

# Of *Heliconias* and Hummingbirds

Katherine Thompson '07



For the past two years, through generous donations of Dee Bates, the Botanic Garden has been able to sponsor a summer internship at the Smithsonian Institution. Students work with botanists and have the opportunity to do field research as well, this year in St. Kitts and Dominica. Katherine Thompson was also able to attend the international meeting of the Association for Tropical Biology in Brazil. Next semester she will be in Brazil studying Amazonian Resource Management and Human Ecology, taking classes related to rainforest ecology and management, visiting research facilities, and doing an independent study project. Now that she has some knowledge of the genus *Heliconia*, she will also be doing an internship with a professor she met at the Brazil conference, studying the effects of forest fragmentation on *Heliconia acuminata*.

Katherine and *Heliconia bihai* on Dominica

This summer I interned for Dr. John W. Kress, chair of the Botany Department at the Smithsonian Natural History Museum. Dr. Kress, who specializes in the plant order Zingiberales, and his colleague Dr. Ethan J. Temeles, professor of ecology at Amherst College, are coauthors of a 2003 *Science* cover article entitled “Adaptation in a Plant–Hummingbird Association” (Vol. 300, Issue 5619, 25 April 2003).

This study is a prime example of coevolution between tropical angiosperms, *Heliconia caribaea* and *H. bihai*, and their pollinator, the purple-throated carib hummingbird, *Eulampis jugularis*. The purple-throated carib, attracted by brightly colored bracts of tubular helonica flowers, feeds on floral nectar. In the process of feeding, pollen is deposited on the head of the hummingbird as it brushes past the anthers. The hummingbird then inadvertently pollinates the next flower it visits when the pollen is transferred to that flower’s stigma.



Purple-throated carib hummingbird photograph by Vinita Gowda

*Heliconia caribaea* and *H. bihai* differ in that the flowers of *H. caribaea* are shorter and less curved than *H. bihai* flowers. Interestingly, the purple-throated carib displays the most extreme sexual dimorphism of any hummingbird species; the male has a short, slightly curved bill compared with the female’s long bill that is twice as curved. In this study, Temeles and Kress proposed that the male purple-throated carib, whose bill corresponds to *H. caribaea* flowers, is the principal pollinator of this species, whereas the female purple-throated carib is the primary pollinator of *H. bihai*.

The story becomes quite complex when various color morphs on different islands of the Lesser Antilles are taken into account. On St. Lucia, located on the northern end of the island archipelago, *H. caribaea* is scarce, but one of two *H. bihai* morphs has longer, curved flowers to “accommodate” the females. Conversely, on Dominica, further south, two morphs of *H. caribaea* are present in addition to an abundance of one *H. bihai* morph. The goal of the research is to observe heliconia–hummingbird pollination systems on selected islands along the archipelago. It is hypothesized that a continuum exists along the islands, with predominantly *H. caribaea* morphs in the north and predominantly *H. bihai* morphs in the south.

Dr. Kress and I joined Vinita Gowda (a student working on her PhD with Dr. Kress) in the field on the islands of Dominica and St. Kitts. We arrived in mid-June and I assisted Vinita for a month, leaving in mid-July. At this time of year it was the rainy season and *H. caribaea* was about done flowering when we left, whereas the flowering of *H. bihai* was tapering off more slowly. It was also apparent that the red *H. caribaea* morph finished flowering sooner than the yellow morph.

*Heliconia bihai* occurs at high altitudes. St. Kitts has only one location where *H. bihai* grows abundantly (population of about 30) at the top of an inactive volcano, just beneath a pond formed by the crater. This was not designated as a plot under observation because it was a very difficult and time-consuming hike to the site. Therefore, there were two plots of *H. caribaea* on St. Kitts and no plots of *H. bihai*. *Heliconia bihai* is much more

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*Heliconia caribaea* plot above the Layou River, Dominica

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abundant on Dominica, which is a larger and much more mountainous island, with a greater area of high land. On Dominica, Vinita established two plots of each species.

There's no doubt that the female purple-throat is the sole pollinator of *H. bihai*, since we observed only females at such high elevations. The only other hummingbirds we saw on the mountaintops of Dominica were occasional Antillean-crested or blue-headed hummingbirds, which have bills too short to feed on heliconia flowers. The female purple-throats display a feeding pattern known as streamlining, in which they cover a large area without being loyal to any particular clump. It did appear that females were feeding in a distinct pattern, appearing in the same plot at a certain time of day. It was a wonder to witness these 10-gram birds flying on the top of the mountain, since it was very gusty and foggy, but they managed to fly up regardless of the wind. Dr. Kress speculates that the females may be nesting at high elevations where they have a reliable nectar source, without males to contend with.

The male purple-throats, on the other hand, were adamantly defending sizable clumps of *H. caribaea* at low elevations. We observed them consistently chasing out other species of hummingbirds (the green-throated hummingbird was a major competitor), much larger birds (primarily bullfinches and bananaquits), as well as female purple-throats. They expended a great amount of energy aggressively chasing intruders such that they needed to feed very frequently



Katherine videotaping the first test of new digital imaging software that identifies plants from leaf photos

inside their territory. In some plots, it seemed that by the end of the day, males were actually abandoning their territory, which must have been exhausted of nectar, and heading into other territories.

Vinita is focusing her research on heliconia phenology, the annual reproductive cycle, as well as the daily cycle of nectar production. Another part of her work constitutes an analysis of genetic diversity within populations. We collected heliconia seeds that were brought back to the labs in Washington, D.C., for analysis. She hypothesizes that *H. bihai* populations, in which the primary means of pollination is streamlining, will be much more genetically diverse, than *H. caribaea* populations. For her research she is measuring flower number, flower length, curvature, nectar production, sugar content of nectar, and fruit number.

After this summer's work, Dr. Kress said that he considers the green-throated carib as a more significant player in the pollination system than he had previously suspected. The green-throated carib most closely resembles the male purple-throated carib in size, beak length, and aggression toward the other hummingbird heliconia pollinators. We observed male green-throats competing almost exclusively with purple-throats. Male green-throats were most aggressive on St. Kitts, where they sometimes chased the territorial purple-throat out of its own territory! Dr. Kress hypothesized that this unusual behavior may be due to the island's small size and much disturbed landscape with less abundant heliconia (due to sugarcane fields).

Dr. Kress also pointed out that loyalty of males and females to different color morphs might be less distinct than he had previously hypothesized, since we observed both sexes visiting both *H. caribaea* morphs frequently on both islands.

Kress and Temeles have ambitious plans for the future. Until now their study has relied on observation in natural settings, but they hope to create controlled experiments to test their hypotheses. They intend to set up an enclosed mesh greenhouse in which there will be *Heliconia caribaea* and *H. bihai* plants growing in pots on wheels so that the plants can be configured into clumps in different arrangements. Hummingbirds will then be released into the enclosed area and their movement and species/morph preferences will be tracked. Dr. Kress was very excited because during our stay on Dominica we may have found the ideal site for them to carry out such experiments.

While it is clear that the relationship of the heliconia and the hummingbird is not fully elucidated, this summer's work added more data that can be used to refine future research. ☞



*Heliconia caribaea*