

Cyclura Behavior During a Hurricane

(Including notes on results of storm surge and wind on habitat plants.)

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The Atlantic Hurricane Season of 1998 was very active. There were ten hurricanes, including Hurricane Mitch, the strongest October storm ever recorded. On 25 September, 1998 there were four active hurricanes in the Atlantic Ocean, the first time since 1893 (National Hurricane Center). On 17 September, Hurricane Georges formed in the east Atlantic. By 20 September it was located 420 miles east of Guadeloupe in the Lesser Antilles with a peak intensity of 155 mph—a strong category 4 storm. On 21 September it grazed the U.S. Virgin Islands and Puerto Rico with 115 mph sustained winds.

In August 1978, Finca Cyclura was established as a permanent location to house a sustainable captive population of rhinoceros iguanas, *Cyclura cornuta*. The Big Pine Key site was chosen as the best possible location within the United States for a *Cyclura* breeding facility. Located about 105 miles north of Cuba, it is at the same latitude as the populations of the Bahamian iguana, *Cyclura cyclura inornata*. At that time, *Cyclura cornuta* was still being legally imported into the United States. It was felt that they would soon be listed under CITES as Appendix I and that they would continue to decline in Hispaniola due to habitat loss and unnatural predation. In 1980, the rhinoceros iguana was listed and became protected and importation was stopped. Finca Cyclura is a 3 acre site within the National Key Deer Refuge. It is located .4 miles inland from the eastern side of the second largest of the Florida Keys. The site was covered in native West Indian veg-

etation with elevations from 3 ft. above sea level to 4.7 ft. above sea level. Enclosures for *Cyclura* were constructed of concrete block cemented to the limestone cap rock that covered large areas on the site. Enclosures were constructed one to five blocks high with either 4 in. by 4 in. pressure treated pine, or 2.5 in. steel posts as supports for steel mesh fabric. All enclosures are at least 8 ft. high. It was well understood early in the project that hurricanes would have an impact on the site sooner or later.

On 22 September 1998, Georges struck the Dominican Republic with 120 mph winds and killed several hundred people. On 23 September, my wife and daughter evacuated the lower Florida Keys for central Florida. It was becoming obvious that the Keys were situated along the most likely path for this hurricane. The storm made landfall in eastern Cuba and tracked along the north coast on the 24th. By early morning on the 25th, Georges moved over the Straits of Florida and reintensified. I had spent four days preparing for the arrival. The house was boarded up with 5/8 in. plywood. Food, flashlights and over 40 gallons of fresh water were stored in anticipation of many days with no electric



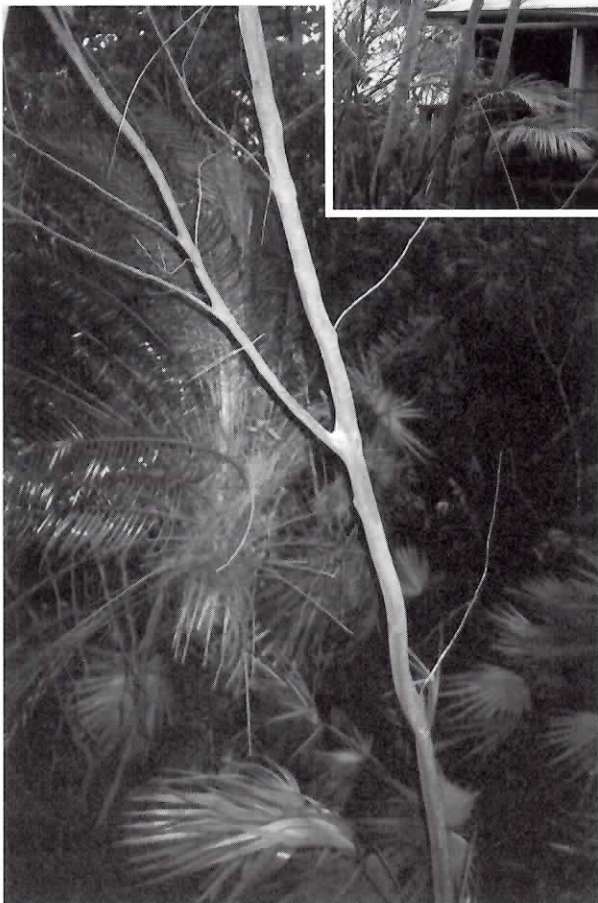
Winds blowing vegetation at 70 mph. Photograph: Robert W. Ehrig

power. Trees were trimmed and objects secured in anticipation of what was sure to be the worst weather in over 34 years. Thirty-four *Cyclura* were brought inside the house on the 24th. Another sixty iguanas would remain outside in their enclosures in what would be a real test of structural integrity. On the night of 24 September, I also enjoyed a meal consisting of all the food left in the freezer and I took a very long shower knowing this would be it. I put all the water I could fit in my empty freezer and went to sleep by midnight, knowing that hurricane conditions would probably not start before sunrise.

The Event

Friday, 25 September 1998 at 0600 hrs., I noticed that the power was gone. It was still dark as I got out of bed. The winds were at tropical

Right: The house after the storm—down, but not out.
Below: Palms blowing at 75 mph. *Photographs:* Robert W. Ehrig



storm intensity as I started to check animals by flashlight. I needed to check over twenty enclosures to make sure that no iguanas were in underground burrows where they could drown in the event of a storm surge. I moved my truck up the road to higher ground (about 7 ft. above sea level). The sun was rising by 0640 hrs. Only one iguana was found underground. The iguanas behaved as they did during storms, finding a secure spot in trees or among boulders and rockwork. All animals had been fed heavily in the days before the storm. Light rain was falling and the wind continued to pick up. I remember staring up at the large black olive tree, *Bucida buceras*, which, at thirty-five feet, towered over my house like a giant umbrella. I thought about the hours that I had spent a few days earlier trying to lighten the tree by trimming off hundreds of pounds of

branches. Its crown moved and shook in the wind. I checked iguana enclosures until 0945 hrs. by which time winds were at hurricane strength. The *Cyclura* all seemed calm and were tightly grasping whatever perches they occupied. All the enclosures have at least one solid side and/or

sections of steel roof. In most instances, iguanas seemed to find perches in wind shadows or in the most protected spot available. The wind blew solidly from due east. Trees were bent to the west and shaking violently. I sat on a porch in the lee of the building talking on the phone, amazed that it was still operational. Although the power was to be out for 11 days, the phone worked throughout the hurricane. I received several calls that morning including two from Europe. The storm center was 65 miles to the southeast of my location. This was just the beginning.

At 1030 hrs., I moved into the bedroom wing of my house knowing that I would be spending the duration of the storm there. This section is seven inches higher than the rest of the structure and has a 4 ft. by 10 ft. walk-in closet in the interior with the two main collar ties of the building running through it. All of the animals that I had

Right: Iguana enclosure covered in debris, but undamaged. Below: Tree damage.
 Photographs: Robert W. Ehrig



brought inside were in this building as well. The iguanas were boxed and bagged with some of the one-year-olds in mesh cages in my daughter's room. A large pair of very tame *Cyclura nubila* had the run of the bathroom. I cracked open a cold beer knowing it would be the last one for days. By 1100 hrs., the wind had picked up considerably. I tried to open the sliding glass door to the building but it was obvious that any movement out of the building was no longer possible. All of the windows were boarded except for part of the bathroom window and the three windows in my daughter's room. I had cut some pieces of 3/8 in. plywood to fit these openings in case of a window blowout. This afforded me a look at the storm which luckily had come during daylight hours. The sun never really did come out. It was overcast

all day but not raining very much. Georges was a dry storm. The sky had a yellow-gray look which I have never seen before or since. What the storm lacked in precipitation it more than made up in wind. Trees that I had grown or known for years had taken on strange positions and shapes. All were leaning or bent over to the west. As the wind increased, the remaining leaves were all being torn from the trees. Minute by minute the hardwood trees were becoming more bare. Palms folded over sideways. I also started to notice a few trees missing. The radio reported that the eye of Georges was moving into a position just south of Big Pine Key. The iguanas in the cages in the bedroom seemed normal, more concerned about my close scrutiny than about the storm outside. The Cubans in the bathroom seemed relaxed and normal, either unaware or unconcerned about the storm. The wooden house vibrated with the wind. Seaweed particles accumulated on the windows that were unboarded. We were in the eyewall.

At 1135 hrs., I noticed the first water on the ground below the building. The building is elevated above the ground level on 7 ft., 5 in. concrete columns and several inches of saltwater were now around them. I thought about the iguanas in their enclosures outside and the rapidly rising water. The wind was pulsing from the east, blowing steadily at 95 mph. The hurricane had moved in at high tide and I wondered how high this storm surge would go. The water was six inches up the column and rising quickly. I had a small shot of Ron Matusalem. The wind continued to pick up and the building gently vibrated, almost humming. At 1230 hrs., I wondered how long this

would last. The eye was staying south and the wind was unrelenting. I was getting used to the wind and it almost seemed to get quieter. Whatever this storm had to give we were getting the worst. The saltwater was a foot up the column and still rising. This could get serious, I thought. The trees I could see were shaking and bowed over. The wind was peaking at 110 mph. The seawater was at 22 in. up the column. It looked cloudy and white. It was surreal, as if this had been going on for days, not hours.

At 1310 hrs., the storm finally seemed not to be getting any stronger. The wind had shifted slightly to the south. The water at the base of the column had dropped an inch or two. The iguanas with whom I shared my retreat were as calm as ever. The wind still blew strong and I could sense

that if I tried to go out yet I would just be blown away. The water dropped another four inches.

At 1425 hrs., I left the building. I dropped to the ground and waded through the remaining storm surge. Trees were down everywhere and debris and branches blocked the paths. I was lost in my own backyard and becoming increasingly more disoriented as I tried to find my way around. I finally spotted some familiar spots and little by little found my way. I checked each of my animal enclosures, doing a fast head count and moving on to the next. In about two hours I was able to establish that everyone was alive. Amazingly, all the enclosures had survived intact. One had a large section of pine tree on the roof but was undamaged. On one enclosure, the wooden door hinges had come unscrewed from the frame but had remained in place. The water had continued to drop as I walked around—now it was just a few inches deep.

The iguanas seemed calm despite what they had been through. They had perched high enough that most would have been above the highest water level. In two cases, green iguanas were swimming around in the seawater in their cages. The *Cyclura cornuta* seemed to have found shelter behind walls and rockwork and hung on tightly during the storm. Our two Galapagos tortoises survived well although they had been floating during the peak of the storm. The 13-year-old was the one animal that seemed most upset. By 1600 hrs., winds were still strong but below 75 mph. It was over, and no one had died and no animals were loose.

Cyclura have existed for millions of years and over this time have adapted well to hurricane events. The islands where they evolved, whether small or large, are greatly affected by these storms. The instincts they have developed seem to ensure their survival. They assume a low profile, find a wind shadow above the water and hold on tight. Whether it is their innate wisdom, or their lack of it, they remain calm and survive. Georges was not a monster storm and surely if it had been a category 4 or 5 there could have been mortality. Hurricane Georges had a storm surge of 8.5 feet above mean sea level. A category 5 storm could have been double that. The instincts of these survivors would have still been extremely valuable to their prospects for survival.



BEFORE (inset): Large black olive, *Bucida buceras*, towers over the house at the start of the storm.

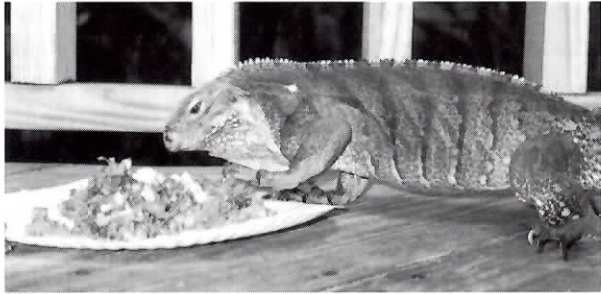
AFTER: The very same spot 28 hours later.

Photographs: Robert W. Ehrig

Notes on the results of storm surge and hurricane winds on habitat plants:

West Indian vegetation has evolved in a harsh environment. The plants that occur in *Cyclura* habitat are adapted to brutal hot dry conditions on thin soils in extremely rocky terrain. They are also affected by tropical storms and hurricanes. The tropical storms may bring heavy rains that the ecosystems absorb and produce abundant food crops that the iguanas depend on for survival. The vegetation is shaped by salt-laden winds on a daily basis and periodically may be submerged by extreme high tides that are produced by the passage of hurricanes. These storms may also produce extremely high winds. The trees and shrubs of *Cyclura* habitat are generally short in stature and have extremely hard woods or are designed to break apart during hurricanes.

The passage of Hurricane Georges on 25 September 1998, allowed me to experience the effects of a moderate hurricane first hand and to observe the results of the wind and storm surge on the vegetation. Finca Cyclura is located on the edge of the largest tract of pine rocklands in the Florida Keys. The native vegetation consists of pine and transitional West Indian hardwood hammock with some freshwater wetlands to the east. In addition, a number of palms and cacti of the Bahamas, Hispaniola, and Cuba have been planted on the site. Populations of many endangered trees and cacti of the Florida Keys have been planted on the site to ensure the survival of these plants as



This free-ranging, female Cuban iguana, *Cyclura nubila*, could not be found the day before the storm. She turned up the next day at her usual spot expecting a meal.

Photograph: Robert W. Ehrig

well. The populations of the cactus, *Opuntia corallicola* and *Opuntia triacantha* are the largest populations that now exist.

Hurricane Georges' winds affected the site for 28 hours. The storm surge flooded the site for about 10 hours. Four to eight inches of salt water were absorbed into the ground. The storm surge was 22-24 inches deep on the lowest parts of the property for 1.3 hrs. Some of the highest areas were not submerged at all. Other areas were submerged for various durations and to various depths. The shallow well on the property was 4 parts per thousand sodium chloride pre-Georges and 67 parts per thousand two weeks afterward. The salt water took over one year to completely work its way through the fresh water lens below the site.

On the following page is a partial list of the results of the hurricane on vegetation.

Acknowledgements

Thanks to David and Laurel Ehrlich for bringing a chainsaw and gasoline to me four days after Georges and returning to help run a chipper a week later. Thanks to Joyce Newman and Jack Benson for running in romaine, frozen vegetables, bananas, ice, and cold beer three days after the storm. Thanks to John Bendon for feeding a chipper for two days, two weeks after the storm.



A very shady spot 24 hours earlier. Photograph: Robert W. Ehrig

Conifers

Pinus elliottii var *densa*, slash pine

Within 90 days after the storm, 24% of this species was dead. The surprise was in June and July, 1999. After substantial rain, another 28% of the pines died within four weeks. It seemed that accumulated salts caused the mortality after they washed through. In Fall 1999, an additional 11% of the pines died. Mortality is at about 63%. Most of the oldest pines have died. Younger pines that have roots into plantings and filled areas seemed to be the most salt-resistant. Pines did well in wind. The pines in the forest to our west had about 10% treefall.

Palms

Coccothrinax argentata, silver palm

Pseudophoenix sargentii, buccaneer palm

Thrinax morrisii, brittle thatch

Thrinax radiata, thatch palm

All of these native palms, which are widespread in the Bahamas and other *Cyclura* habitats, did well. Many had distorted crowns from the wind but recovered completely within 1.5 years. The *Pseudophoenix* seemed most salt-resistant and liked the higher light levels after the storm. Only a few very low-lying palms were killed by salt. Several palms were broken in half by the wind.

Trees and Shrubs

Amyris elemifera, torchwood

No effects from storm

Ardisia escalloniodes, marlberry

Some salt burn

Bumelia celastrina, saffron plum

No effects

Bursera simaruba, gumbo limbo

Wind broke many trees, salt killed some low-lying trees that were exposed to long surge duration

Byrsonima lucida, guanaberry

Some low-lying trees killed by salt

Canella winterana, wild cinnamon

All trees above 3 ft elevation, no effects

Capparis flexuosa, limber caper

No effects

Casasia clusifolia, seven year apple

This iguana favorite was not affected by salt or wind

Chrysobalanus icaco, cocoplum

Some very low trees killed by salt

Chrysophyllum oliviforme, satinleaf

Most trees killed by salt, several high trees survive

Coccoloba diversifolia, pigeon plum

No effects

Coccoloba uvifera, seagrape

No effects from salt, some wind breakage

Conocarpus erectus, buttonwood

Slight salt burn on few plants, wind damage on large trees, and several large trees overturned but most did well

Erithalis fruticosa, black torch

No effects

Eugenia axillaris, white stopper

Slight burn on low-lying plants

Eugenia foetida, Spanish stopper

Some burn on low plants, most no effects

Eugenia rhombea, red stopper

No effects

Ficus aurea, strangler fig

No effects, some broken branches but both native *Ficus* stood up very well to hurricane winds for large trees.

Ficus citrifolia, short leaf fig

very well to hurricane winds for large trees.

Guapira discolor, blolly

No effects, iguana favorite

Guettarda scabra, rough velvetseed

Low-lying died, higher trees burned

Gymnathes lucida, crabwood

No effects

Krugiodendron ferreum, black ironwood

This extremely heavy dense wood tree was not bothered much by salt but the wind blew trees into strange shapes.

Lasiacis divaricata, wild bamboo

No effects

Lysiloma latisiliquum, wild tamarind

No effects from salt, wind mangled some trees

Manilkara jaimiqui, wild dilly

No effects, iguana favorite

Mastichodendron foetidissimum, mastic

No effects except leaf loss

Metopium toxiferum, poisonwood

Most no effects, few very low-lying salt killed

Myrica cereifera, wax myrtle

Most killed by salt, most killed islandwide

Nectandra coriacea, lancewood

All killed by salt

Piscidia piscipula, Jamaica dogwood

No effects, several overturned

Pithecellobium guadalupense, blackbead

No effects, some split by wind

Reynosia septentrionalis, darling plum

No effects, iguana favorite

Swietenia mahagoni, mahogany

Few effects, leaf loss, breakage