Ask-a-Biologist Vol 042 (Guest: Vaughn Bryant)

Pollen - Nature's Tiny Clues

Pollen and sneezing go together like Spring and fresh flowers in bloom. And even though pollen gets a bad reputation, it is actually a powerful tool in crime scene investigation (CSI), as well as anthropology, underwater archeology, and oil and coal exploration. Dr. Biology gets a chance to visit with palynologist Vaughn Bryant to learn more about pollen including its sweet connection to honey.

Transcript

Dr. Biology: This is "Ask a Biologist," a program about the living world and I'm Dr. Biology. Let's test your skills of deduction. This is where I describe something and you try to figure out what it is.

So are you ready? Many of these things look like intricate microscopic sculptures, or maybe jewelry. In some cases I think like they could be tiny alien brains or maybe miniature puffer fish, the ones with the spines that pop out. And even though these are really small, they are amazingly strong. They can last a long, long time.

Have you figure out what I'm talking about? Could you use just a few more hints? All right. Here are a couple more. Many plants depend on them to reproduce. And for your last hint, people that suffer from summer allergies know their name and most likely dislike them because they make them sneeze, give them watery eyes and a runny nose.

Yep, I'm sure you know we're talking about pollen. And today I'm on the road visiting with Dr. Vaughn Bryant a professor of anthropology and the Director of the Palynology laboratory at Texas A&M University. Now we're going to learn about what palynology is in just a moment.

Professor Bryant is a botanist and an expert on pollen. He's also a detective. You know the type of person that helps solve mysteries like you read about or see on television, where a crime has been committed. And to find out who's responsible a person or a group of people look for clues. That's right. He's one of the CSI people that solves not only current crimes but he's also interested in mysteries that have happened over time.

He's actually an anthropologist which deals a lot with history. Welcome to the show, Professor Bryant.

Vaughn Bryant: Good to be here.

Dr. Biology: Let's start off with the very basics. First of all, what's palynology?

Vaughn: Well, palynology is the study of pollen and spores. It's a word that combines both. So rather than having to say pollen and spores, you can just say palynology.

Dr. Biology: All right and I'm assuming that this is something that comes from the Greek or the Latin. Right?

Vaughn: Almost everything does these days. [laughter] Yes, palynology comes from the Greek and what it really means is very small, dust like flower. It's essentially dust. So that's why they came up with the word.

Dr. Biology: All right. So this dust and this powder that's out there that's making us sneeze. There's got to be a little bit more to it. What is pollen actually if we were to put it under a microscope? What are we going to be seeing?

Vaughn: Well, pollen is really the sex cells plants use to get the male sperm from the male plant over to the female. This is to complete fertilization. Plants can't move around like animals. Animals can go find each other in order to reproduce but plants can't. So they have to rely on pollen to carry the sex cells from the male plant to the female plant.

And this is done sometimes by wind and sometimes by insects.

Dr. Biology: Oh, so they can travel two different ways. All right, is there a difference between the pollens that are traveling by wind and those that travel with the aid of say hitching a ride on an insect?

Vaughn: Yes, there is. The ones that have to rely on the wind have to be aerodynamic. In other words they have to be shaped so that they travel very easily without much wind resistance. They also are usually pretty small and they are usually not very ornamented.

Anything that sticks out of course creates wind resistance. So they usually are pretty blah in terms of how they look. But they are very effective in order to carry the pollen from one location to another.

Dr. Biology: Well, how far can these pollens that are spread by wind travel?

Vaughn: Most pollen that is dispersed from a plant travels about maybe 100 meters. That's about three football fields. That's where most of it is going to fall pretty close to the plant. But a small percentage and it depends again on the size of the pollen, the type of the plant, but sometimes pollen can travel, oh, miles and in some cases they have found that even a thousand or two thousand miles away from its source.

Dr. Biology: A thousand to two thousand miles. That's impressive. And all this with just a little tiny object that, as you said, they are very aerodynamic. So are they round? Are they cut maybe like some kind of a flying saucer?

Vaughn: they come in a number of different shapes. Some of them are round. Some of them are square actually. Some are triangular shaped. The pine and the spruce and the fir grains actually have two big air bladders. They look very much like Mickey Mouse ears. They are very effective for traveling on air currents because the air bladders are sort of like balloons. They help them travel.

Dr. Biology: Now, do all plants use pollen for their sex, so that they can reproduce?

Vaughn: Well, no. Only the flowering plants use pollen. And the flowering plants would include the ones that we call angiosperms and the ones that we call gymnosperms. Now, we don't usually think of pine trees as flowering plants but nevertheless they are flowering plants.

Now, the other kind of plants, such as mosses and ferns and algae and fungi produce spores. And spores are somewhat different than pollen. I don't want to get into the complexity, but spores in these other plants usually have an alternation of generations. Sometimes they produce sporophytes and gametophytes.

It's a lot more complex but the important thing to remember is that they do disperse these spores, which are traveled, carried anyway, by wind current, sometimes by water. And they reproduce into new plants.

Dr. Biology: Let's talk just a little bit about pollen anatomy. When I look at a pollen, if I were to actually cut it in two, is there an actual structure that's pretty common for all pollen?

Vaughn: well, yes. If you were to cut a pollen grain in two, what you would find is a multilayered outer wall, which we call the exine, which is just a word for the outer wall. And this wall consists of cellulose. It also consists of various kinds of proteins. But it also has a substance called sporopollenin which is a very durable type of organic material. In fact, it is one of the most durable organic materials produced in nature.

In fact, the oldest plant material in the world is about 2.5 billion, yes that's billion, years old. What they found back that early are these little tiny round things that look very much like fungal spores and guess what, they are made of sporopollenin.

So sporopollenin is a very durable substance. It is one of the components of the wall of a pollen grain. Now, in addition to the wall of course what you are going to find inside the pollen grain are going to be what we call cytoplasm and in the cytoplasm is going to be various kinds of proteins and carbohydrates and fats.

But there are also going to be those important DNA components of the sex cells, the sperm. That's the important part that's going to complete fertilization.

Dr. Biology: You brought up DNA. A lot of people think of DNA today and they think of criminal cases and the crime scene investigation. Can you tell us how and why pollen is used in crime scene investigation?

Vaughn: Yes. It's actually one of the very components. Now, you have to remember that a lot of pollen is being dispersed by the wind. And in fact, some of these plants are producing literally millions and millions of pollen grains. So, these millions and millions of pollen grains get dispersed by the wind and they get carried around.

Some of them reach their intended destination and complete fertilization. But the vast majority, 99.9% fall harmlessly to the ground. Now, where these fall, of course, are going to depend on what kind of plants are growing there.

And so when you get different kinds of plants growing in a region, they are going to produce different kinds of pollen and so what you are going to recover from a sample at a particular location is going to be different at one location than it is another.

We call these "pollen prints." Very much like finger prints. And so, the pollen print of Chicago is going to be different than Los Angeles or New York or Atlanta or you name it. Every place has a unique composition of pollen because the plants grown in each area are going to be somewhat different.

So, that's one of the important things that we use for forensics in order to identify where the location of these things are.

Dr. Biology: Right. Right. So every location has a unique place, therefore, it's easier for you to find out if, for example, a body that's located was actually dumped there from some other place?

Vaughn: Well, yeah. Actually there is a very important case that was solved oh maybe about five or six years ago. This occurred in Hungary. And what happened was they were building a new building in downtown and they accidentally uncovered a mass grave with about 40 or 50 people in it. They were all males and they had all been shot in the back of the head.

This indicated that they had been executed. Now, the question was: who killed these people? The age of the deposits were right around the end of the Second World War, back in about 1945. So the question was were these prisoners that were executed by the Germans or were they executed by the Russians who then captured that area as they were moving across into Germany?

Well, turned out that the key to the whole thing was the palynologist. What they did was very carefully collected the dirt inside the nasal passages of a number of these skeletons and they found that the pollen was from plants that pollinated in the middle to late summer.

Well, by the middle to late summer that whole area was under the Russian occupation. It wasn't by the Germans. The Germans had already left. So, essentially what pollen confirmed then was that the Russians had executed these prisoners, not the Germans. So the Russians get blamed and not the Germans.

That's a good case of how pollen can be used in a real important forensic case.

Dr. Biology: Excellent, excellent. Because you do this, do you testify in the courtroom cases?

Sometimes you do have to go and testify. One of the most important things to remember if you have to testify is two things. First of all to be calm, to be truthful and to be able to not get flustered by the questions that some people are going to ask you. The object in some cases is to try to destroy your credibility.

So you have to be very careful what you say and how you say it. You can't lose your cool. You just have to tell the truth and stick to the subject.

Dr. Biology: I've actually seen a picture of you out in the field collecting pollen samples. You're wearing what a lot of people have seen, what we call "bunny suits" in the technology trade, because you are covered from head to toe with this special suit. You have a mask on and a hat. What's that all about?

Vaughn: Well, if you've ever watch something on TV where they make chips for computers or sometimes in surgery in places like that, the individuals that are doing these tasks have to be absolutely sure that they are not spreading around any germs.

Well, in my case, I have to be absolutely certain that I'm not accidentally spreading around pollen. Now, the reason we have to get dressed up in these sterile white suits and wear face masks and all of these things and surgical gloves is because if we go into court and somebody were to ask us: well, isn't it possible that some of the pollen you recovered at the crime scene fell off your clothing?

We all know that clothing is full of pollen. So yes, it actually could. So if I'm wearing this outfit, I can say: no, I took very special precautions to make sure that this did not happen.

Dr. Biology: Now, you talked about we all have pollen on our clothing. I assume we have pollen in our hair and we might even have pollen in our lungs. How much pollen is found in the air?

Vaughn: You would be surprised. In the average location, oh, I don't know, anywhere in the United States, particularly during the spring and summer and maybe early fall, you would expect to find anywhere from 10,000 to maybe as much as a 100,000 pollen grains per cubic meter of air.

A cubic meter is one meter in each direction, one cubic meter. The average person during the day would breathe about seven to ten cubic meters of air. Let's just say that there were 100,000 pollen grains per cubic meter and your breathe 10 cubic meters, why you are breathing a million pollen grains.

That's why some people have these terrible cases of allergy and they suffer horribly with runny noses and eyes and all of this stuff.

Dr. Biology: Yes and I am one of those people who during the summertime I have what's called hay fever. I've always wondered why is it called "hay fever?" Is it really the pollen from the hay that is causing the problem?

Vaughn: No, not really. The reason they call it "hay fever" is because people have suffered from hay fever for centuries. They generally find that it occurs most frequently during the haying season. In other words, when people would go out to cut the hay for the livestock.

You plant grasses in the spring. You generally can harvest the first harvest of hay somewhere around May or June, early part of summer, which is also the peak time when most plants are pollinating. So it's called "hay fever" because it is during the hay collecting season, not because of the pollen of the hay.

Dr. Biology: All right so the culprit is not the hay, it's the plants that are actually releasing their pollens at the same time of year. Well, that's good. It's good for hay, at least they get off the hook.

Let's shift gears just a little bit. Let's make this podcast, well, just a little bit more sweet, so to speak. You also do some research with honey. And I was very intrigued by this because I love honey and I probably have honey every other day. But I didn't really think about the fact that I'm not only taking in a lot of honey, I'm taking in a lot of pollen.

Vaughn: Yes, that's true. If you read the label on some honey you will find that they will say "do not feed this to young children under the age of one" or sometimes two. It is true that the pollen does have proteins inside of it. And it's those proteins that get released in your nose that creates the hay fever.

The proteins, your body thinks that it's some kind of a foreign bacteria and it sends a defense system. What we call T-cells. It's kind of like your lymph system. That's why you get watery noses. It's trying to flush out and wash out all of these, what they think are bacteria.

So what we find then is that this protein then is going to be in the pollen which is in the honey. So some people do in fact have to be very careful what kind of honey they eat. Now, where I get involved is that in the United States, we only produce about one to two thirds of the honey that we consume. We have to import a tremendous amount of honey to satisfy the needs of people in the United States.

Now, what happens is that people will pay different prices for different kinds of honey. Premium honey, such as sour wood or Tupelo, cactus, orange blossom, avocado, some of your exotic honeys, will cost a lot. And some of the cheaper honeys which are made just from clover and stuff like that are pretty cheap.

What happens is some of these importers import honey. They are paying very good prices for let's say, orange blossom, but what they are really getting is clover. A lot of times, they can't tell the difference but they don't want to feel like they are getting cheated. So they send me samples to find out what actually is in the honey.

I can tell you real quickly from looking at the pollen whether the honey was made from clover or whether it was made from orange blossoms or from avocado.

Dr. Biology: I see. OK. So you are basically keeping the suppliers honest so that the importers don't get taken. That means when I buy my honey and I want that exotic honey, I'm going to be getting the right kind of stuff.

Vaughn: Well, in some countries, yes. In the United States, no. The reason for that is because the USDA or the FDA, the Food and Drug Administration, does not require what we call "truth in labeling" for honey. If you pick up a bottle of honey and it says "Pure Honey" the only thing that that means is that it cannot have been watered down with water or sugar or anything else. It has to be pure honey.

But if you pick up a jar and it says "Pure Orange Blossom Honey" and you later find out that it is really clover honey, which is a lot cheaper, you can't sue anybody because there is no rule that says that you have to tell the truth.

If you were in the United Kingdom, or you were in Europe, the EU, the European Union has very strict rules. If you buy Orange Blossom honey in France or Belgium or England and it's not that, you can sue somebody. They demand that the correct label be put on honey.

Dr. Biology: We learned a little bit about your detective work, but how else do we use pollen in everyday life or in science?

One of the most important ways is in finding new resources for oil, gas and coal. Right now of course with the gasoline running almost four or over four dollars a gallon that becomes very important. The way they use pollen is that by looking at the pollen that they get from wells, they can tell how old the deposits are.

They can also tell what kind of organic material used to be there maybe thousands of years ago, millions of years in many cases. So yes, oil and gas separation are very important parts. They use palynologists to help them find these resources.

Dr. Biology: At the beginning of the show we talked about the fact that you are an expert in pollen. You are also in the anthropology department. How do those two combine? What's the link between them?

Vaughn: There's a very good link because have always needed to eat plants. Plants have always been a very important part of one's diet. Now, what we use pollen for in anthropology is a number of things.

First of all, of course, we are very much interested when people begin cultivate plants, like wheat, rye, barley and corn and potatoes. One of the nice things is that all of these plants produce pollen. So even though the plants aren't there, we can find the pollen grains in ancient deposits and date these deposits.

We know that agriculture began maybe 10-12,000 years ago in certain locations. Another thing that is very important in the way we use pollen is that we very often can tell how they used rooms in architectural structures, like the pueblos in the American southwest.

We can sample the floor surfaces of these pueblos.

We can tell you whether these were lived for living quarters, kitchens or where they stored their plant food, like corn, beans and squash and things like that.

Another thing that I'm particularly interested in is Texas A&M of course is one of the big centers in the world for the study of underwater archeology. A lot of times when they recover these sunken shipwrecks from hundreds, sometimes thousands, of years ago, we can recover material inside of various kinds of containers and down in the bilge and we can then look for the pollen and very often tell you where the ships came from, because the pollen from that port got settled on the ship.

We can tell you a lot about what the ship was carrying, the cargos, because the cargos very often had pollen in them. So even thought the cargos are gone, the pollen grains, because they are so durable, are still left behind.

So, those are just a few of the ways that we use pollen in archeology and anthropology.

Dr. Biology: So, I would have to say that pollen an amazing story teller, so to speak.

Vaughn: Oh, yes. It's very much like being a detective. It's just like CSI only we are doing it with archeology.

Dr. Biology: Marvelous. Now when you were talking about the proteins in the pollen that actually cause the allergic reaction and this is why you have to be careful about feeding honey to very young children. What I had always thought was, especially seeing these pictures of pollen, especially the ones that look like the puffer fish and have those exotic spines on them. I thought that was what was causing the watery eyes and the runny nose. So, I'm wrong.

Vaughn: Yes. It's actually the protein inside the pollen grain. Each pollen grain, of course, carries a lot of protein, because the protein makes up the DNA and the other important aspects that are needed for fertilization.

And so, what happens is when the pollen grain ruptures in your nose, it breaks open and the protein that is inside cytoplasm then comes out and gets absorbed into your system through your skin and through you nasal membranes. Then your body picks up this "strange" protein. It thinks that it is a bacteria and it immediately sends this defense system into overdrive. So the more pollen you take in, the more your defense system kicks in.

This is why you get stopped up. All that fluid collects in your nasal passages and stop everything up, because your body think that you are being invaded by a harmful bacteria.

Dr. Biology: Right. So we have this influx of histamines. That's why I go to the store and by anti-histamines?

Vaughn: That's true. That's exactly what you have to buy. And this is why Dristan and all these other things become so important. What it does is it tells your system, don't worry about this stuff, it's OK. [laughter]

Dr. Biology: Right. Well, on this show we always ask our guest scientists three questions. So let's start off. When did you first figure out that you were going to be a scientist? What was the spark?

Vaughn: Well, you know, I think, like a lot of people, when I first went off to college I didn't have any idea that I would be doing today what I thought of when I first went to collect. When I went to college to be hones the reason I went to college was I didn't want to go to work. [laughter] My father gave me a choice. He said, either you go to college or go to work.

I said, ah, I'll go to college. [laughter] But I first started majoring in journalism. I wanted to be a reporter because it seemed like an exotic thing to do. You go talk to important people. But then after a while I found that I really didn't like that too much.

So since I had lived in a lot of different places, I went into geography. I thought, gee, that ought to be easy. I've been to a lot of places in my life. I studies geography for quite a while. After I finished I wandered over into anthropology because I could draw maps and the anthropologists needed someone to draw maps. After all that's what geographers do.

Then I was studying anthropology and going along OK until one day somebody came in and said that they needed somebody to work with palynologists. I said, well does it pay anything? And they said yes, we'll hire you for a whole year if you want to help the palynologists.

I said: well, sure. I'll be happy to do that. And then when I left I had to go find a dictionary and look up the word, because I didn't have the foggiest idea what a palynologist was or did.

Dr. Biology: Well, that's actually what I had to do as well. I had to look up palynology because I didn't know what it was either.

OK, well you found your way. Sounds to me like you didn't really know you wanted to be a scientist, you just followed this curvy road and that's the way a lot of people go. It's not necessarily a straight line.

Vaughn: I think it's very important that for anyone to keep your options open and don't just automatically exclude something because you don't know what it is. You got to try it. If you don't like it you can try something else. You know, you have to be brave. You can't just live in a little closed world.

So, my advice to anybody would be follow your instincts and just try things out and if you try things out you may find something you really and enjoy doing.

Dr. Biology: Well, I know you enjoy doing this but guess what, I'm going to take it all away from you. You can't be a scientist. You're not going to be a palynologist. You're going to have to get away from anything that's like that. If you couldn't be a scientist, what would you be or what would you do?

Vaughn: Probably if I wasn't a scientist, I would be a farmer. And the reason I would be a farmer is because as a kid I used to live in Alaska. We had to do some farming and I learned to grow potatoes and cabbage and strawberries and stuff like that.

It was a lot of fun because I would plant things. I would see them come up and then we could harvest them. I thought that was great fun. But I'll tell you one thing, being a scientist is a lot easier than being a farmer because farmers work very, very hard. It's not that we don't work hard. Most farmers I know have to get up before dawn and they are still working long after dark. So I much prefer being a scientist.

Dr. Biology: Well, it's interesting that you had mentioned farming because I'd have to say that as an occupation or career, farmers really are scientists.

Vaughn: Well, yes. Quite honestly if you go way back in time and you look, you have to stop and think. How did people learn how to domesticate plants? How did they learn to grow wheat and cotton and corn and beans and all these things?

They were early people that were out there watching plants grow and they eventually decided that, well, maybe they could try to cultivate some of these. That's how farming got started.

And I think another thing that a lot of people may not recognize or remember unless you have studied well in biology. Our whole system of genetics, all we know about genetics and everything, started with a monk by the name of Mendel. Mendel lived in Czechoslovakia and the monastery as a hobby he grew peas, these little garden peas. He watched them grow and he noticed that they were different. He crossed them back and forth and eventually what Mendel brought into the whole study was mathematics.

So by bringing mathematics and then observing very closely how they grew, he worked out genetics. This is the beginning. Of course, later Watson and Crick found DNA and double helix and everything. But it all started with Mendel and that was because he was watching plants.

So, I think farmers are very aware of plants and how they grow and probably know more about plants than most people.

Dr. Biology: Yeah. So Mendel, just as a reminder. If you haven't done your Pundit squares, that's where you start blending this math and science or math and biology and you get your genetics.

All right. One more question. What advice would you have for someone who is either

young and they are thinking about a career in science or palynology, or maybe it is someone out there that wants to switch careers. What would you say?

Vaughn: Well, I lecture a lot of high school students who come to Texas A&M. They come here to look over the university. They are thinking about maybe coming here to go to college. My advice to all of them is to be aware of what is going on in the world.

It's going to be your generation that is going to save us. Our generation has really messed things up. And this whole system with climatic warming and all these things is going to be up to the next generation to change this.

So my advice to anybody would be to study, keep your eyes open and work hard. Give it a try. You can always say you don't want to do it later, but if you don't try it, you'll never know.

Dr. Biology: OK. Well, in that case we're going to say "Think Green" and think in a flexible manner. Professor Bryant, thank you again for sitting down and taking some time out to talk to us about pollen. We now know what palynology is and we know it has a lot of links to a lot of different areas in science.

Vaughn: It was a real pleasure working with you.

Dr. Biology: You've been listening to "Ask a Biologist" and my guest has been Dr. Vaughn Bryant, professor of anthropology and the director of the palynology laboratory at Texas A&M University.

The "Ask a Biologist" podcast is produced on the campus of Arizona State University. It's usually recorded in the Grassroots Studio, housed in the School of Life Sciences, which is an academic unit of the College of Liberal Arts and Sciences.

For today's program, we're on the campus of Texas A&M in College Station, Texas, where the Botanical Society of America, BioQUEST and Texas A&M are running a wonderful workshop for high school educators, as well as high school students. For two weeks, educators will be learning about new and innovative ways to teach science. The second week they are joined by high school students that are eager to learn about pollen and the science surrounding pollen.

You can tell there is a lot of that, just from the show. I'm planning on having some of the students do field reports for "Ask a Biologist." So make sure to look for their stories in a future episode. Remember, even though our program is not broadcast live, you can still send us your questions about biology using our companion website.

The address is http://askabiologist.asu.edu or you can just Google the words "Ask a Biologist." I'm Dr. Biology.