To get us started with a little bit about your background.

Jeff Lowenfels: I grew up in New York in a very ritzy community, but I grew up on a farm situation in a sense; my father was a gentleman farmer, which means he would come home from work every day and put on his old shoes and go out and garden. And so we grew a lot of our own food and we were very, very into gardening. We had a gigantic orchard, acres of vegetables, etcetera etcetera, and, you know, one of these families where the water had to be boiling before the corn was picked, that kind of stuff.

And my father was very organic except for one thing: he used MiracleGro! And the reason why he used MiracleGro is because his company employed a young man right out of his grad school in advertising, and this young man had to take care of the business of advertising butter, which is what my father sold. And the young man hated the job so much that he ended up, long story very, very short, founding MiracleGro! And so my father and MiracleGro had a very tight connection. MiracleGro, as you know, has gone on to be Scott's MiracleGro, and they are a gigantic chemical company, and my father was a big user and I was a big user! And I used to argue with fellow gardeners about the use of chemicals. And, my argument was that it didn't make a difference to the plant whether the nitrogen came from a brown manure or a green powder! It was nitrogen, and so it didn't make a bit of difference, and if anybody could explain to me why it made a big difference, you know I would stop using MiracleGro and I'd become a gigantic organic farmer.

And I had this argument every year and nobody would be able to solve the argument to my satisfaction, until one day about 1996, a friend of mine sent me a picture of, an electron microscope picture of a nematode being strangled by a fungal hyphae that was literally protecting a tomato root from nematode attacks. It blew my mind. I had no idea what I was looking at; I finally figured it out using the internet, and then I noticed some words called 'the soil food web', and I couldn't figure out what that meant, and I dug through the internet again--this is back in 1996--and I found Dr. Elaine Ingham's diagrams of the soil food web and it had all of these diagrams of the relationships and words and terms that as a twenty, twenty-five year garden writer, I should have known about and I didn't!

And so I spent a tremendous amount of time studying the soil food web trying to figure out what my friend was trying to tell me, and it became quickly very evident why it makes a difference between organic and chemical. **(5:00)** And, that led to a series of philosophical changes, it led to--and I'm a garden writer as you may know, I write a garden column in the Anchorage Daily News--and it caused me to change my column attitude and the way I practiced the hobby of gardening. And eventually it led to serious discussions among fellow garden writers about the soil food web, our lack of knowledge about the soil food web, real soul-searching, and then a book! And so here we are today talking about the soil food web as a result of a bet that somebody couldn't show me that nitrogen did make a difference if it came from a brown manure versus a green powder.

Is that a bet that you're kind of happy that you lost?

JL: Absolutely. I mean, it's just incredible. And, just, you know, obviously I think your listeners understand, but, if you use chemicals you end up destroying the soil food web, we'll be talking I'm sure about what that is, but, organics, that support the soil, that's the ultimate answer at the end of the show, it'll be the take-home message; that was the ultimate discovery. The soil food web itself of course is something that anybody who practices permaculture gardening needs to understand. Because if you don't understand the soil food web, then you don't understand what's supposed to be happening in the soil between plants, the soil, and the community that's in the soil.

And from reading your book, one of the things that stood out to me is how much of the soil food web and the life that's there exists on the microscopic level; that it's things that we don't see. It's one thing to go out into the garden and see that you have a mole or a vole digging around or perhaps you see some insects on the surface and spiders but like when you talk about bacteria and fungi, in most cases we never see any result of that except for maybe every once in a while you see a mushroom, not realizing that that's the fruiting body of the actual fungus in the soil.

JL: Right. It's just, the numbers are staggering. So for the bacteria, and we have to add that it's not just bacteria it turns out that in, oh, gee, in 1976 or 1978, somebody was fooling around with the bacteria and noticed that the kind of bacteria that they were fooling around with had a different kind of cell wall than the regular bacteria and discovered a new form of life, well it was actually an ancient form of life, the third branch of life, plants, bacteria, and archaea; A-R-C-H-A-E...oh, I can't spell it, but anyway, they look just like bacteria but they're *completely* different. They have different cellular structure, they are different organisms, but in any case, in a teaspoon of soil, there are, oh, anywhere from some six hundred million, billion bacteria and archaea, some people would say a trillion, but let's stop at a billion. It's unbelievable! The numbers are phenomenal. That's in a teaspoon of soil. And fungi, there are fourteen *feet* of invisible fungal hyphae in a teaspoon of good soil.

And these things are there for real reasons in terms of our activities. And it all starts with the plants, which is the most amazing--and I think you and I probably take home and ponder about more than anything else--you know plants, 'cause they don't move, the have to deal with an incredible range of activities. It seems to us plants are an inferior, lesser organism. But what we don't understand--most of us--is how they operate and what's really going on. And this is an amazing thing.

So, to go into that real quick, what happens is, plants in photosynthesis produce energy. And about fifty to seventy percent of the energy doesn't go into making the tomato, or the leaves, or the flowers, it goes into making things that drip out of the roots called exudates. And exudates are designed specifically by the plants, specific bacteria, and specific fungi. And they live in the rhizosphere, the area right next to the roots, eating these exudates. And they in turn attract protozoa, things we studied

in high school, amoebas and parameciums, and nematodes--which are true worms, but hair-size or smaller, microscopic--and *these* eat the bacteria and the fungi, and they eat them for carbon, and some of the other stuff, but basically the carbon, and they excrete the excess. The excess contains nitrogen in plant-usable form. The plant takes that nitrogen up, it has these little, this little factory system going up right in its rhizosphere *because* it puts these exudates out in the soil. And, if it wants a different mix of bacteria and fungi, it changes the exudates. It can bring in different kinds of bacteria and fungi. Absolutely spectacular.

So the plant is in control of the system, and the bacteria and fungi attract the protozoa and the nematodes, and the protozoa and the nematodes attract worms and micro arthropods, and all sorts of things, and all of these things are not only working ultimately to make this material nitrogen and goodies available to the plant, but they're also making structure in the soil so that the plant can live in the best possible environment. And it's a beautiful, beautiful system.

(10:00) **One of the things that stood out that I remembered just because of the way the analogy came across was the fact that the plant is the factory producing the exudates, but then your fungi and archaea and bacteria are the fertilizer bags, and then your nematodes and protozoa come in and they're your fertilizer spreaders.**

JL: Right, exactly. And it works just that way because that's how plants feed themselves. *They feed themselves.* And one other thing with these exudates: they attract very specific fungi called mycorrhizal fungi. And mycorrhizal fungi are one of these unbelievable things that exist in the world that most people have *absolutely* no idea about. And what's worse, most gardeners--up until at least four or five years ago--have *never* heard of! Mycorrhizal fungi are these very special fungi that, in return for these exudates, they go out and bring back to the plant all sorts of things, particularly phosphorus, which is tied up in the soil and very, very difficult for the plant to get on its own, and nitrogen, copper, all of the heavy, all of the metals, they bring...They're *unbelievable*! And water, they bring them all back to the plant in return for these exudates. And if they don't bring things back, they don't live! It's fascinating.

This system that's underground there, just *all* came together in the nineties. Combination of electron microscopy, soil science, chemistry, biology, cellular biology, and these all converged around the plant-soil-micro-organism relationship. And, in fact, I would venture to guess, some people would say this is where permaculture came from! You know, this is the *ultimate*, ultimate getting along, mixing of different systems and having them all work like finely tuned gears. 'Cause that's what happens in the soil. It's a beautiful, beautiful system. Everything that's in the soil plays a role in helping that plant grow. It's absolutely spectacular, absolutely spectacular. But I can go on forever.

And your book is a great place for anybody if they would like the, if you will, short version of all of this. And one way to sit down and take all of it in. I know

that the first time I ran across mycorrhizal fungi was only a couple of years ago through the work of Paul Stamets, but since then I've looked into the work of Dr. Elaine Ingham. You're probably the third or fourth person I've spoken to, she keeps coming up as someone to talk to about soil.

JL: Oh! Not just soil, but about microbiology in the soil is, well, I can say enough about her. She's a wonderful, wonderful scientist; as far as I'm concerned, she is the guru of the soil food web movement, and she's done a lot to teach the world, I'll tell ya, and *does* quite a bit of that. She's a [garbled] asset. What she's explained about the soil food web is such an eye opener. And again, we indicated, I think, before the mic went on, every [garbled] I read in science news that I learned from Elaine Ingham, ten years ago. It's absolutely fascinating, she's at the Rodale Institute now, she's the chief scientist, and she's going to do some phenomenal...If you ever have the opportunity to go hear her, you should! Because she suffers no fools, she is a *scientist*.

Well, I'm fortunate enough that I live not too far from Rodale, they're within driving distance of where I am in Pennsylvania. Hoping to go out and see her, but also if anyone else is interested, I'll include some links in the show notes to Dr. Elaine Ingham so you can look up her information with Rodale, she's constantly offering classes both at Rodale and elsewhere, at least in the United States, so people can get a chance to go see her.

JL: It's one of the things that has been operating, in the book I always indicate it in my column, I always indicate it--who ever put MiracleGro on the redwoods? Who had to ever sprayed them for ages? The system works by itself, what happens is, we come along. And we're part of the soil food web, too. Unfortunately, we're not beneficial as worms and, you know, even slugs. I mean, everything has this little role, even the birds that fly have a role in the soil food web. They touch the ground and then they deposit protozoa; they're taxicabs. We come along, and we figure, well, no, the plant's not in control, *we're* in control, we're growing the plants, and so we use chemicals. 'Cause we've been told that they're going to work better. They're going to grow things, we've seen the commercials, we've seen the ads. And sure, they work! They do a great job. But if you read the label on these chemicals, they say you've got to apply them every two or three weeks. The reason you've got to apply them every two or three weeks is because you've *killed off*--or you have destroyed in terms of moving them off--the soil food web that would normally feed the plant itself.

And it happens many, many different ways. Starting with just the nitrogen aspect alone. Nitrogen is the key element that plants require, and, they don't get it, they don't do well. We come along and we give them nitrogen with these chemical fertilizers, and they get it *too* easy, so they don't need nitrogen-fixing bacteria anymore. So they don't adjust the pH of the soil so the nitrogen-fixing bacteria will live there. And so there aren't any nitrogen-fixing bacteria there, and when you stop giving them nitrogen, uh-oh! The mycorrhizal fungi, if you give the plant phosphorus, and this is N-P-K, those three numbers on the fertilizer, if you give your

plant phosphorus over number ten or twelve at the *very* most, if you give it phosphorus, the mycorrhizal fungi aren't **(15:00)** needed, because there's enough phosphorus for the root to come into direct contact with in a short growing season or in an annual growing season, for example, and lo and behold, the mycorrhizal fungi disappear! Well if they're not there when they're needed, they're not there!

So it's a serious problem, we alter it. And then, we start to lose soil structure. Because all these things, worms for example, make tunnels, they make burrows. They pull in organic material. Micro arthropods--even those slugs I talked about--for every one you see an aboveground eating a leaf, there's five or six of them down below the ground, in the soil, breaking down dead material and making it more available for those bacteria and protozoa and the nematodes, and it, it...And we come along, and we put down a chemical that they don't like, worms don't like the smell of MiracleGro and they go away! If you don't have them, then you're not pulling organic material down. It--the *whole system* caves in when we step forward and try to override what has been developed over millions of years. It, it's just simply an incredible, incredible system.

You talk about feeding them fertilizer and having to apply it over and over again. Here in central Pennsylvania there's a farming newspaper, very popular on the east coast and they've done some reports in there that I've gotten to see that are about some of the farms that are doing research tests with organic versus chemical fertilizing. And one of the things they showed is just the root mass that's occurring with their plants when they're going organic versus feeding them chemical because the chemicals, as they wash away, the roots may follow them so far, but they're not really getting that deep, full penetration so they don't have as much access to water and then, as you were saying, these mycorrhizal fungi that are building the support structure with the plant can bring them all this nutrient and water and everything even as this root mass gets larger and larger. It gives them so much more area to pull from as opposed to these chemically fed plants with their small root structures and I think about the fact that drought is occurring because of the use of chemicals.

JL: Mycorrhizal fungi alone, in terms of what they do in terms of bringing in water to the plant, but they do something else. This root mass--first of all, the root mass itself contains tremendous amounts of carbon, and not all of that root mass is harvested--and so carbon is left in the soil. But more important, the mycorrhizal fungi produce thirty-three percent of the carbon in the soil. And if you've killed off that mycorrhizal fungi, forget the fact that your plant is now dependent on *you*, the following year, you don't have that thirty-three percent, you don't have the carbon growth that you get from the mycorrhizal fungi. They convert the energy from these exudates, from the sun, that ends up in these exudates, or ends up in stuff when they decay *and* they convert it into carbon. It's unbelievable. It's a serious, serious problem, and people had no idea it was going on because they never even *heard* of mycorrhizal fungi.

Now here's the shocking fact: even ninety-six percent of every single plant on the planet earth have this relationship. And until 1996, I know not one gardener who wrote columns, books, or magazines in the United States of America had *any idea* that mycorrhizal fungi existed. I asked 960 of them in a meeting and not one raised their hand, they'd never heard of a mycorrhizal fungi. *Ninety-six percent of the plants!* That's like, that's almost like not ever hearing of the fact that we acquire oxygen that we live on!

And so we came along unknowingly and destroyed that mycorrhizal fungi network. It forms a network under your system. If you have a yard, there is a mycorrhizal sub-waste system under there that is *unreal*. It's a Milky Way of invisible hyphae. If you take a rye grass, just a piece rye grass, that teaspoon of soil which would normally have fourteen feet of mycorrhizal fungi has *three miles* of mycorrhizal fungi in it. *A teaspoon of soil!* So, it makes a difference. And, we come along with chemicals and, sure, we can say, sure, yeah, we can feed the world with chemicals! But we destroy the soil and we run out of chemicals, as we're running out of phosphate, we are now almost at peak phosphorus, which means that we are in a fast decline. In our lifetimes, we're going to run out of phosphorus. That's a pretty scary thing when you consider that it's an essential element. Not only that, but it's the macro element. What are we going to do? It's a fascinating question.

All of this relates to the soil food web, of course, and we come along and have a tendency not to treat the soil well. We've got to learn how to deal with it, and we can't do that until we learn what it is. And thank goodness for people like Dr. Elaine for spreading the word, really. Because there's a lot of people who disagreed with the message.

Because it went in the face of what we now consider conventional agriculture, or were there other issues that she encountered?

JL: Well that was clearly the main one; I mean, my goodness, **(20:00)** anybody who works at a university is getting paid by a major chemical company that does work for the ag industry! You know, it's an incredible world we have out here! There is a great deal of opposition to organics, you constantly hear that organics can't feed the world, that there's no difference in nutrition [garbled] the amount of which I think is [garbled] which are true, it's disturbing to people. And there are, as we know, we know, there are multi-national billion trillion dollar companies that rely on a practice that does not support the soil food web.

I imagine the face of that, with a lot of the information that comes out of organic gardening and your work about spreading mulch, make sure that you use a good healthy compost you can make yourself on your own on-farm or in-home materials, I can see where there would be that resistance.

JL: Well, there is a lot of resistance to it. I mean, if you were a large fertilizer company and you wanted to sell fertilizer, then you don't want people making their own! [laughs] And that's an unfortunate thing. 'Cause really, there's plenty of room

for fertilizer. The largest fertilizer company in the country, Scott's MiracleGro, makes a chemical fertilizer, no question about it. And as I indicated, it works, there's no question about that either. But what people don't also realize is that they're also the largest purveyor of organic fertilizers in the country. So there's money to be made on both sides of the fence, and I just hope that we push them to the point where that's what they want to do, is make money selling *organic* fertilizers.

And really, anybody uses a chemical fertilizer has to ask themselves whether they want to work as hard as they are working, because that's what happens. The name of the book is *Teaming* with Microbes, T-E-A-M. And the reason why we are *teaming* with the microbes is because *they* do the work, *they* feed the plant. You're not fertilizing the plant, you're feeding the microbes, *they're* feeding the plant. They create the soil structure that the plant enjoys. They help the plant get water. You're *teaming* with these guys that do work while they take care of the plant and take care of themselves.

Again, as I indicate every time I get an opportunity, it is a *gorgeous* system that we really need to learn about so that we don't destroy it.

Going through the material that you present, combined with some of the other stuff out there, it's just that initial input to get everything working to do the research--the planning, if you will, the design of your garden--to know what's my soil like here, what's my soil like there, doing the census of the creatures that are living in the soil. Finding out what's a little acidic, what's a little alkaline. Bringing that all together, applying the rules that you have, and then making it easier year after year.

JL: Yeah. Again, it's so easy to do. There are three basic ways that you make soil. All of them require adding stuff to the soil. It's something called the Law of Return in agriculture. And basically what it says is that, if you take something off of the property that was going to supply nutrients to the plant, then you've got to supply the plant with those nutrients. I mean, that makes sense, doesn't it? And as gardeners, and as farmers, we harvest, we take stuff out of the garden. Out of, off the farm. And all that stuff would have normally rotted, would have fed the soil food web system, it would have returned back to the soil and gone back into the cycle and back to the plant! It's a very nice, beautiful system.

By nature, we need to eat, we need to take some of that, we need to break that Law of Return. Then we need to amend and go back and replace what we took off the land. And so we can do that by putting on mulches, you can do that by putting on compost, you can do that by putting on organics, or, I guess there's really five ways you can. You can also add the mycorrhizal fungi if they've been killed off. *And,* you can add compost tea, which we believe adds lots of microbiology to the soil. Of all five of those, the last one is the only real controversial one. Only really controversial because it's very hard to duplicate different soil conditions around, well, around the block, for that matter!

Compost tea was the one question that I was going to have for you because that's, as you say, that's the one that's controversial. One of the gardening websites that I like to read from time to time is the one from, it's Washington State University's Linda Chalker-Scott and her crew.

JL: Yeah, Dr. Linda Chalker-Scott and Dr. Jeff Gilliam?

Yes. And one of the articles that they have out there is on compost tea because I think there are only like eight actual studies that have ever been done on it. Some show that it does work, some show that it doesn't.

JL: Both of them are my friends. And we've discussed it, let's start it this way. Do I use compost tea? Absolutely. Does Harvard University use compost tea in its entire system? Absolutely. Does New York Botanical Garden use compost tea? Absolutely. Does it work? Absolutely. Does Morton Arboretum use it? Absolutely. Did they do a study? Absolutely. Was it reviewed by Dr. Linda Ch...I don't think so. You know, there were lots of studies. And I've seen many of them. I understand where Dr. Linda Chalker-Scott is coming from. There are darn few real, long-term studies on compost tea and this is one of the things that Dr. Elaine's doing down in Rodale. So, we see the studies and, you know, I ask people to go look at the Martin Arboretum study, I've seen several studies from out of the University of Hawaii **(25:00)**, I saw a beautiful study out of the University of Arizona. Absolutely spectacular study out of the University of Arizona. I don't know what they story is there. I don't. I use it. I'm a big believer and I urge people to do it.

I do agree with two things: if you're going to be using manure, you better be darn sure you know how to make compost tea. It's got to be aerated. Otherwise you run the risk of E. coli. I think that's very, very important. And I don't use manures when I make compost, frankly. I'm a little bit worried about whether there are antibiotics that don't break down in the compost pile. I worry about E. coli, frankly. So I don't use manures, it's very simple. The reason why people use manures in compost traditionally is because we had animals. Today, you know, other than the dog or cat, we really don't as a general rule. It's not something you *need* for compost. The second thing, of course this is a little bit controversial, although getting to be much less so as the mycorrhizal fungi, and I say that for this reason. The mycorrhizal fungi is ubiquitous. If you've not disturbed the soil food web system, the mycorrhizal fungi exists in your system. It's when you disturb it that you lose it. It's when you use compost--which doesn't have mycorrhizal fungi in it--to start your plants like we do here in Alaska, and move them out to be transplanted outdoors. We add the mycorrhizal fungi when we start the plant so that it immediately has it, rather than wait six to eight weeks before we get it outside for it to establish relationships with these fungi.

So, there was a period of time where people were saying, "No mycorrhizal fungi, you do not need to add them to anything." This has fallen by the wayside for sure. There are unbelievable studies on the use of mycorrhizal fungi in existing situations. Unreal differences. More nodules in soybeans, more nitrogen fixing. Just

phenomenal stuff. I urge the listener to just type in mycorrhizal fungi and just see what's out there. It is *incredible*.

I'll certainly include some links for folks to additional information and some places where they can go check out what the different varieties are. My local gardening center sells several different types. It's in their organic fertilizer section and it's very reasonable. It goes a pretty long way.

JL: I suggest to the listener that also to take a look at a special website. About ninety percent of the mycorrhizal fungi comes from one company and their website is www.mycorrhizae M-Y-C-O-R-R-H-A...euh. H-I-Z-A-E. Mycorrhizae.com. They have a *phenomenal* website. You type in the name of your plant, and it'll tell you the kind of mycorrhizal fungi that are associated.

While we're on the topic of mycorrhizal fungi. Did your book reference a story, was it Haiti, and trying to grow--

JL: Puerto Rico.

Puerto Rico.

JL: Yeah. I think it's in the book. Yeah, in Puerto Rico they couldn't, they started to grow and they would turn yellow after about the first year and then they would die off. After two or three years they'd be completely gone. Sometime in the 1950s, somebody brought down evergreens *in soil* that had the mycorrhizal fungi in it. And *those* particular evergreens lived and they were surprised, and now there's evergreens all over Puerto Rico.

We have a similar situation here in Alaska. We do not have maple trees here. We do not have maple trees here. About twenty-five years ago, Sears-Roebuck brought in about ten maple trees *in soil*. Most of the things that get shipped here, because we're far away, end up being soilless, 'cause it's lighter. And so they shipped this particular ten or so plants in soil, in pots. Those plants actually produced maples that are alive today, big ones, throwing off seedlings that will grow in that little area, and we discovered it's the mycorrhizal fungi who take a little bit of the soil when you pick up these transplants--Bingo! You get a maple tree.

You see the thing now is, we're bad! We are best beginning to have that debate because of the impact it might have not only on the soil food web, but on the aboveground web as well. The atmosphere food web, so to speak. So it's fascinating. But this, the mycorrhizal fungi, it makes a difference.

Your book is where that story came from. I read one today that was about clear-cutting in Oregon, I believe, it's the Douglas Fir. Even though they have saplings in place, they're finding out now that the mycorrhizal fungi that's required, it's usually processed because of the squirrels who wind up carrying that in their gut flora. And then as they live in the trees and, of course, poop it out on the soil and that spreads it around. And now as they've clear-cut and

the squirrels have moved out, they've disturbed the soil, destroyed the mycorrhizal fungi, and of course they don't know if they're going to be able to replant Douglas Firs on that ground.

JL: Yeah, the connection is phenomenal! And I think you'd get--well, it's just a very phenomenal thing that people need to be aware of. And intuitively we are, I think intellectually, we're not. And that was one of the things that I wasn't [garbled] book, it really caused me to sit down and think about some of these things in a way that we're not accustomed to. I had to really think in terms of scientific terms, and it was fun! **(30:00)** Really a lot of fun. So I hope people do read the book. I hope they get the sense of enthrallment and fascination in the system we know little teeny things about. We barely know how to identify things we see in the soil. You know, when we see a bird, many of us know exactly what that is. We're birders. We have binoculars. When we see things in the soil, either the tendency is to ignore it--flinch--or maybe just to go away.

And there's a wonderful book out by a guy named James Nardi, N-A-R-D-I. And I think it would be kind of fun--I've never met him, we've emailed together--and I'm certainly a big fan of his book called *Life in the Soil*. In a sense, it's an identification book; the things that you find when you're looking at the soil. And I would highly recommend people get that book as they start to pay attention to what's happening in the soils that they walk on and that they garden in and, you know, they're around. I think they'd be fascinated by it. It's fun to be able to give a name to things, and then to look them up and to know what they do and how they do it. Little pill bugs, for example. These are true crustaceans; they are throwbacks from the oceans. They *have* to circulate their urine inside their system, I mean right underneath their little shell, they circulate their urine to simulate that ocean environment. How many millions of, you know, hundreds of thousands of years since they were there? Wow. Unbelievable. To note, they eat little teeny bits of copper. They eat their own dung because it contains copper. They need copper in their system. So when you see them around your plants, they're getting that little micronutrient that they need, there's copper, around there. Just, the whole system fits.

Amazing, it's so stunning that it's right outside our door every day and we just don't know about it. The information that you provide breaks it down in a way that's very understandable, and that what we can do to support it is so simple. We just have to be aware of the fact that this is what we need to do.

JL: So simple. You're absolutely right. And, it's not hard work! That's the amazing thing. As a gardener, I used to love to rototill but it's a lot of work! A *lot* of work when you pick up *Teaming with Microbes*, one of the first things you learn is, ah, no rototilling. That's not good. Once you do it, that's the last time ever. You go, wow, I just saved myself a *lot* of work. One thing after another, just like that. I never weed anymore, I have mulch! It takes care of it, I don't have to weed. I haven't taken my hose out once this year, except in my greenhouse, where I have tomatoes. *Not once!* It's the first time *ever*! Things are just operating by themselves! Pat, my wife, says,

"Gee, why don't you go out in the garden!" [laughs] Sad to be [garbled]. That's what happens when you team with microbes.

It's *great* material. And I'm really happy that you've written this book, and even who recommended it to me, by Dr. Tallamy because I don't know when I would have found it. And the material is just, it's great. I really, really like everything you put there, it's an easy read, it's not like reading a textbook, though it is, as I've said before we started the interview, it is a little heavy at points if you're not familiar with the material and just because how big the soil food web really is, from bacteria and fungi and archaea all the way up.

JL: Well I think I did make a promise in there that I would repeat myself enough times so that by the time you put the book down, you wouldn't even have to go back and look stuff up. You'd just know it.

It's one of those things that comes from teaching is there's the idea of circular learning. If you keep coming back to something, I think it's something like six times, but I, sitting here now, even tough I just finished the book a couple of days ago, and all of the material makes sense because I can follow it the way it was laid out from the small to the large and your rules, it's now a part of my gardening consciousness.

JL: Well, that's great. That's what it was supposed to do. I appreciate that. You made my month!

Well I appreciate it and I'm certainly looking forward to the next book that you write on how we can team with the soil.

JL: I've already written it, it's at the publisher's, and *Teaming with Nutrients: The Organic Gardener's Guide to Plant Nutrition* will be out in May.

May of 2013.

JL: Right. We'll have another show if you like.

Well, I'll certainly put it on my calendar to keep an eye out for.

JL: Alright.

Thank you so much for everything that we covered today. Is there anything else that you'd like to add? We have the takeaway that we have to support the soil food web as the big lesson for the episode, but is there anything else you'd like to add to our interview?

JL: Well, you know, I think since you've mentioned Doug and since I know you're a permaculturist and, I just wrote a column in my daily news column and I think we're in a stage now where gardeners have to have discussions that you seem to be fostering about how we are doing things and how they relate to the soil food web. You know, Dr. Doug, his food web is above the soil level. Mine is below the soil level.

And I think together they present a picture that everybody has to take a look at. How are we impacting these two food webs? How are they being impacted by things that we as gardeners and people who love plants do? That's a take-home that we all have to be thinking about and discussing.

As we noted, gardeners are polite people who are intellectual and who seem to get along. So I think this is a discussion we need to have, **(35:00)** and we need to have a hard one about it in terms of invasives and what their impacts are on the wildlife. All of the permaculture stuff that we talk about, we are permaculturists, all of us. And everything we do impacts everything else. And so we have to discuss that amongst ourselves.

Well, as you continue to write your column and spread your word and do your part, I'll continue to do mine. And we'll get this information out there.

JL: I like it. I like it a lot.

Thank you.