Evolution in action: Observing a split in the butterfly family tree

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Scientists have found a population of tropical butterflies that may be on its way to splitting into two distinct species based on wing color and mate preference. Credit: Nicola Chamberlain, Harvard University

Larry Gilbert got hooked on observing butterflies when he was a just a kid.

"I found a chrysalis of a black swallowtail in a lot near our house. I raised it in a Coke bottle in the window, and have been interested in butterflies ever since," says Gilbert, a professor of integrative biology at the University of Texas.

In a rooftop greenhouse on the Austin campus, where he has worked since 1971, and as director of the 82-acre Brackenridge Field Lab just a few minutes away, Gilbert focuses much of his research on Heliconius butterflies.

From the southern United States south through Mexico, Central and South America, these tropical butterflies have a huge variety of color patterns. Their dazzling array of colors is primarily to warn predators that they taste bad, so local birds learn to avoid them.

"The color pattern is a complex of two forces, the anti-predator force, which is probably the predominant thing, but the details may involve the selection of the right mate," says Gilbert.

"Heliconius are not just beautiful, they are smart in the sense of having flexible behavior," continues Gilbert, as he points out several butterflies on passion vines in the campus greenhouse. "So in nature, they can learn the position of these flowers and return to those on a regular basis. This was stuff I worked on as a grad student. If you put numbers on their wings, they are able to cruise around and show up at the same little inconspicuous flower at the same time every day. They run a very complicated route in the forest, and then they go roost in the same place every night. "

By being so efficient in finding food sources, Heliconius can expand their lifespan from a month and a half to six months. That also means they can extend their reproductive output from about 200 eggs in their lifetime to about 2,000 eggs.

With support from the National Science Foundation (NSF), Gilbert and his colleagues are studying a population of Heliconius that they think is in the process of evolving into two distinct species. It's known as "speciation" when one species branches into two that no longer

interbreed, and for Heliconius, the process involves those color patterns.

While evolution is unfolding all the time, it is rare for scientists to be able to observe it up close, as they are doing now with a population of Heliconius in Ecuador. The simplest reason for a split in any family tree is geography, explains Marcus Kronforst, who worked with Gilbert on Heliconius studies and is now at Harvard University.

"So we are used to, say, a mountain range coming up and splitting a formerly interbreeding population into two. The individuals can't make it over the mountain so they are separated on the two sides," explains Kronforst. "They spend maybe millions of generations like that, and over time they become so different that even if the mountains disappear, or if it is a river splitting them, if that disappears, and they come back into contact, they can no longer interbreed."

But with the Ecuador population, these biologists are seeing something different.

"So what we are finding is the butterflies shift their color pattern to avoid predators, but it has this secondary consequence of causing them to no longer recognize each other as potential mates, and we think, actually causing speciation," says Kronforst.

In Ecuador, the scientists observed that yellow and white butterflies of the same species live and mate with each other. But when studying them in captivity, the biologists discovered an interesting twist.

"There is an incipient process going on there, where the yellows are preferring yellows, but the whites are not caring much about which color it is," says Gilbert. "So, it's an initial step in the direction of correlating color with mate preference, which under some circumstances could lead to speciation." They have been comparing the Ecuador butterflies with

some of their close cousins in Costa Rica where the two different colored butterflies are actually two different species.

"In Costa Rica, they are genetically different and we can tell them apart," says Kronforst. "But in Ecuador, the only place on the whole genome where they are different is the gene that causes color, because everywhere else that we look, genetically they are exactly the same."

Gilbert says there are thousands of color patterns possible from Heliconius hybrids, and sometimes the offspring don't look like either mom or dad. Evolution may have hidden some of those patterns. "So basically, what we're talking about here are patterns that in the course of the evolution have been replaced. But they haven't been done away with totally. And so, it's very much like a window on your computer that is now not being shown on the screen, but with the click of a mouse, you can show it on the screen," says Gilbert.

As director of the Brackenridge Lab, Gilbert oversees butterfly research but also a wide array of other biological studies. "This is some serious nature," he says, as he points out one of the large ponds at the field lab. "We have everything from fire ant research, to frogs, butterflies, snakes, vegetation studies, and biofuel studies."

At Brackenridge, there is a large butterfly greenhouse, an open habitat designed as a breeding "free for all."

"So the butterflies that are out in the open in here are ones that are in an active hybrid zone. And so, it's just allowing it to cook along, and generate whatever variety might come about," says Gilbert.

Along with his butterfly studies, Gilbert has also been studying invasive fire ants for several years. They are a costly problem for Texas farmers and ranchers. Huge populations of these non-native fire ants, originally

from South America, have been attacking livestock, small birds, mammals, and reptiles across the south for decades. They have also caused electrical fires by getting into circuit boxes.

Gilbert has been using phorid flies as a possible natural way to control the invasive ants. These female flies inject an egg into the fire ant's body. The injected egg develops in the ant's thorax, killing the ant in about ten days. In some areas the flies are being integrated into the more common pesticide control of the ants.

The Brackenridge lab is a mecca for environmental biology, ecology and evolution studies. "It's also a place where faculty can set up research projects, such as this shelter for native switchgrass for biofuels study," Gilbert says, showing off some new growth.

Graduate students or teaching assistants on campus can set up and monitor experiments, and some faculty members do some of their teaching at the field lab. "Having a facility like this where undergrads are initiating research enables us to put students onto gathering data that would not otherwise be funded or supported," notes Gilbert.

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