Laura Bizzarri sampling mites on the beak of a hummingbird with the overlaid illustration highlighting the hummingbird-flower-mite study system. PHOTO CREDIT: Mario Alberto Salazar Araya. IMAGE CREDIT: Erin K. Kuprewicz

SPECIALISTS TO GENERALISTS IN TROPICAL ECOSYSTEMS

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DNA barcoding allowed scientists to challenge the importance of the 30-year old Mating Rendezvous Hypothesis in the specialization of flower parasites on host plants.

Commentary on: Bizzarri, L., C. S. Baer, and C. Garcia-Robledo. 2021. DNA barcoding reveals generalization and host overlap in hummingbird flower mites: implications for the Mating Rendezvous Hypothesis” *The American Naturalist* <https://doi.org/10.1086/718474>.

Testing hypotheses on how nature works is at the heart of the biological sciences and determines our rate of progress in understanding the complexity of nature and the natural world. We know that the diversity of life on Earth is concentrated in the tropics: the gradient of increasing species diversity with decreasing latitude from polar regions to the equatorial tropics and decreasing elevation from montane summits to lowland forests has been recognized since the explorations of Alexander von Humboldt and other scientists in South America in the early 1800s.

There are many hypotheses as to why the tropics are so diverse and speciose. Most of them are dependent on

accurate and reliable identifications of species. One such hypothesis is that ecological specialization of interactions among tropical species can lead to reproductive isolation and speciation, hence greater biotic diversity¹.

As a tropical biologist myself focused on the interactions of species of plants and their pollinators, I first encountered floral mites while I was mist-netting hummingbirds at [La Selva Biological Station](#) in Costa Rica as part of my ongoing investigations of the pollination biology of the genus *Heliconia*. What were these funny little “insects” that I observed running up and down the bills of the hummingbirds and hiding in the hummers’ nostrils as they were transported from heliconia flower to flower, stealing

A HUMMINGBIRD VISITING A FLOWER OF HELICONIA.

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nectar and having sex along the way?

I learned from papers by Rob Colwell and his colleagues^{2,3} that these “insects” were specialized flower mites that robbed nectar from the flowers where they mated and were then carried between plants by the hummingbirds. I was fascinated and began my own observations of these interactions. In fact, I have a flower mite named after me, *Tropicoseius kressii* Naskrecki & Colwell, which Rob and his collaborator discovered in a preserved flower of *Heliconia* that I had collected in Costa Rica.

From his observations in the field at La Selva, Colwell⁴ suggested that a process analogous to sexual selection may result in rapid ecological shifts of mites to specific host flowers, which in turn would lead to speciation in the mites. Doug Futuyma and Gabriel Moreno¹ later labelled this as “Mating Rendezvous” and recognized it as “an appealing hypothesis” for host specialization in flower mites. However, they admitted that evidence was slim for mate location as a source of “selection for specialization.” Colwell’s observations on flower host specificity by the

mites were based on morphological identification of the tiny floral parasites, which was admittedly difficult.

Nearly twenty years later along comes the idea of “[DNA barcoding](#)” and the implementation of DNA sequence data as a much more accurate means of species identification across the tree of life⁵. A short 500-bp stretch of DNA of the cytochrome c oxidase I mitochondrial gene in many cases provides a much more precise and repeatable identification than morphology. It didn’t take long for [Laura Bizzarri](#), [Christina Baer](#), and [Carlos Garcia-Robledo](#) at the University of Connecticut to apply this new genetic tool to identify Colwell’s flower mites and test the Mating Rendezvous Hypothesis. Not unexpectedly, after collecting 10,654 mites from 489 flowers at La Selva and generating CO1 DNA barcodes for 1,928 of the mites, [they report](#) in the latest issue of *The American Naturalist*⁶ that generalist flower mites were much more common than predicted among 14 species of plants pollinated by hummingbirds. Moreover, they discovered that multiple species of mites, often in the same genus, could be found in the flowers of a single host plant. They did determine that eight species

of mites were specialized on a single host plant, but these specialists often shared their host with other generalists. The hypothesis on the importance of “Mating Rendezvous” in the specialization of parasites on hosts now appears to be on wobblier ground than originally suggested by Futuyma and Moreno¹.

Colwell’s data supporting the Mating Rendezvous Hypothesis stood the test of time for over thirty years. However, as is common and necessary for science to progress, a new tool, DNA barcoding, which is now easily available to ecologists and evolutionary biologists⁷, allowed scientists to challenge that hypothesis.

How many other hypotheses on the origins of tropical specialization and high species diversity can be tested using DNA barcoding and other new tools? Understanding and explaining tropical diversity remains a significant challenge for biologists. The investigation by Bizzarri, Baer, and Garcia-Robledo is just one example of how we advance our understanding of the complexity of nature and the natural world.

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A MITE RIDING THE BEAK OF A LONG-BILLED HERMIT (*PHAETHORNIS LONGIROSTRIS*) AS THE HUMMINGBIRD IS VISITING A *HELICONIA IMBRICATA* PLANT AT LA SELVA.

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