Butterflies and bats reveal clues about spread of infectious disease (w/ Video)

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(Medical Xpress) -- There's a most unusual gym in ecologist Sonia Altizer's lab at the University of Georgia in Athens. The athletes are monarch butterflies, and their workouts are carefully monitored to determine how parasites impact their flight performance.

With support from the National Science Foundation (NSF), Altizer and her team study how animal behavior, including long distance migration, affects the spread and evolution of infectious disease. In monarchs, the researchers study a protozoan parasite called Ophryocystis elektroscirrha, or "OE" for short.

In Altizer's lab, the adult butterflies are tethered to a "flying treadmill" and the time and speed of each lap is recorded on a computer. They fly at between two and five miles per hour in this setting. Infected butterflies, on average, fly about 20 percent less well than healthy butterflies. "So, they actually fly shorter total distances, they've got slower flight speeds and they lose more weight per distance flown than healthy butterflies," says Altizer.

Up to two billion monarchs migrate every year to central Mexico, where Altizer and her colleagues capture, sample and release hundreds of butterflies each day during the researchers' field study. "The sound of the wings of the butterflies just whirring past your head is about as good as it gets for a terrestrial ecologist, I think!" says Altizer.

Altizer says even a tiny impact from infection on the monarchs' migration ability could make the difference between survival and death. Her work is providing some details on the differences in how diseases spread in human and animal populations.

"General models for predicting the spread of infectious disease largely ignore behavioral changes," says Alan Tessier, program director in the Division of Environmental Biology within the NSF Biological Sciences Directorate. "This research addresses a critical gap in understanding how infection changes the movement behavior of animals from the scale of individuals to the dynamics of populations spread across a landscape. Lessons learned from this work will be broadly relevant to disease spread in other species, including humans."

"We know that for humans, travel and migration can help spread disease. With more and more air travel, a person can get on a plane and move a virus to the other side of the world in a matter of hours. But, many animal species have to undertake these really strenuous long-distance journeys on their own power. And, if these journeys are really costly, animals that are heavily infected are probably not going to make it," explains Altizer. "So, we can think about it from our own perspective. If we had to run a marathon with the flu, we probably wouldn't do very well. The animals that are the most heavily infected simply can't make a long-distance journey."

Take the migration away and what's left are smaller remnant populations that don't migrate. "We could actually see infections build up in those populations and that could possibly increase the risk of pathogens jumping over into people and their domesticated animals," says Altizer.

Human activities, from logging and other habitat destruction to herbicide use, are disrupting longstanding migration patterns for monarchs and other animals, according to Altizer. Over a decade ago, around half of the monarch population that overwinters in Mexico originated from the corn belt of the United States, where their milkweed host plants commonly grew in agricultural fields and roadsides. Altizer says that today monarch populations in those same areas are declining, in large part due to transgenic crops that are tolerant of herbicides. This allows farmers to more effectively eliminate weeds, including milkweeds, thus removing a large fraction of the monarchs' former habitat.

Another aspect of this research builds on the fascination many people have for these beautiful insects and their arduous migratory journey.

"Monarchs have this amazing annual lifecycle where they've got three or four short-lived generations that breed during the summer months, and then they've got one long-lived generation where butterflies that emerge at the end of the summer live for eight, nine, sometimes 10 months. It's that generation that travels all the way to the overwintering sites and then re-migrates north in the spring to re-colonize the southern part of their breeding range. So, it's the great, great, grand-progeny of that generation that will make the journey the following year," explains Altizer.

Graduate student Dara Satterfield processes data sent in from volunteers who sample the butterflies in their backyards. She's looking for OE infection.

"The Monarch Health Program is our citizen science project. People from the eastern part of the U.S. and Canada send us samples from monarchs in their own backyard," says Satterfield. "The citizen scientists put a piece of clear tape on the monarch's abdomen and that will pick up spores and scales from the monarch. Then they place those tape samples on index cards and mail them to us. We can tell from the samples whether or not the monarch in their yard has a parasite."

"Monarchs, like a lot of other migratory species, face complex conservation challenges because they have very different habitats at different times of the year and they cross international boundaries. We need to identify the threats and protect them," says Altizer.

"There's also a need to study pathogen dynamics in other migratory species, as well as how human activities affect those dynamics," she adds.

Vampire bats may not have the beauty factor that monarch butterflies do, but the bats are important in Altizer's study of how the spread of infectious diseases by animals is affected by human activities.

In Peru, University of Georgia postdoctoral researcher Daniel Streicker focuses on these bats whose populations have exploded in recent years. Ranchers have introduced livestock into the Andes and the Amazon. More bloodthirsty bats might mean more rabies.

"One of the main goals we have is to try to understand what determines the frequency and intensity of rabies outbreaks and what we can do about it," says Streicker.

That fieldwork involves capturing vampire bats to determine what's on their menu.

"We're catching bats in the Amazon jungle, particularly in areas where there aren't a lot of livestock. These are usually areas where bats are reported to bite people, but we don't know what else they're feeding on," continues Streicker. "So, we catch these bats after they've taken a blood meal and we extract the stomach contents in a way that's fairly non-invasive, and then we can use genetic typing to figure out what species were actually being fed upon."

While vampire bats have a hyped Hollywood reputation for danger, Streicker says there are things people can learn from them about rabies and other diseases. For example, some bats have antibodies against rabies, so they appear healthy even though they have been exposed. This runs counter to the common wisdom that rabies is universally fatal to all mammals. If antibodies protect these bats from future exposures, that could fundamentally change our view of how rabies persists in wild bat populations. Understanding how bats survive these exposures could also eventually help researchers develop a treatment. Vampire bat saliva has already been used to develop a medicine for treating stroke victims.

Streicker and Altizer say that the results of this study will improve rabies control efforts in Latin America, where vampire bats cause most human and livestock cases. More generally, because deforestation and livestock rearing are intensifying in much of the developing world, a better understanding of how wildlife-pathogen interactions will respond to such changes is urgently needed.

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