Video Transcript – Butterfly Adaptations – How They Come by Their Colors

Maggy Benson:	Welcome everyone. Thank you so much for joining us [00:00:30] here at the Smithsonian's National Museum of Natural History. I'm Maggy Benson. We're here at Smithsonian Science How? exploring butterflies. When was the last time you saw a butterfly and what did you do when you saw it? If you were like me, you probably got really close to take a look at them because they're so beautiful and interesting. A lot of that has to do with their colors. Today, we're going to be exploring butterfly coloration and how butterflies come by their colors. To help us do that, we have two special guests.
Maggy Benson:	[00:01:00] Our first special guest is Eric Wenzel, manager of the Butterfly Pavilion, who's going to help us understand the adaptations that butterfly colorations serve. Our second guest who will speak after Eric is Juan Pablo Hurtado Padilla, who will help us understand how butterflies produce their colors by taking a really close look at their wing structures with microscopy. Before we get started and we introduce Eric, I want to remind all of our viewers that you can submit questions [00:01:30] to us during our live shows today. We'll take as many questions as we can. We know that we have the Winthrop School with us. We see you Front Royal home school and we can't wait to take some of your questions. So, Eric, thank you so much for being here today with us exploring butterfly coloration. You have a totally awesome job. You work in the Butterfly Pavilion and get to see butterflies every day.
Eric Wenzel:	That's right. I've been working with butterflies here in the museum for about 10 years now. Insects have always been an interest of mine, so this is a match made in heaven [00:02:00] I guess.
Maggy Benson:	Help us understand the main function behind coloration. What function does color serve in both butterflies and animals?
Eric Wenzel:	You can think of it as an adaptation either to blend into your environment, or to stand out.
Maggy Benson:	So we have two things: blending in, camouflage; or standing out, showing off.
Eric Wenzel:	Mm-hmm (affirmative).
Maggy Benson:	You have a lot of wonderful examples here to walk us through that concept. Let's start with a butterfly that we're all familiar with. And Joseph, I see [00:02:30] he wants to know more about the Monarch. Let's start there.
Eric Wenzel:	Okay. I'm sure that many of our viewers today are familiar with the Monarch - it's a common resident of North America. It's known for having that very bold and orange black pattern. That actually serves as a warning to potential

predators that it would not be a good idea to eat them because they do indeed contain toxins.

Maggy Benson: What would happen if a predator ate it?

Eric Wenzel: Hopefully it would be able to throw it up first and if it didn't, it may actually develop heart problems. Because what [00:03:00] they do as a caterpillar, they eat the leaves of the milkweed plant. Those contain what are known as cardio toxins and they store those up in their body for the rest of their lives.

Maggy Benson: So this warning coloration, this is part of that family of colors that show off.

Eric Wenzel: Yes. They are definitely showing off. They have nothing to fear.

Maggy Benson: Now right next to it, we have a butterfly that's very closely colored and patterned, the Viceroy. Is that also [00:03:30] poisonous?

Eric Wenzel: Originally we thought that it wasn't. But now we know that it does contain its own type of toxin. What we have here is a case of two butterflies mimicking each other for dual protection.

Maggy Benson: So can a predator tell the difference between a Viceroy and a Monarch?

Eric Wenzel: Not reliably. As a matter of fact, it is somewhat difficult to tell the difference between the two.

Maggy Benson: I'm sure that you know how to tell the difference, being an expert in butterflies. I think it's a great opportunity to check in with our audience and see if they can spot the [00:04:00] difference between a Viceroy and a Monarch.

Eric Wenzel: That's right.

Maggy Benson: So viewers, here's an opportunity to participate in a live poll with us. Take a look at the picture that is coming up on your screen and tell us how many of these butterflies are Monarchs?

Speaker 3: This is a Monarch and this is a Viceroy. As you can see, one is smaller and one is larger. The Viceroy looks exactly [00:04:30] like our Monarch, but it is way smaller. And then this is our Monarch. Our other second physical difference is the hind wings, which are our two bottom wings on each butterfly. They look like similar patterns, but our Viceroy actually has a lateral line going straight through on both sides of the hind wing where our Monarch does not. Once it closes it's wings as well, if you guys can see, they (Viceroys) have a lateral line as well. So you can see it from the front and the backside.

Maggy Benson: [00:05:00] Here is the answer key. It looks like only one of these butterflies are Monarchs.

Eric Wenzel: And three Viceroys.

Maggy Benson: Can you show us on your specimens here, can you reiterate how to tell the difference?

Eric Wenzel: Absolutely. The key difference between the two is this lateral line on the hind wing of the Viceroy. Look for that. The Monarch does not have that and it never will. That is the key difference right there, that lateral line.

Maggy Benson: Very cool. We actually have another student question right now, but this one comes in by video, so let's have a look.

Eric Wenzel: Let's take a look.

Adam: [00:05:30] My name is Adam and I was wondering why the butterflies have different colors?

Eric Wenzel: There are a great number of reasons why they do. We just pointed out one here, to warn predators that they're toxic and they shouldn't be eaten. But they are also used for species identification and to blend in their environment and camouflage.

Maggy Benson: Now, is warning coloration something similar that is something that other animals in the animal kingdom [00:06:00] have?

Eric Wenzel: Yes. There are many examples in the animal kingdom of warning coloration and we're going to show you a few right here (in a series of pictures). That is a Yellow Jacket, a type of wasp. Poison Arrow Frog. A Salamander and a Millipede. The thing that all of these different animals have in common is they are brightly colored to warn potential predators that they are dangerous.

Maggy Benson: You showed us a wasp in that. That wasp is actually venomous. Can you -

Eric Wenzel: That is an important difference between the two. Some [00:06:30] people use the ... the terminology is the same - venomous versus poisonous. But a venomous animal like the wasp actively injects the poison into their victim whereas in the case of poisonous animals like the other three and our butterflies here, you have to eat them in order to have harm happen.

Maggy Benson: I want to bring us back to a different butterfly specimen that I saw when I was in the butterfly pavilion with you a couple weeks ago, which is the Blue Morpho. The Blue Morpho has this fabulous blue, iridescent color on the back of its wings as we can see a picture [00:07:00] of it right here. Now that bright blue color, is that warning coloration like we see in a Viceroy and our Monarch?

Eric Wenzel: Yes. This is about everybody's favorite when they visit the pavilion. They love to see the Blue Morpho butterfly. But something different is going on here. In the case of the Morpho, it spends most of its time when it rests with its wings tightly closed like this. That exposes the dark, dull brown coloration, which is a good camouflage if you happen to be in a tree. It's only when they detect a predator stalking [00:07:30] them will they flash that brilliant blue color.

Maggy Benson: Very cool. So if we look at this specimen again, it's almost like it's two different butterflies, but it is in fact the same. When those wings are closed, you have that dull brown and when they're open you have that bright blue color. So they're really doing both of the color adaptations that you mentioned.

Eric Wenzel: They are.

Maggy Benson: They're hiding and they're showing off.

Eric Wenzel: That's called flash coloration.

Maggy Benson: Ah. We actually have another video from one of our butterfly pavilion experts to help us see flash coloration in the butterfly [00:08:00] pavilion. Let's take a look.

Eric Wenzel: Sure.

Speaker 3: This is a Morpho butterfly and as you can see, when it's resting, it folds its wings up and you can see the pattern it uses to camouflage. And as you can see, there's some patterns that look like eye spots on it as well to scare off predators. As you can see when the wings are open, you can see that blue color. That may be used to scare off predators.

Maggy Benson: Very cool. [00:08:30] Before we get onto another specimen, another example, we have a student question and this one comes from the Winthrop School from Michael. Michael wants to know what's the difference between a moth and a butterfly?

Eric Wenzel: Well, it's actually the evolutionary relationship between the two. Moths came first and it was actually the butterflies that evolved from moths. The very first Lepidoptera, which is the name for the order of insects that both belong to, the moths definitely came first.

Maggy Benson: Very cool. Do you have another example that you brought to show us [00:09:00] the hiding adaptation, the camouflage?

Eric Wenzel: Yeah. I want to show you this butterfly here that takes a very different approach than the Morpho. It never tries to stand out. If you look at it closely, you'll see that it looks much like a dead leaf and as a matter of fact, it's called the Dead Leaf Butterfly.

Maggy Benson: If I saw that in a forest, I would definitely have to look twice to make sure that it was not a dead leaf. We have a fun poll for our viewers to participate in again.

We have a poll to test your ability to tell the difference between the Dead Leaf butterfly and [00:09:30] leaves. Take a look at the image on your screen and tell us how many of these are butterflies? Take a moment to think about it and put your response in the window that appears to the right of your video.

Maggy Benson: Eric and I are watching your results coming in and we're kind of split a little. We have answers all over the place, but the majority of our viewers, 56 percent of you think that there are four butterflies. So let's take a look at that answer key, and Eric help us understand which are-

Eric Wenzel: They would [00:10:00] be right then if they said there are four butterflies there. Only two of the examples are indeed dead leaves.

Maggy Benson: That is an incredible adaption. Now what is that adaptation called when a butterfly is mimicking something like a leaf instead of another butterfly?

Eric Wenzel: That's a special kind of mimicry known as mimesis, when a butterfly or other animal mimics something entirely different from itself.

Maggy Benson: Now Eric, you've shown us a lot of great examples, but this diversity of colors and patterns makes me wonder if [00:10:30] butterflies are able to recognize these colors and patterns themselves.

Eric Wenzel: Well, as a matter of fact they are. These butterflies right here, which are known as heliconias are long winged butterflies illustrate this point very well. It's a good study in species recognition as a matter of fact. You'll notice that all of these butterflies are approximately the same size and shape, but they differ greatly in the color patterns that are on their wings.

Maggy Benson: So why is it important that butterflies recognize each other?

Eric Wenzel: Well, you have to mate with a member [00:11:00] of your own species in order to successfully reproduce and this is one of the ways that these butterflies are able to do that. There are other adaptations they have that facilitate that as well through chemical pheromones that the female releases and attracts the male. But visual cues like the wing pattern play an important role in that.

Maggy Benson: Thank you for all of your awesome questions. Keep them coming. Eric is going to be back with us in about 10 minutes to answer more of your questions about butterflies and their life histories. But for now, we are going [00:11:30] to go to our next expert, Juan Pablo Hurtado Padilla, who is the microscopy educator here at the Smithsonian's National Museum of Natural History. We see some beautiful images, including a Blue Morpho there on your screen now. We're going to talk with Juan Pablo to learn a little bit about how butterflies are producing this color in the first place.

Maggy Benson: Thank you, Juan Pablo for being here today with us.

Juan Pablo Hurtado Padilla: Thank you for having me.

Maggy Benson: I want to remind our viewers to keep your questions [00:12:00] coming. We'll try to get to as many as we can. And Juan Pablo will actually take your questions in Spanish as well if you feel more comfortable submitting them that way. So, Juan Pablo, before we learn about how butterflies are producing some of these brilliant colors, it would be helpful for you to help us understand how color is produced in the first place, which is typically pigments.

Juan Pablo Hurtado Padilla: Absolutely, yes. Basically, most things in nature, animals, plants, even our daily lives have colors due to [00:12:30] pigments. So pigments are chemical compounds that are inside the animals or the things that we have. What those chemical compounds do is they absorb different wavelengths of light. As you know, light is composed by all colors. Every color has a specific wavelength. So this chemical can absorb different wavelengths. However, the ones that are not being absorbed, they reflect them.

Juan Pablo Hurtado Padilla: And that's how we get the perception of color.

Maggy Benson: So to look at my shirt, my shirt is absorbing [00:13:00] all wavelengths of color except orange, which is bouncing off of my shirt.

Juan Pablo Hurtado Padilla: There you go, yes.

Maggy Benson: Butterflies, do butterflies have pigments? Or is there something else at work here?

Juan Pablo Hurtado Padilla: Many, many species of butterflies, I will say the majority of them, they have pigments on their wings. However, there are a couple families of butterflies that they use color in a different way.

Maggy Benson: And you as a microscopy educator here at the museum, you take a really close look to figure this [00:13:30] out. So where do we start?

Juan Pablo Hurtado Padilla: All right. Back here we have two different microscopes. We have an electron microscope and a light microscope. First, we're going to take a look at this one so we have the beautiful Morpho in this light microscope, so we're going to get a little bit closer to it.

Maggy Benson: So this is the Blue Morpho that Eric helped us understand a little bit more about with the drab underside of the wing and the bright blue on the inside.

Juan Pablo Hurtado Padilla: Exactly right.

Maggy Benson: What level of magnification are you looking at its wing right [00:14:00] now?

Juan Pablo Hurtado Padilla: Right now, we are 15X.

Maggy Benson: So 15 times. And that's really, really beautiful. What are all of those structures?

Juan Pablo Hurtado Padilla: That's a very good question. Why don't we make it to our viewers?

Maggy Benson: I think that's an excellent idea. Viewers, we have another opportunity for you to participate in a live poll with us. Take a look at the butterfly wing under the microscope and tell us what is the texture on this Blue Morpho butterfly wing: is it tiny feathers? protective scales? insulating tiles? or colored beads? Take [00:14:30] a moment to look at it and put your answer in the window that appears to the right of your video screen.

Maggy Benson: Juan Pablo and I are looking at the results coming in live and 100 percent of our viewers say that they are scales. How did they do?

Juan Pablo Hurtado Padilla: They are 100 percent right.

Maggy Benson: These are tiny scales covering the butterfly [00:15:00] wings.

Juan Pablo Hurtado Padilla: Yes. For example, if you have ever touched a butterfly, you get this kind of dust on your fingers. That's actually the scales that you took off.

Maggy Benson: Butterflies are part of a group called Lepidoptera, which actually means scaled wings.

Juan Pablo Hurtado Padilla: There you are, yes.

Maggy Benson: All right. Is this light microscope giving you enough magnification to understand how the color is actually produced?

Juan Pablo Hurtado Padilla: Well no. Light microscopes, by physics, they have a specific limit. So if we want to [00:15:30] see a better image about the very small structure of the scales, we have to use a different microscope and that will be the scanning electron microscope. For example, the one that we have here.

Maggy Benson: So this one here, this is not a computer sitting next to us. This is a scanning electron microscope.

Juan Pablo Hurtado Padilla: Yes, you're right. It's confused by a computer, but it's actually a full-fledged, scanning electron microscope.

Maggy Benson: Wow. So you have a tabletop scanning electron microscope here, but you have another microscope here at the museum that you use to look even closer.

Juan Pablo Hurtado Padilla: [00:16:00] Definitely. So for example, this small one can reach 30,000 times. However, the big one that you are looking at right now, it can reach actually 1.5 million times magnification.

Maggy Benson: Wow. That's incredible. So let's start with this electron microscope. Tell us, you said that this one can reach 30,000 times magnification. How close is that?

Juan Pablo Hurtado Padilla: Yes, for example, let's take a look here. We have the microscope and I'm going to increase the magnification here.

Maggy Benson: So this again, the Blue Morpho butterfly wing.

Juan Pablo Hurtado Padilla: [00:16:30] It's exactly the same species of butterfly, so we're going to take a look at. . . .

Maggy Benson: Wow.

Juan Pablo Hurtado Padilla: . . . a higher magnification so you can see how we get closer and closer and closer and closer to a sample. If we reach around 15,000 times, I can just focus a little bit and then we can see the actual structure of those scales at that magnification.

Maggy Benson: Wow. That is simply incredible. So much detail is revealed when you're able to look at it 15,000 times [00:17:00] closer than if you were to look at it without any magnification.

Juan Pablo Hurtado Padilla: Yes. For example, we have SEM images at 15,000 times. It's very important to understand how small this scale is. If we take a look at this image we have, the magnification is also 15,000 times and you can see the scales out to the right, this one micron. So to have an idea how small a micron is, we can use human hair. So one human hair would be between 80 to 100 microns. [00:17:30] That means that this structure will be at least 80 to 100 times smaller than the weight of one human hair.

Maggy Benson: Wow. That's incredible. Now, if you were to look even closer, you said in that other setup with a scanning electron microscope, you can look at 1.5 million times. How close is that? Help us understand.

Juan Pablo Hurtado Padilla: Well in terms of resolution, we can raise the nanometer scale. For example, in this image we can see an image of 15,000 magnification. [00:18:00] And the scale right now is in nanometers, 500 nanometers.

So it's very important to understand how small this scale is. To understand that, I use this ball. This ball is very important for me. Let's imagine that you have one single nanometer. If you compare that nanometer to this ball, it will be like comparing this ball to the planet Earth.

Maggy Benson: Oh my goodness. That's hard to even wrap my head around. [00:18:30] That is incredible. This level of magnification is necessary to understand microstructures that may play a role in butterfly coloration?

Juan Pablo Hurtado Padilla: Yes, exactly right.

Maggy Benson: I know that you have a demonstration for us to help us understand a little bit more visually how these structures work.

Juan Pablo Hurtado Padilla: Sure. We have the butterfly here. Something that we can do is reveal the pigment color in this butterfly.

Maggy Benson: Before you do that, we [00:19:00] have another poll for our students, which seems a little bit like a trick question. Viewers, we have another poll for you to participate in before Juan Pablo does his demonstration. We want to ask you what color is the Blue Morpho Butterfly? It's the butterfly that is under magnification right now. Is it blue, brown, green or purple? While you're thinking about that, Juan Pablo, why don't you lead us through your demo?

Juan Pablo Hurtado Padilla: Of course. Here we can see the wing under [00:19:30] the light microscope. I'm going to put on drop of alcohol on top of it.

Maggy Benson: This is simple rubbing alcohol. Wow. Oh my goodness. So what was brilliantly blue and iridescent is now quite brown.

Juan Pablo Hurtado Padilla: Yes. What happens is the alcohol is coloring the structure on top of the scales. This structure is the one responsible for the color. So by covering them, we can get rid of the blue and only show the actual pigment colors inside the butterfly.

Maggy Benson: [00:20:00] We see our poll here again. What color is the Blue Morpho butterfly? Is it fair to say that the Blue Morpho butterfly is both brown and blue?

Juan Pablo Hurtado Padilla: I would say it is, yes. Even though we see it blue, it's due to a specific structure. But the pigments, once revealed, they show this brown color.

Maggy Benson: Now it's hard to look away at this microscope image because as this alcohol is drying, I can actually see the color, that blue color coming back. I was worried for a moment that it would stay brown. What's happening?

Juan Pablo Hurtado Padilla: You don't have to. Again, the [00:20:30] alcohol only covered the structure. However, the alcohol is very light, so it's going to evaporate very quickly and as it does, the structure is free again to intervene with the light and we can see the blue coming back.

Maggy Benson: As it's evaporating, I even see hints of green and this all has to do with the structure, not actually the pigment.

Juan Pablo Hurtado Padilla: That's right, yes.

Maggy Benson: Wow. That is really incredible. Are butterflies the only kinds of animals that have this kind of structural color or are there other animals that have it?

Juan Pablo Hurtado Padilla: [00:21:00] Actually, there are many animals that have this type of coloration. Even though it's not, uh, again it's not a very popular way to produce color. We have other examples. Like peacock feathers, dragonflies, blue jays and other butterflies.

Maggy Benson: There's a common theme there. They're all blue.

Juan Pablo Hurtado Padilla: Yes.

Maggy Benson: What's up with that?

Juan Pablo Hurtado Padilla: Well, it's very interesting because in nature there is actually only one species that can produce blue pigments. That's another butterfly. So every [00:21:30] blue that you see in nature from animals or plants, they're actually made by a structural color.

Maggy Benson: Wow. That's really incredible. So we have a student question right now, but it comes in by video.

Juan Pablo Hurtado Padilla: All right.

Maggy Benson: Let's have a look.

Juan Pablo Hurtado Padilla: Let's take a look.

Alexis.: Hi, I'm Alexis. I was wondering do different butterflies have different wing structures?

Juan Pablo Hurtado Padilla: Well, that's a very good question. We can tell, being in the same family, butterfly scales are relatively similar. However, once you see them

[00:22:00] in detail like in the scanning electron microscope, you can discover the differences. If we take a look for example at different butterfly that we have, the Esmerelda Green butterfly. So this butterfly lives in Asia and it produces color by structure. However, the structure is completely different from the Blue Morpho.

Juan Pablo Hurtado Padilla: If you see on the images, we have the same ridges. Those ridges led to this very different looking bowls of what we had before. And [00:22:30] those bowls are the ones that actually reflect blue on the sides and yellow at the center. So by mixing those two, we have green.

Maggy Benson: Now, that's so fascinating. If we take a step back to the Blue Morpho, can you help us understand? I know you have a couple images to help us understand how exactly this light is entering into the nanostructure of the scales to produce the blue.

Juan Pablo Hurtado Padilla: Absolutely, yes. If we get the image, we [00:23:00] can see how ... first, you have to remember that light is composed by all colors. Every color has a specific wavelength. So when something has been shined on, you are getting all the colors on top. However, the structure of the Blue Morpho butterfly is designed to reflect only blue light back. So if we see the actual SEM picture, you can see this, what we call Christmas tree structure where you see layers in the space between the layers. With a diagram of [00:23:30] that, we can see that the light coming in, some of the wavelengths are going to bounce from the top. Some of them are going to bounce from the bottom of the layer. However, only blue color can bounce on the same phase.

Juan Pablo Hurtado Padilla: If you see the right side as well is bounding on the same phase. So that means that the wavelength is getting added up. That means that the output has increased. However, every other color is bouncing out of phase, so that means that when they meet each other, they're going to cancel out.

Maggy Benson: So that's [00:24:00] how we get our blue color because those wavelengths are actually being amplified together to produce that brilliant blue.

Juan Pablo Hurtado Padilla: Exactly.

Maggy Benson: Now do you always get that iridescent color with structural color?

Juan Pablo Hurtado Padilla: Yes. Iridescent color is basically a property of structural color. Structural color depends on the angle of the light that's going into the sample so that's why every time that you see these iridescent samples, you can see different colors or different shines when you move that around. Sometimes that doesn't happen [00:24:30] with pigments.

Maggy Benson: All right. We're going to learn a little bit more about that in a moment, but we have a lot of questions, so we're going to try to get to a couple of them.

Juan Pablo Hurtado Padilla: All right.

Maggy Benson: This one comes from Gillian. She wants to know: how did the butterfly get its name?

Juan Pablo Hurtado Padilla: Wow.

Maggy Benson: The Blue Morpho butterfly.

Juan Pablo Hurtado Padilla: That's a very good question. Blue definitely to the color and Morpho is based on the family of this butterfly. So Morph is a family of butterflies and all these different species inside that family share this kind of structure.

Maggy Benson: [00:25:00] All right. This question, another butterfly question, but it's from Front Royal home school. Does the flash coloration blind the predator?

Juan Pablo Hurtado Padilla: All right, yes. So that's one of the objectives of this coloration. In the case of the Blue Morpho butterfly, this can confuse the predators and also it's a signal to other butterflies so they can find each other in the rain forest.

Maggy Benson: So Jacob asked - (our questions are coming in so quickly) - that can the butterfly change [00:25:30] it's color? So is the structure a little bit different? Can it be different on the same butterfly?

Juan Pablo Hurtado Padilla: That's a very good question. If we don't change the optical properties, if we don't change the structure, the color is always going to be the same. We can confuse that with sometimes it seems a little bit darker or lighter blue, but this is only a consequence of the angle of the light. Actually, the butterfly cannot change that color as it desires.

Maggy Benson: And J. Lasky wants to know: how big is each individual scale?

Juan Pablo Hurtado Padilla: [00:26:00] Oh, that's a very good question. If I'm not wrong, every individual scale is around 100 microns wide.

Maggy Benson: Wow.

Juan Pablo Hurtado Padilla: That will be one hair.

Maggy Benson: One hair.

Juan Pablo Hurtado Padilla: Yes.

Maggy Benson: Question from the Q?rius Lab, people who are watching here on site at the Smithsonian. Why is it important to study butterflies and insects?

Juan Pablo Hurtado Padilla: Oh, that's a very good question. By looking at this, for example, we find very interesting properties that we didn't know about before, like this structure, how it produces a color. That [00:26:30] can lead to many other discoveries and applications of this. Right now this butterfly is being used for many scientists and engineers to try to develop new materials for example.

Maggy Benson: And here at the Natural History Museum, you are collaborating with many scientists across the museum to help do microscopy work to understand different properties and structure. Isn't that right?

Juan Pablo Hurtado Padilla: Yes, that's right. With the powerful microscope that we have now, we have a lot of scientists that are trying to see new samples so we have 150 million different [00:27:00] specimens in the museum, so that's a lot of things that you can take a look at. So we're having a great time with that.

Maggy Benson: And even just looking at the Blue Morpho example that you shared with us and/ those images of the green butterfly, you can see how they're radically different even though they're both butterflies.

Juan Pablo Hurtado Padilla: Exactly. They look the same except for the color. They are butterflies, but once you get into the details, you can see the structure of these high magnifications. You can see the physics of the use, how the structures that they use are completely different.

Maggy Benson: Thank you so much for helping us [00:27:30] see the Blue Morpho up close and learn a little bit about its structural color. We're going to get to more of these student questions, but before we do, I want to ask Eric to come back to the set. Eric, again, if you're just joining us is our Butterfly Pavilion Manager here at the Smithsonian's National Museum of Natural History. Thank you Eric. Thank you Juan Pablo. It's been a pleasure learning a little bit more about butterfly coloration here with you today.

Eric Wenzel: Thanks for having us.

Juan Pablo Hurtado Padilla: Thank you.

Maggy Benson: I should mention to our viewers that Juan Pablo and Eric work here in the museum of Natural History so if you're [00:28:00] ever visiting us here, you will have to check out the Butterfly Pavilion where Eric works and Q?rius where Juan Pablo and scanning electron microscope activities are here for you to explore. And too, you can check out our Q?rius website at qrius.si.edu to get more resources about butterfly coloration. That is the same place where this program will be archived later this evening. That's it for our show today and for this school year, but Science How? will be back next school year. We will be starting off [00:28:30] the season on September 27 when we feature Kay Behrensmeyer, a Paleontologist who will talk to us about fossilization. We hope to see you then. For now, have a great summer and we'll see you next time on Smithsonian Science How?