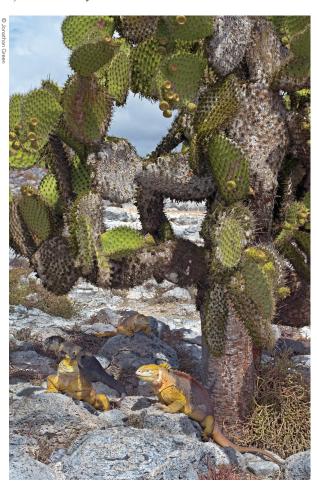
THE MYSTERY OF THE DISAPPEARING **OPUNTIA**

by Frank J. Sulloway



have spent an inordinate amount of time poring over thousands of old photographs from Galapagos. In some of them there are giant tortoises, others show Darwin's famous finches, and land iguanas also make the occasional appearance. But it's not the animal life I am principally examining. It's the giant tree Opuntia or prickly pear cacti, whose life histories have drawn me into a considerable mystery.



I made my first visit to Galapagos in 1968 as part of an expedition to film the sites visited by Charles Darwin during the Beagle voyage. I returned in 1970 with three fellow students to explore unresolved questions about Darwin's conversion to the theory of evolution. In the process, I and my fellow expedition members accumulated more than 5,000 photographs documenting our work on 11 different islands.

Over the next 30 years, I looked at these images only occasionally. But around ten years ago it occurred to me that this collection of photos, along with others taken in 1982, could form the basis of a "repeat photography" project. With enough images, perhaps they could act like a visual "time machine", providing a powerful way to





reveal ecological changes that, although imperceptible from one year to the next, might be substantial over the longer run. I began to augment the collection, searching through archives and writing to dozens of scientists who might have similar photographs taken during the last 50 years.

The giant Opuntia trees are one of the Galapagos' most striking features. Botanists recognise six different species of these spine-laden plants, all of them confined to just one or a few islands. I decided to use the photographs to track the extensive loss of Opuntia in recent decades, and I began on the small and beautiful island of South Plaza just of the east coast of Santa Cruz.

By analysing the photographs, I have been able to identify and follow the fates of more than 1,000 individual cacti on South Plaza. In order to develop such a comprehensive database, my research associates and I have had to find the precise spots from which hundreds of old photos were taken. In the field, our efforts resemble a treasure hunt. In some cases, it has taken several years of arduous searching to locate these photographic sites. With numerous recent images captured from precisely the same places, and using image-processing software to line up the old and the new, we have successfully created a detailed record of the comings and goings of Opuntia on South Plaza.

This decade-long toil has revealed some surprises. Over the last 50 years, roughly 70% of the Opuntia on South Plaza (and on some other islands as well) have perished. It is known that the extreme rainfall during an El Nino year can cause older and larger Opuntia to collapse. In addition, some cacti inevitably die from old age and other causes, such as desircation.

A steady stream of young cacti would normally compensate for such losses. Our photos, however, show that recruitment into the population virtually ceased in the 1950s. Indeed, we cannot find evidence of even a single new recruit that has survived past the juvenile stage. Using the height of each cactus as an indication of its age, we have determined that the age structure of the surviving Opunta is dramatically skewed.

What is going on? By comparing cactus populations on South Plaza and elsewhere in

the Archipelago, we think we may have the answer: an "ecological cascade" involving the demise of the Galapagos hawk on nearby Santa Cruz. By the 1950s, settlers had all but driven the hawks on Santa Cruz to extinction. In the absence of hawks – the main predator of land iguanas – the land iguanas on South Plaza had a field day, eagerly consuming all the fallen cactus pads and fruits, as well as seedlings, which are the three means by which these giant tree cacti reproduce. On other islands where there are both hawks and land iguanas, there has been no reduction in the recruitment rates of *Opuntia*.

This ecological cascade explains an otherwise puzzling fact about South Plaza. Although there is no evidence of new recruits in any of our old photographs, we have identified half a dozen cacti that have survived long enough to reach adulthood. All these specimens are growing in unusual places, typically on steep cliff faces, where land iguanas cannot reach them.

Now that the full extent of cactus loss on South Plaza has become clear, the Galapagos National Park and Charles Darwin Foundation, funded by a generous grant from the COMON Foundation in the Netherlands (comonstichting.org), have initiated an extensive reforestation program, with newly planted cacti being placed inside wire cages to protect them from hungry land iguanas.

These old Galapagos photographs have revealed far more than I ever could have imagined. Sometimes even the most ordinary images turn out to contain meaningful details of potential scientific value. I cannot help feeling that the study of such images – in Galapagos and elsewhere – has a whole lot more to tell us about the natural world and the impact we are having on it.

Left, closeup: Hungry land iguanas converging on a fallen Opuntia pad. Despite the numerous spines, a single land iguana can consume a large pad in less than 10 minutes. © Frank J. Sulloway.

Right: Frank J. Sulloway uses a laser-guided hypsometer to measure the distance of cacti from where a photograph was taken in 1967. © Eric Rorer.

Top: This 1970 photograph (left) from South Plaza shows 57 cacti. By 2006, when Sulloway returned to set up his tripod on the same spot, only 18 of these remained. There had been no new recruits. (right) © Frank J. Sulloway.

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If you have any photographs from South Plaza or Santa Fe, especially those taken before the year 2000, please do send them to Frank J. Sulloway (sulloway@berkeley.edu).