Tracing malaria's ecology using blood samples from birds

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The site in the Andes where the researchers processed bird specimens and took the blood samples used in this study. Credit: John Bates, Field Museum

Malaria is the deadliest pathogen in human history. Nearly half the people on Earth are at risk of contracting the disease from the parasites

that cause it. But humans aren't the only ones who can get these parasites—different forms are found in other animals, including birds. By studying the DNA of those strains, scientists can get a better picture of how malarial parasites live, which may give clues on how to stop the disease. In a new paper in *PNAS*, researchers analyzed blood samples of more than 1,000 species of birds from the Andes looking for malaria; they found that the strains of malaria present in a local area don't always neatly align with the types of birds living there.

"Traditionally, we thought that there's kind of a one-to-one relationship between hosts and parasites, that the evolutionary relationship between the parasites will mirror the evolutionary relationships of the host," says Heather Skeen, a Ph.D. student at the University of Chicago and the Field Museum and one of the study's co-authors. "And what we found is that with birds and malaria, this is largely not true."

"This study was an opportunity to ask the question, 'What does a community of malarial parasites actually look like?'" says John Bates, curator of birds at the Field Museum and a co-author of the paper, which was led by Cornell University's Sabrina McNew and University of New Mexico's Christopher Witt. "It involved changing the way we do fieldwork to collect the relevant data. This research is an attempt to figure out how the ecological and evolutionary relationships of parasites compare to those of bird communities. We found that it's not simple."

He's right, it's not simple, but here's the background: malaria is a single-celled organism that lives as a parasite inside multiple host organisms during its life cycle, including the blood of birds and mammals and the guts of insects like mosquitoes. When humans are infected with malaria, it can kill us, but other animals, including most birds, often survive malaria infection. . And while humans can't catch bird malaria, getting a better understanding of malaria in birds might help us treat or prevent human malaria in the future.

Co-author Heather Skeen in the field with a bird specimen. Credit: John Bates, Field Museum

To learn about malaria in birds, the researchers collected blood samples from thousands of birds in different parts of the Andes Mountains in Peru. These blood samples were then transported back to the Field Museum in Chicago and genetically sequenced at the museum's Pritzker DNA Laboratory.

The researchers then compared the DNA from the different birds as well as the different malaria parasites present in their blood. "There are hypothesized to be as many malarial strains as species of birds—about

10,000," explains Skeen.

To better understand how the ecological and evolutionary relationships of birds and their malaria pathogens, the team sampled 18 different biological communities in the Peruvian Andes, and when they analyzed the DNA of the birds and malaria present, they found around 1,350 bird species but only about 400 strains of malaria. They demonstrate that the kinds of birds in a community were good predictors for the strains of malaria in a community, but not vice versa—those same malaria strains might turn up in a different community of birds.

Lawrence's Thrush (Turdus lawrencii), one of the birds studied in this project. Credit: John Bates, Field Museum

Instead, the researchers learned that the weather in different areas made a bigger difference to the strains of malaria present than the kinds of

birds in the community. "Microclimate, or the climate in very specific habitats, appears to be the main driver of pathogen prevalence in communities," says Skeen. "Rainfall is one of the most significant predictors of community turnover, and I think that's because the insects that spread these parasites are more affected by variations in precipitation than birds are." For instance, extra rain might create stagnant puddles that mosquitoes lay their eggs in, and these mosquitoes help spread malaria throughout a community of birds.

The researchers, who along with Skeen, Bates, McNew, and Witt included Shannon Hackett and Shane DuBay from the Field Museum, analyzed the community patterns they found and mapped the biodiversity of both the birds and the parasites. These analyses could help scientists attempting to protect areas of extreme biodiversity within the Andes and give biologists a better understanding of how malaria strains evolve and change.

"It's a whole other research area for multiple people to potentially work on. There's a lot to do, there are literally people that have spent their graduate career pulling out salivary glands from mosquitoes and squashing them on the microscope slides in order to get access to the malaria in the salivary glands of mosquitoes," says Bates. "It highlights how far we've come and how far we have to go."

More information: Sabrina M. McNew el al., "Contrasting drivers of diversity in hosts and parasites across the tropical Andes," *PNAS* (2021). www.pnas.org/cgi/doi/10.1073/pnas.2010714118

Provided by Field Museum