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HORTI SELBYANI

DOCUMENTING ORCHID DIVERSITY

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INTRODUCTION

Documenting diversity started here at Selby Gardens when graduate student Mark Whitten came on an internship. He talked me into purchasing an Apple IIe computer. I was aware of the possibilities of computers. In 1946, during my service in the Army, I went on a fieldtrip to Tokyo to see the Army's system for keeping track of records. It was a "chad machine" like the ones we voted on in Florida in the last presidential election but bigger. Each military person in the Pacific Theater had a card with little holes punched in it; and the Army could run vast stacks of cards through a prototype IBM computer and pick out whatever was needed. Well, in the 1970s, I found that I could do the same thing on my Apple IIe, but without the "hanging chads."

ORCHIDS OF ECUADOR

I had become involved with the orchids of Ecuador in 1957 while researching orchid diversity for my doctorate. I spent a year there exploring the variability of orchid species. Rudolf Schlecter of Germany had reported 746 species of orchids in 1921; and by the 1950s, another 100 orchid species had been added. Colombia to the north had about 1500 orchid species, as did Peru. In comparison, it seemed that poor Ecuador was hardly worth an orchid scientist's time.

When I came back to the United States, I started work on a list and, while teaching at the University of Miami, began putting together a file based on 3x5 cards on all the orchids of Ecuador. Then with my Apple IIe, I was able to organize and expand that list. In January 2001, I counted 3331 Ecuadorian orchid species. How were we able to quadruple the number of species? The availability of computers, the opportunity to get into unexplored areas, and the nature of Ecuador made it all possible. We could go out into the forest, walk down a path, and if it started getting dark, stop at the nearest little house, and the people would put us up. Today it is no longer safe to wander around in the woods. Consequently, at this point in time, it would be impossible, even if the forests were still there, to be able to tabulate the total number of species, because starting in 1954, roads began to be built everywhere, and the construction continues today. The country went from a land of vast untouched forests to a land of even more vast pastures and banana plantations. Today the chances of finding undescribed species are much slimmer, because roads have made it possible for the countryside to be peeled.

Ecuador has two ranges of the Andes, all of them high and snow-capped in many places. Much of the country sits on the Pacific Ocean. The Humboldt Current, an offshore current of cold water, comes up from Antarctica and sets the climate. About midway up the coast of Ecuador, the current turns abruptly and goes out past the Galapagos Islands. A branch of the California Current, known as El Niño, comes down the coast from the north. The result is that north coastal Ecuador is always warm with lots of rain most of the year, and south coastal Ecuador is cool in the dry season and warm in the rainy

season. The further south you go, the cooler and drier it gets. Beyond the low coastal ranges rise the Andes, which provide striking differences in plant distribution based on elevation.

Years of gathering data from orchid literature and herbarium specimens have resulted in some fairly accurate estimates for the number of orchid species per country in the western hemisphere. In 1993, using computer systems, we estimated 3237 orchid species for Ecuador; but today, that number has increased to more than 3900 species documented by herbarium specimens. This is the kind of information we use in textbooks, the kind of information that Peter Raven, director of the Missouri Botanical Garden, puts together so eloquently when he talks about the numbers involved in conservation, particularly in the Tropics.

Using a database to enter where a specimen was collected, who collected it, and when it was collected, we are able to identify a plant's life zone or habitat and evaluate the accompanying orchid species. An early surprise was that tall tree jungle actually has very few orchid species. Rio Palenque in coastal Ecuador at 200 m elevation turned out to have only 89 orchid species in a square km of forest; but at Centinela, 20 km away, a hilltop at 750 m elevation had 212 species. The two sites are within view, so what makes the difference? Rio Palenque was tall tree rain forest, and the site across the way was on the top of a ridgeline in cloud forest, a different habitat, with an extremely abundant population of orchids.

With almost a third of Ecuador composed of tall tree rain forest, visitors expect a marvelous number of orchid species, but we came up with only 176 species for the region east of the Andes. At Lita on the west side at the tail end of the Choco Rain Forest, we came up with 312 species in a sq. km. Thus we did away with the myth of the tall tree rain forest being the site of all diversity and concluded that diversity is much more dependent on inclination, on rainfall, on what direction the slope faces, and on a series of local parameters.

A cross-section of Ecuador would have the Pacific Ocean to the left, a low coastal range of mountains, and then the Andes. Humboldt produced a similar cross-section in his famous text, *Voyage of Humboldt and Bonpland,* that shows two ranges, coming off of a third range down low on the far eastern side and then going out gradually all the way to the Atlantic Ocean, some 3000 miles away.

What caused all the diversity, not only in orchids but all plants? In terms of the rest of the world, the number of plant genera in Ecuador is far off scale. The only other places that even compare are perhaps New Guinea and Borneo and basically for the same reasons, high mountains and lots of forest.

Ecuador has a number of mountains with permanent snow. They won't have it for long, because it is melting rapidly. (As a result, Sarasota, Florida, is going to be knee deep in seawater before long.) But for the time being, the Ecuadorian mountaintops are covered in snow, and the band between 500 and 2500 m elevation has the highest biodiversity.

I propose rapid climate change as an explanation for Ecuador's rich biodiversity. Paul Collinvaugh, using fossil pollen samples, has come up with some figures indicating that out in Amazonia the temperature has changed 5°C in the last 10,000 years. That means it was pretty cool way out there on the Amazon 10,000 years ago. Geologists suggest that Quito, at 2700 m (10,000 feet) elevation, was under ice 10,000 years ago. On the right kind of day, you can stand in Quito and look up and see that the Pichincha volcano behind town has snow on top, but it usually doesn't stay more than a few days. Back 10,000 years ago, ice covered the place where the city is now. Not many orchids grow on ice, but a lot of orchids had to be in the region prior to that time. Where did they go? How did they survive? Well they obviously went downhill, and that compacted the populations further below. Then the climate changed, and it must have been pretty abrupt. They are still finding skeletons of mastodons and saber-tooth tigers right outside of Quito that are dated, according to Alex Hirtz, at only 4,000 years ago, after man had arrived. Those animals could survive in that kind of cold. Let's picture now the climate changes that brought us back to something similar to what we have now. All of a sudden all of that region is now reforested and opened up to invasion by orchid plants like crazy, but it is divided north and south up and down the Andes, so that there are small populations that can move up into these areas.

A favorite genus of mine, *Telipogon,* one of the pansy orchids, has about 25 species in Costa Rica and western Panama. Venezuela, Colombia, Peru, and Bolivia have lots of them, but Ecuador has the most, with about 60 species (FIGURE 1). Flowers of some species are 3 inches across. They are big and beautiful. What makes them so diverse? Why is it that in places in Ecuador, several species grow on the same limb side by side? They would certainly be candidates for hybridization. Back 10,000 years, these plants couldn't have existed, certainly not at the elevations where they grow today. When we started studying them, there were 100 described

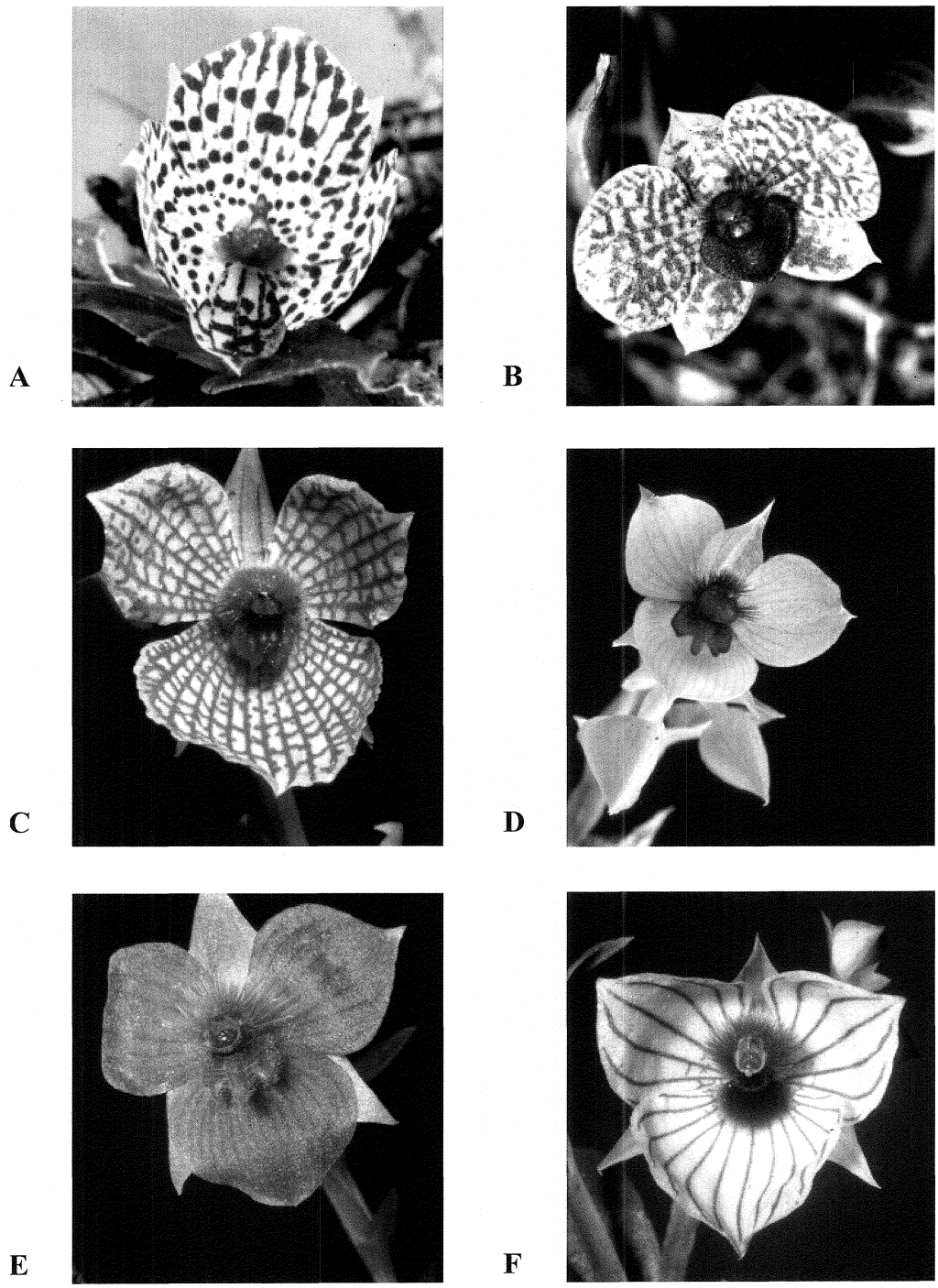

FIGURE 1. Ecuadorian *Telipogon* species: **A.** *Telipogon dodsonii*; **B.** *Telipogon dalstroemii*; **C.** *Telipogon asuayanus*; **D.** *Telipogon cuyujensis*; **E.** *Telipogon hagsateri*; **F.** *Telipogon pulchra.*

species. Today the number of described species is near 150, with several still undescribed.

I have always pushed the idea that a lot of orchid diversity is based on pollination systems. In Ecuador on the road from Quito to Baeza, I collected 25 plants of a spectacular orchid (*Telipogon hausmannianus*) with large flowers. I really wanted to know what the pollinator was, so I grew them in a suitable garden, and watched them for a year. In that time, one plant produced a seedpod. The others all fell off because they weren't pollinated.

During a trip to Colombia in 1987, on the road from Pasto to Macoa, we were stopped and told, "Don't go any further, or you will be kidnapped or killed." So we stopped at a monastery, where a monk was growing the same spectacular orchid in the garden. The 25 plants that he had collected down the road at San Francisco (10 km away) had seedpods all over them, and so we went there, and every tree in the area had the orchids with seedpods. Large flies, the size of bumblebees, were swarming over them. The flies were really fast, and they were flying territories. We could swing a net and catch them. They belonged to a very large family known as the Tachinidae. The *Telipogon* flowers mimic and deceive the flies that are in search of a mate or a prey upon which to lay eggs. Any one area would have 30 species of the flies, which are notable for parasitizing other insects by laying eggs on them; the grubs then eat the host insect. The flies, distinguishable by the large spines on their abdomens, pollinate Telipogon flowers that have a large spot or callus in the center of the flower. We know that some *Telipogon* species are visited by male flies and others by females. Male flies seem to like spiny flowers that mimic the abdomen of the Tachinid flies. These flowers have a spiny callus that develops on the surface of the lip and a hook at the end of the pollinarium of the column. The hook is captured by the legs of the fly, which drags away the pollen.

In northern Ecuador, many *Telipogon* species occur together, some on the same branches. I took a specimen from southern Ecuador and a slide up to Harvard and got an identification of it at the Ames Herbarium. It was declared to be *Telipogon sprucei,* and I published an illustration of it as *T. sprucei.* Was I embarrassed when a botanist in Holland said, "That's not *sprucei,*" and named it *Telipogon dodsonii.*

When Humboldt and Bonpland came down through tropical America on their famous trip at the turn of the century (1800), they collected orchids and wrote a tremendous tome. They described one of these orchid plants as *Telipogon latifolius* and another as *T. angustifolius.* So I went to Paris, got out all their material, took a look, and found five specimens from their original collection labeled *T. latifolius.* Actually, they were five different species. Humboldt and Bonpland noted having collected the type specimen of *T. latifolius* in Peru down on the Rio Marañon. This species, however, only occurs on the path where they walked just outside Bogota, Colombia. My finding meant changing a bunch of names. You have to be very careful with the old literature, because sometimes those guys didn't remember very well either.

ABOUT THE AUTHOR. Calaway Dodson, first Executive Director of Selby Gardens, first Director of Research, and founder of the Orchid Identification Center, currently serves as a Selby Senior Scientist. A Senior Curator Emeritus at the Missouri Botanical Garden, he has worked on orchids for the Tropicos online plant database, made extensive pollination studies, and pioneered the use of gas chromatography in studying orchid flower fragrances. Dr. Dodson has an A.B. in botany from Fresno State University and a Ph.D. from Rancho Santa Ana Botanic Garden/Claremont College. In 1970, he and four other University of Miami faculty purchased threatened rain forest in coastal Ecuador and founded the Rio Palenque Science Center. Combining plant exploration and conservation, he co-authored the first completely illustrated, comprehensive Flora of flowering plants for a region of Ecuador (published in *Selbyana* 4(2) in 1978; a reprint of the Orchidaceae is available as a separate). He has completed Volume 4 of *Native Ecuadorian Orchids* and is working on Volume 5. This essay is based on a slide lecture delivered by the author at the Expeditions Seminar held in January 2001 to mark the Silver Anniversary of the Marie Selby Botanical Gardens.