Heliconia: Evolution at Work

W. John Kress and Yota Batsaki

From Mount Helicon to the Amazon

Heliconias rank among the great botanical beauties of the natural world. Visually alluring with sculptural bracts and stunning colors, they have been widely distributed in ornamental gardens and the horticulture trade over the past two centuries. Yet until recently, these iconic tropical plants were little known to scientists. As large herbs with banana-like leaves and fleshy, bulky inflorescences, they are hard to collect in the field. For the same reason, their character is difficult to capture on the herbarium sheet, where the sensuous bracts are reduced to a shriveled shadow of their showy presence in forest clearings. However, over the last few decades, both field observations and controlled experiments by botanists and ecologists have produced a wealth of new information about heliconias. These fascinating discoveries illuminate the sophistication of plant–animal interactions, expand our understanding of evolution, and invite us to reconsider the astonishing capacity of plants to act on their environments.

Margaret Mee, Heliconi...

Heliconia chartacea...

Heliconia chartacea...

The genus *Heliconia* was named after Mount Helicon—in Greek mythology, the home of Apollo and the Muses—by none other than Carl Linnaeus, the father of modern taxonomy. The name, evocative of art and beauty, was intended to emphasize the close taxonomic relationship of *Heliconia* to the genus *Musa*—the banana. Taxonomists recognize approximately 185 species of *Heliconia* worldwide, but there are undoubtedly one or two dozen more species to discover and describe in the tropical forests of the two distinct regions across the globe (South America and the South Pacific) where they grow as native plants.

The eight families of the order...

Map showing regions of South America and the South Pacific...

A Short History of Horticultural Excitement for Heliconia

Heliconias became an object of desire for gardeners as soon as they left their natural habitats. Several species, including *Heliconia psittacorum*, *Heliconia bihai*, and *Heliconia metallica*, have been cultivated as ornamentals since the 1700s. They were carried around the world by horticulturalists and today they are found in many botanical gardens from Europe to Asia to the Pacific.

Margaret Mee, Heliconia...

In 1800, *The Botanical Magazine, or, Flower-Garden Displayed* (renamed *Curtis's Botanical Magazine* the following year), published a plate (#502) with a description of *Heliconia psittacorum*. This botanical periodical featured colored illustrations of plants and introduced many exotics to British and European horticulturalists and gardeners. The entry on "Heliconia Psittacorum. Parrot-Beaked Heliconia" that accompanies the plate explains that this "beautiful stove plant is a native of Jamaica…." It emphasizes that the source of the image was a living specimen painted at a specific moment of the plant's cycle that precedes the most distinctive stage: "At a more advanced stage than that at which our drawing was taken, the top of the stem becomes flexuous or zig-zag," alluding to the plant's trademark bracts. The drawing "was made from a plant which flowered in August 1800, amidst a great variety of beautiful and rare exotics, in the superb collection of E. D. Woodford, Esq., at Vauxhall." The "stove plant" designation is a reminder that growing the first heliconias outside the tropics required expensive hothouse infrastructure available only to the wealthy. The flowering of a stove plant was often a noteworthy and sometimes competitive feat that brought prestige to the owner. It was also ephemeral, and therefore might be commemorated with the commissioning of a plant portrait. Collectors basked in the glamor that came with coaxing a rare exotic into bloom.

The Botanical...

[502]

HELICONIA PSITTACORUM. PARROT-BEAKED HELICONIA.

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Class and Order.

PENTANDRIA MONOGYNIA.

Generic Character.

Spathæ. Cal. 0. Cor. tripetala. *Nectarium* diphyllum. *Fructus.* tricoccon. Sem. solitaria.

Specific Character and Synonyme.

HELICONIA Platanorum glabra, foliis lanceolatis ellipticis acuminatis, spathis erectis lanceolatis. *Banks's Mss.*

HELICONIA Platanorum foliis caulinis basi rotundatis, spadice terminali flexuoso, spathis lanceolatis, nectario lanceolato concavo integro. *Swartz. Obs.* 98.

This beautiful stove plant is a native of Jamaica, growing in the mountains, in places cleared of wood, and in this Situation acquires the stature of eight feet, with leaves proportionally large. With us it rises about three feet, with a straight round polished stem, naked at the upper part and cloathed below with smooth shining leaves, alternate lanceolate-elliptic acuminated many-nerved, with membranaceous foot-stalks sheathing the stem. At a more advanced stage than that at which our drawing was taken, the top of the stem becomes flexuous or zig-zag, and from each bend there grows an erect lanceolate concave spatha, within which the flowers grow in clusters upon short peduncles, these remain closed during the function of flowering, opening only just before they fall. The Corolla, properly speaking, is monopetalous, the whole falling off in one piece; if carefully examined it divides into five segments, the three outermost of which are usually described as the three petals of the corolla; the two innermost form what

The Botanical...

Finding and Describing a New Heliconia – Art Meets Science

The striking beauty of heliconias continued to attract both the plant explorer and the painter well into the twentieth century. In botanical study, the interests of art and science have often informed one another; in the case of heliconias, a work of botanical art led to the discovery of a new variety. The renowned botanical painter Margaret Mee (1909–1988) undertook 15 expeditions into the Amazon in the course of which she painted several heliconias. One of them, published in Mee's *Flowers of the Amazon Forests*, caught the attention of Smithsonian botanist John Kress. After spending several years in South America searching for new species of *Heliconia*, in 1990 Kress was back in his office at the Smithsonian, leafing through Mee's botanical paintings, when he came across a form unknown to him. Recorded by Mee near the border between Venezuela and Brazil, the flowers' unusual greenish-yellow color differed from the more typical form of *Heliconia chartacea*, which is bright pink and rose. (The green–yellow variety may be a partial albino form of the typical species that is called "Sexy Pink" in the horticultural trade.) Kress realized that this was a new variety, and maybe even a new species, and resolved to find it and name it after Mee.

Margaret Mee, Heliconia...

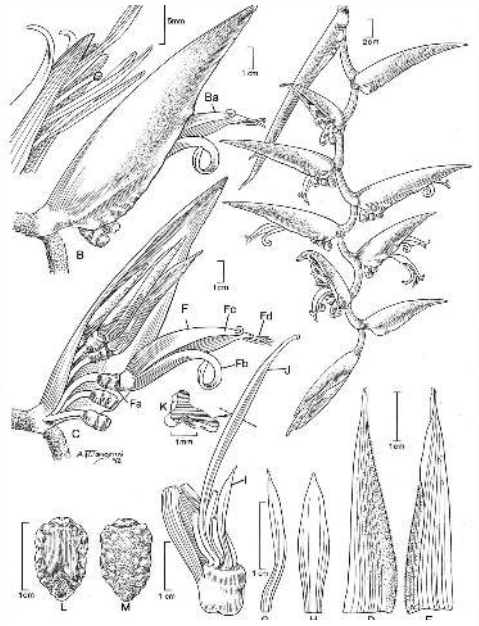
Margaret Mee, Heliconi...

“Several years later, when I was in Venezuela collecting plants, I decided to find this *Heliconia* so I organized an expedition up the Orinoco River to where it meets the Vaupés River. With two other botanists (one from Venezuela named Ernesto Foldats and the other a student from Germany) along with my research assistant Cheryl Roesel, I flew down to a missionary group working with the Yanomano indigenous people where we knew there was a little air strip near Platanal along the Orinoco. Once we landed and paid our respect to our hosts in the region, I headed into the forest along the river. It took me about five minutes to find the new *Heliconia*!

heliconia Kress and team with heliconia DO-...

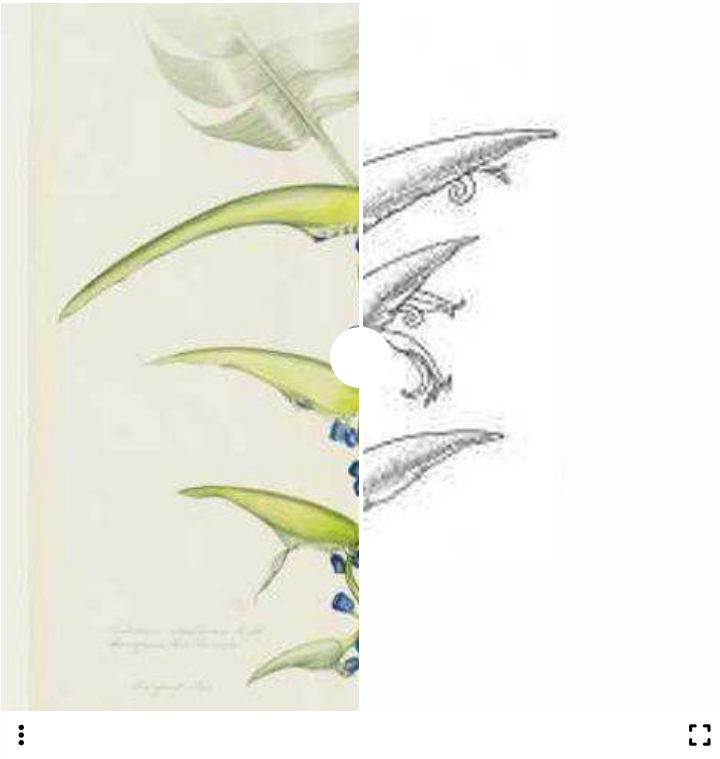
You can tell how excited we were from the photograph. We made some botanical specimens for the local herbarium in Venezuela and the Smithsonian. I took copious notes and measurements. Later I decided that the plant was not a unique species so I named it as a variety and called it *Heliconia chartacea* var. *meeana*. We flew back that afternoon after a brief celebration. It was a one-day expedition and finding the plant was not that difficult. The return was another story. We had to fly out on a tiny little plane while it was still light. After takeoff I was sitting next to the pilot when the engine stopped while we were high over the rain forest. I thought: ‘Hey, I have finally found Margaret Mee’s *Heliconia* and the engine has stopped. What is happening?’ Then the pilot looked over at me and commented ‘Oh, I forgot to switch the gas tanks.’ He flipped the switch and we continued on our way.”

A pen-and-ink drawing by the Smithsonian’s scientific illustrator Alice Tangerini employed a mix of photographs, dried specimens from Kress’s travels, and dissections under the microscope to capture the plant’s structures for the ensuing botanical publication. The discovery and description of this new variety exemplifies the entanglement of art and science in the long tradition of plant representation.



Heliconia chartacea var. meeana

Mee's gift of observation, honed through the painstaking sketching of plants and conversations with expert botanists, led her to notice the plant. Her painting, though with a primarily aesthetic purpose, was detailed and accurate enough to convince Kress, an expert on the genus, that this discovery was of a new variety. His scientific publication then called for the skill of a botanical illustrator, shifting the emphasis from color and composition to the accurate description of the plant's parts, yet with a graceful economy of means that produces its own version of aesthetic pleasure.

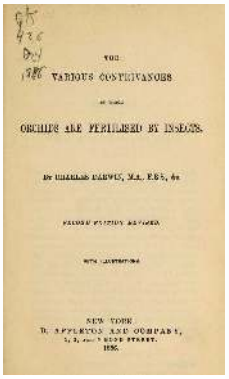


The Natural History of Heliconias – Experts in Interactions

Heliconia distribution showing regions where plant...

Heliconias are not only a source of ornamental and visual pleasure—they are also of particular interest to science and offer an arresting point of departure for our understanding of ecosystems and plant–animal interactions. In fact, the distinctive forms and vivid colors that make heliconias so beautiful offer a key to their extraordinary evolutionary adaptations. To begin with, heliconias' respective habitats—which encompass regions as wide apart as tropical South America and the islands of the South Pacific—determine their appearance. Heliconias are mostly found in the neotropics, from central Mexico down to northern Argentina, including the Caribbean. In tropical America, heliconias are diurnal and brightly colored because they are pollinated by hummingbirds that are attracted to their reds, oranges, pinks, and yellows. In exchange for transporting the pollen, hummingbirds gorge on the plentiful sugary nectar of the small flowers protected within the bracts, whose shape ensures that access is restricted to preferred pollinators with suitably evolved bills. Another species of heliconias extends from Samoa to New Guinea in the South Pacific, and are of a dull, green color and flower nocturnally because they are pollinated by color-blind bats that forage at night. We now believe that the most ancient heliconias that lived in South America about ten million years ago, and had bright red and yellow flowers, somehow got to the South Pacific islands where they lost their bright colors and switched from hummingbird pollination to bat pollination.

The highly specialized relationships between heliconias and their pollinators reveal evolution at work. Indeed, these close—sometimes exclusive—relationships between specific plants and animals played a key role in the development of Charles Darwin's ideas on the process of natural selection and evolution. While Darwin was especially interested in the relationship between orchids and the insects that pollinated them, heliconias offer equally interesting and unique relationships with their animal pollinators. An extraordinary example of coevolution, or reciprocal evolution, between two species is the relationship between heliconias and hummingbirds in the eastern arc of the Caribbean islands. The two species of heliconias native to the islands, *Heliconia bihai* and *Heliconia caribaea*, and the one species of hummingbird found there, have coevolved in a unique and interesting way. The two heliconias are quite different from each other, but the single species of hummingbird that pollinates them is so specialized that the small-bodied females visit *Heliconia bihai* and the larger-bodied males visit *Heliconia caribaea*. Astonishingly, the shape and size of the bills of each sex correspond to the shape and size of the flowers of the specific heliconias that they visit and feed from. In other words, the male hummingbird has evolved with one species of heliconia and the female hummingbird has evolved with the other species of heliconia.



Charles...

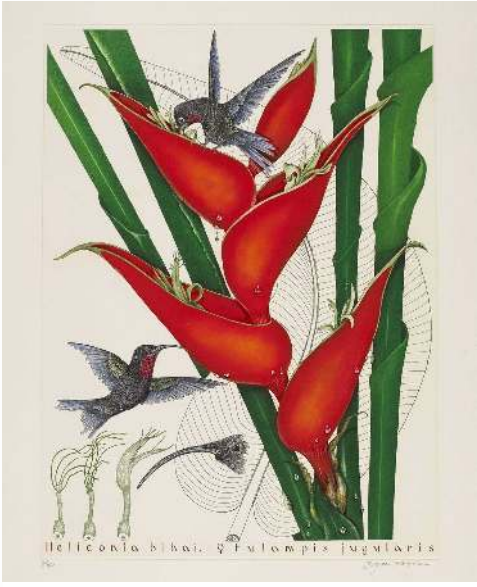

Charles...

NHM Xanthop...


Caroline...


Andean Emerald Hummingbir...

Archipelagos are ideal environments for observing plant evolution driven by interactions with animals of various kinds. Darwin's ideas on evolution and natural selection were in part based on his experiences and observations in the Galápagos Islands and other archipelagos. The fewer species of plants and animals on islands compared to mainland habitats allow biologists to study more closely ecological and evolutionary processes in natural communities. This is certainly true with the heliconias and hummingbirds in the arc of islands in the Eastern Caribbean. Douglas Altshuler and Christopher James Clark describe the dynamic nature of these interactions: "Hummingbird and Heliconia engage in a coevolutionary dance, with flower shape evolving in response to hummingbird bills, and bill shape evolving in response to flower shape. By offering nectars containing different amounts of energy, Heliconia species select for different body sizes" in the hummingbirds as well. Echoing the famous "Darwin's Finches" in the Galapagos, Altshuler and Clark referred to the hummingbirds in the Caribbean as "Darwin's Hummingbirds."



Bryan Poole, Heliconia bihai wi...

Another species, *Heliconia tortuosa*, from Costa Rica, provides a fascinating example of plant adaption in selecting specific pollinators, where the distinctive shape of the plant's flowers acts as a screening mechanism. An ingenious aviary experiment has shown that the plant has the capacity to distinguish among pollinators and respond to their visits. Specifically, *Heliconia tortuosa* plants allow pollen tube growth after visits by two species of hummingbird that are more likely to carry high-quality, long-distance and more diverse pollen, and prevent pollen tube growth and discourage fertilization and seed production after visits by less effective species of hummingbirds. The plants apparently discriminate by measuring how much nectar has been removed by the particular hummingbirds. This experiment is perhaps the first evidence of specific pollinator recognition by plants, and a form of decision-making that identifies the desired pollinator to optimize reproduction.

Bryan Poole, Heliconia caribea...

Nature's Network in Tropical Forests

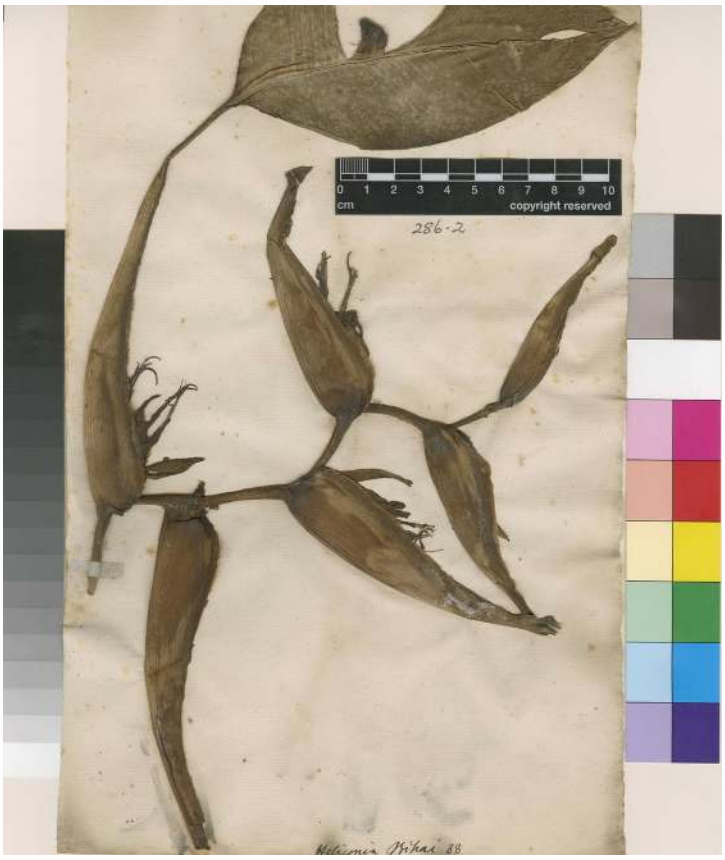
The close relationship between heliconias and their pollinators highlights the vital role these plants play in the broader ecosystem as a source of food and shelter. A number of birds, such as toucans and tanagers, as well as squirrels, feed on the bright blue fruits and seeds of most species of heliconia. Some plants, like *Heliconia imbricata*, are keystone species crucial to the survival of many other rainforest inhabitants. In addition to feeding energy-rich nectar to the hummingbirds that pollinate its flowers, this heliconia offers a daytime home to tent-making bats, who fold over the banana-like leaves to provide shelter from the tropical sun and rain. The species also serves as the perfect spot for hummingbirds to build their nests under the tips of the leaves. Meanwhile, the liquid that pools in the bracts enclosing the flowers is a breeding ground for insect larvae, especially mosquitos, midges, and flies. One group of tropical beetles, the rolled-leaf hispine beetles, is highly specialized to feed inside the unfurling leaves of this and other species of heliconias and their relatives.

Botany has always been a highly visual science, and our understanding of plants depends partly on the ways in which we have chosen to represent them. One of the conventions of both the botanical portrait and the scientific illustration is the rendering of the singular plant removed from its natural context and portrayed against a neutral background. Similarly, the herbarium sheet removes the plant from its ecosystem, rendering it suitable for transportation, archiving, and future reference and comparison in museums, but divorcing the specimen from its web of interactions and relationships. We know that plants do not exist in isolation; they inhabit rich and diverse habitats populated by many plants, numerous birds, other animals, and microorganisms. Today, many of these highly specialized interactions are severely under threat of extinction. Botanists are therefore using the conventional forms of plant representation, such as herbarium specimens, to understand more about natural habitats of the species and repurposing them to determine effective strategies for their conservation.

Conserving the Diversity of Heliconia

A full assessment of the conservation status of each known species of *Heliconia* is currently being conducted by John Kress, Gary Krupnick, and Serenity Montaño at the Smithsonian. Using information from specimens collected over the last 200 years and maintained in herbaria around the world, such as the United States National Herbarium at the Smithsonian Institution, they are using both the International Union for Conservation of Nature's Red List Criteria method of assessment and a second rapid assessment method, to determine the conservation status of each species. Geospatial Conservation Assessment (GeoCat) maps and Red List descriptions of the conservation status of 185 species are being produced. For example, data from over 200 herbarium specimens found in 20 institutions suggest that *Heliconia bihai* from the Caribbean and northern South America is of "Least Concern" for conservation. Whereas the six available specimens of the very closely related species *Heliconia aurea* from Colombia and Venezuela indicate that it is "Vulnerable" and at risk of extinction, most likely due to habitat alteration, degradation, and destruction.

Our understanding of the diversity and ecology of heliconias has grown tremendously in the last few decades. Many exciting new forms and species have been discovered and described by botanists. And yet, even after years of observation, the intricate web of interactions between heliconias and their animal partners in natural ecosystems is still to be fully comprehended. Each new plant we find and each additional observation we make opens up entirely new fields for exploration. Horticulturists, scientists, and citizens have so much more to learn and appreciate about these disciples of Apollo and the Muses from Mount Helicon.



Heliconia bihai plant specimen

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Heliconia Society International https://www.heliconia.org/