writes about China's big plans for outer space in a News Focus this week.

Music

[29:21]
Interviewer – Kerry Klein

Finally today, I'm here with online news editor David Grimm, who's here to give us a rundown of some of the recent stories from our daily news site. So Dave, in our first story, we're talking about dolphin brains.

Interviewee – David Grimm
Right. Well, Kerry, dolphins actually have the second biggest brains on the planet, at least compared to their body size. They're right below us and right above chimpanzees. And for a long time scientists have wondered how did they get such big brains? What sort of happened evolutionary-wise to give them such a large noggins?

Interviewer – Kerry Klein
So how do we begin to answer that question?

Interviewee – David Grimm
Well, what the researchers did here is they actually took a genetic approach. And about 50 million years ago, the ancestor of all cetaceans – this is a group that includes dolphins and whales – began to transition from life on land to life in the water. And some of the dolphins' closest relatives at this time were groups that also include today's cows and horses, actually. And what happened when the dolphin – the ancestors of dolphins – went back into the water, they had to evolve some pretty radical adaptations. They had to lose their limbs, they had to develop fins, and they obviously had to gain the ability to hold their breath for long periods of time. And also what researchers think happened is their brains got about three times bigger. And so to figure out sort of how this happened, the researchers in this study did some genetic analysis. They looked at the dolphin genome. They compared it to the genome of the cow and the horse, and also of the dog to see, you know, these creatures with smaller brains, are there mutations that might explain why dolphins have evolved much larger brains than these other animals? And what they found was they found about 200 so mutations that seemed to have sort of swept through the dolphin genome. And the researchers were able to determine that these mutations seemed to have been advantageous. There were a number of things these genetic mutations seemed to be doing. A few of them were associated with proteins in the nervous system that helped transport sugars across the blood-brain barrier – obviously something that would be important if your brain is getting bigger. Also a protein known as microcephalin, which partly governs brain and head size. They also found changes in genes that allow neurons to form and break connections more easily, which is crucial for learning and other high cognitive functioning. So you're really seeing a lot of genetic evidence to show that there was a lot of sort of what scientists call positive selection for genes that control not only brain size but brain function.

Interviewer – Kerry Klein
And the idea is that these were necessary changes because of the changes in environment that dolphins were moving into.

Interviewee – David Grimm
Exactly. Exactly. The mystery still is why did dolphins have to evolve such big brains? You know, obviously they had to develop fins, they had to hold their breath. That seems

obvious if you're going to go into the water. But why do you need such a big brain? And that's still something that's really debated in the dolphin community. But now, at least, we have a better sense of how the brains got so big in the first place.

Interviewer – Kerry Klein
So does this tell us anything at all about our own big brains?

Interviewee – David Grimm
Well, that's a great question. In fact, actually one of the mutations that the researchers saw in dolphins is in this gene called microcephalin – which I just mentioned, which governs head and brain size – and that's a mutation that's also been seen in humans. So it's possible that the same sort of genetic mechanisms that led to large brains in dolphins also led to large brains in us.

Interviewer – Kerry Klein
Very interesting. And speaking of human brains, we move into this is your brain on stress.

Interviewee – David Grimm
Right. Well, I guess one of the problems with having big brains is that we're sort of stressed out all the time. And one big question in neuroscience is, "Is there a link between stress and mood disorders?" And when we say mood disorders, we mean things like depression, anxiety, bipolar, things like that. There's been some tentative clues that this is the case. Post-mortem studies and brain scans revealed that mood disorders can shrink and atrophy parts of the brain. People with mood disorders are also known to have low levels of a growth factor called BDNF, which keeps neurons healthy. And finally, people with mood disorders tend to have low activity in a gene called neuritin, which coats for a protein that has the same name that seems to be involved in our ability to respond to new experiences. And, as you can imagine, that could be something that's associated with stress. But, you know, we're still a bit unclear about, you know, what exactly is the link between stress and mood disorders.

Interviewer – Kerry Klein
Right. And we do know a lot about the effects of stress on the immune system and the rest of our physiology. So what new sort of methods did researchers bring in here?

Interviewee – David Grimm
Well, what they did here is they sort of made rats depressed. They basically deprived them of food and play; they isolated them; they switched around their day-night cycles; just really made these guys pretty depressed. And the way you know a rat's depressed is they don't move around a lot. And when you place them in a tub of water, normally a rat is going to try to swim and get out and save itself, but rats that are depressed just kind of sit there. It's kind of depressing just to think about actually. And so they got these rats all good and depressed, and then they were able to show that the depressed rats were showing low levels of this neuritin gene activity. When they treated the rats with antidepressant, the levels of neuritin went up. The activity of the gene also went up. So

that suggested that there was a link between this protein that seems to be involved in, you know, stress and new experiences with mood disorder, at least in these rodents.

Interviewer – Kerry Klein
So is there a possibility here for a new kind of pharmaceutical involving this?

Interviewee – David Grimm
Well, that's really the key here. It turns out that only about 30% of people with mood disorders achieve full remission on the antidepressants that are out there right now. So doctors are really desperate for another kind of antidepressant. And what the researchers found is when they actually increased the neuritin activity in these rats, they behaved almost exactly the same as if they had been given an antidepressant. So that is really potentially promising for trials with humans. It could suggest a whole new way to treat depression and other mood disorders, as well as, you know, reinforcing this link that there seems to be a connection between mood disorders and stress.

Interviewer – Kerry Klein
Great. And in our third story today, we have a change of pace to a mysterious phenomenon called fairy circles.

Interviewee – David Grimm
Fairy circles, right. Fairy circles, Kerry, are these bare patches of soil. They're about 2 to 12 meters in diameter, and they freckle grasslands everywhere from Southern Angola to Northern South Africa. And you can actually see a picture of what these things look like on the site. It sort of looks like you've got this field of grass, and you've got all these sort of bald pockmarks in it. And it's a really strange formation, and it's a really mysterious formation. For decades, scientists have tried to figure out what causes these things. The locals attribute them to footprints of the gods and other supernatural phenomena, which is why they're sometimes called fairy circles. This new study centers on a researcher named Walter Tschinkel who decided to visit Namibia in 2005 on vacation and saw fairy circles for the first time. And he's a biologist by training and was really just sort of taken with the whole mystery, and decided that he was going to be the guy that for once and for all tried to solve what exactly these things are.

Interviewer – Kerry Klein
And so what were some of his initial explanations?

Interviewee – David Grimm
So initially, he thought that maybe it was termites causing the fairy circles. Perhaps these insects were sort of burrowing under the grassland, and then they were killing grass from underneath, and this was causing these circular formations. Termites also are known to give off gases and vapors, which he thought might be poisoning the vegetation. But when him and his wife came back to Namibia a couple years later and did some digging around the fairy circles, they didn't see any evidence of termites. They also wondered, well maybe it's sort of a nutrient thing. Maybe these soils are missing zinc or some other essential nutrients. But when they did analysis for that, they didn't see any real

difference between the type of soil that was in the fairy circles versus the type of soil that wasn't. So it really remained a big mystery for him.

Interviewer – Kerry Klein
Well, we've got a story about him, so he must have brought in some new technique at some point along in the process.

Interviewee – David Grimm
Well, so he went much more high-tech in this new study. He actually looked at satellite images that were collected over four years. And these were photos that were taken over a lot of the regions that have these fairy circles. And then he did some statistical analysis to sort of extrapolate for far more than four years. And what he found, which was really fascinating, is that these fairy circles seem to be alive, or at least they're very dynamic. They appear and disappear at somewhat regular intervals. He calculated that the smaller circles seemed like they arise and vanish every 24 years, while the larger fairy circles can last up to 75 years before vanishing. And so he said, you know, these circles have about an average lifespan of 41 years. He confirmed this by doing some further analysis at some of the national parks. It turns out people can actually buy fairy circles – sort of like how you buy a star, you can sort of have a fairy circle in your name.

Interviewer – Kerry Klein
Or a piece of a highway.

Interviewee – David Grimm
Exactly. And so what happens is when people buy a fairy circle, the park sort of takes photographs and records it for the people. And so Tschinkel, you know, took this data and he combined with the satellite data. And when he combined all this data together, he sort of surmises that these fairy circles have an average lifespan of about 30 to 60 years. So they appear, they last for a few decades, and then they disappear.

Interviewer – Kerry Klein
So do we yet understand what is actually causing this?

Interviewee – David Grimm
No. I wish I could tell you that Tschinkel had actually solved the mystery of the fairy circles, but he's maybe about halfway there. At least he's showing something about these fairy circles that we never knew before, that they're dynamic. And that could lend some clues into what is actually causing them in the first place. And he is still on the hunt. He says he's still going to dedicate his time to figuring out what caused these things. And so maybe in a few years, we'll have some sort of update.

Interviewer – Kerry Klein
Great. So what else have we had on the site this week?

Interviewee – David Grimm

Well, Kerry, we've got a *Science*NOW about the diet of one of our very early ancestors, and how it may have eaten a lot more like a giraffe than we do. Also, a story about why supermarket tomatoes taste like cardboard. Also, for *Science*Insider, we've got a story about how climate change science is faring in the U.S. courts. Also, a story about a very controversial video that was released last week by the European Commission ostensibly aimed at getting girls interested in science. It's sparked a lot of outrage on the web, and you can check out the video and our analysis of it on the site. And, finally, for *Science*Live, this week's *Science*Live is about PhDs in the workforce. Are we training too many scientists? And next week's *Science*Live is about ethics in research. What's behind a rise in retractions and other unethical behavior in the scientific laboratory? So be sure to check out all these stories on the site.

Interviewer – Kerry Klein
Great. Thanks, Dave.

Interviewee – David Grimm
Thanks, Kerry.

Interviewer – Kerry Klein
David Grimm is the online news editor of *Science*. You can check out all of our news at news.sciencemag.org, including daily stories from *Science*NOW, and science policy from *Science*Insider. While you're there, be sure to check out *Science*Live, a live chat on the hottest science topics every Thursday at 3 p.m. U.S. Eastern time.

Music

Host – Edward Hurme
And that concludes the June 29th, 2012, 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 – Edward Hurme
The show is a production of *Science* Magazine. Jeffrey Cook composed the music. I'm Edward Hurme.

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

Music ends