MARTIN TERRY

Stalking the wild Lophophora

PART 1 *Chihuahua and Coahuila*

Ay, Chihuahua!

Saul Ross State University graduate student Robert Hibbitts and I set off in my old Dodge truck from Alpine, Texas, in late May and crossed into Mexico at Presidio-Ojinaga, which is the only official border crossing between El Paso, at the westernmost corner of Texas, and Del Rio, some 500 miles downstream. Presidio, Texas is a town of about 3000 souls. Ojinaga, on the Chihuahua side, is considerably larger, famous for its delicious asadero cheese and its high murder rate. From here a scenic two-lane, Mexican Highway 16, winds through the massive mountains of northern Chihuahua to the state capital, Ciudad Chihuahua, where we arrived on the campus of the agricultural school of the Autonomous University of Chihuahua on the southwestern edge of the city. Hoping to receive guidance with regard to the exact locations of populations of *Lophophora williamsii* on the western edge of its range (and also of the range of the genus), we were disappointed to learn that no one had managed to locate a single *Lophophora* population in the state—valuable information nonetheless. Contrary to the report of Robert Bye, quoting anonymous sources suggesting that *Lophophora* occurred in "the hills west of Chihuahua City"[1], Dr Toutcha Zebgue told us that such an occurrence was extremely unlikely. Not only had peyote not been found there, but the geology was all wrong: igneous rock, rather than the limestone normally preferred by Peyote.

Disappointed but undaunted, we headed south-

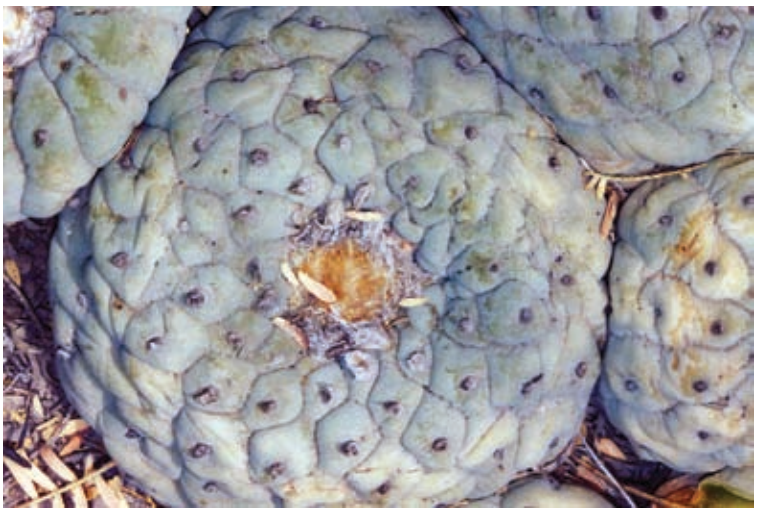
► On a limestone mountainside south of Viesca, Coahuila we found a montane population of *L. fricii*. Most plants here were single-headed. The unusual color of these plants is characteristic, as is their lack of prominent raised ribs that are typical of *L. williamsii*.

▲ The exclusive Little Cow Motel, Matamoros, Coahuila. A shower-curtain-like arrangement allows customers to hide their vehicles from public view, thus marginally decreasing the likelihood that their spouses will learn of extramarital dalliances.

east on federal Highway 45 (a well-maintained toll road equivalent to an Interstate highway in the US), toward the town of Julimes, where we had GPS coordinates for the one and only Chihuahuan *Lophophora* locality in the entire UNAM herbarium database. From Julimes we veered west toward the Sierra de la Amargosa, a range noted a century ago by Lumholtz as an area to which the Tarahumara had traditionally traveled from their homelands to harvest the *hikuli* (*L. williamsii*) that they used for medicinal and ceremonial purposes[2]. We drove fast down arroyo-cut dirt roads as the sun set, taking successive forks in the road too small to appear on the map, hoping to cover the remaining distance to our GPS coordinates before nightfall. As darkness descended we found ourselves on a road running perpendicular to the direction we needed to go, so we stopped to camp about a mile from our destination. Ranch-style beans (eaten cold, right out of the can) and tortilla chips served as supper, and sleeping bags on the ground beside the truck provided a welcome buffer from the chilly, spring-night wind of the Chihuahuan Desert.

The objective of our trip was to collect tissue samples from 15–20 representative populations covering most of the Mexican portion of the geographic range of the genus *Lophophora*, including populations of all four (now five!) of the *Lophophora* species that are generally recognized as valid by Continental European systematists,

▼ This *Lophophora fricii* at the Laguna site has 21 ribs, which is common here and in *L. diffusa* in Querétaro. Most globular cacti have stable configurations of ribs at Fibonacci numbers (1, 1, 2, 3, 5, 8, 13, 21…). For instance, *Astrophytum asterias* and *Echinocactus horizonthalonius* normally have eight ribs all their lives. *Lophophora williamsii* starts life with five ribs, transitions to eight by the time it reaches 5–6 cm in diameter, then switches to 13 ribs as a large adult (usually > 8 cm in diameter). *L. diffusa* and *L. fricii* follow the same pattern, but as large old plants they frequently jump up to the next Fibonacci number in the series.



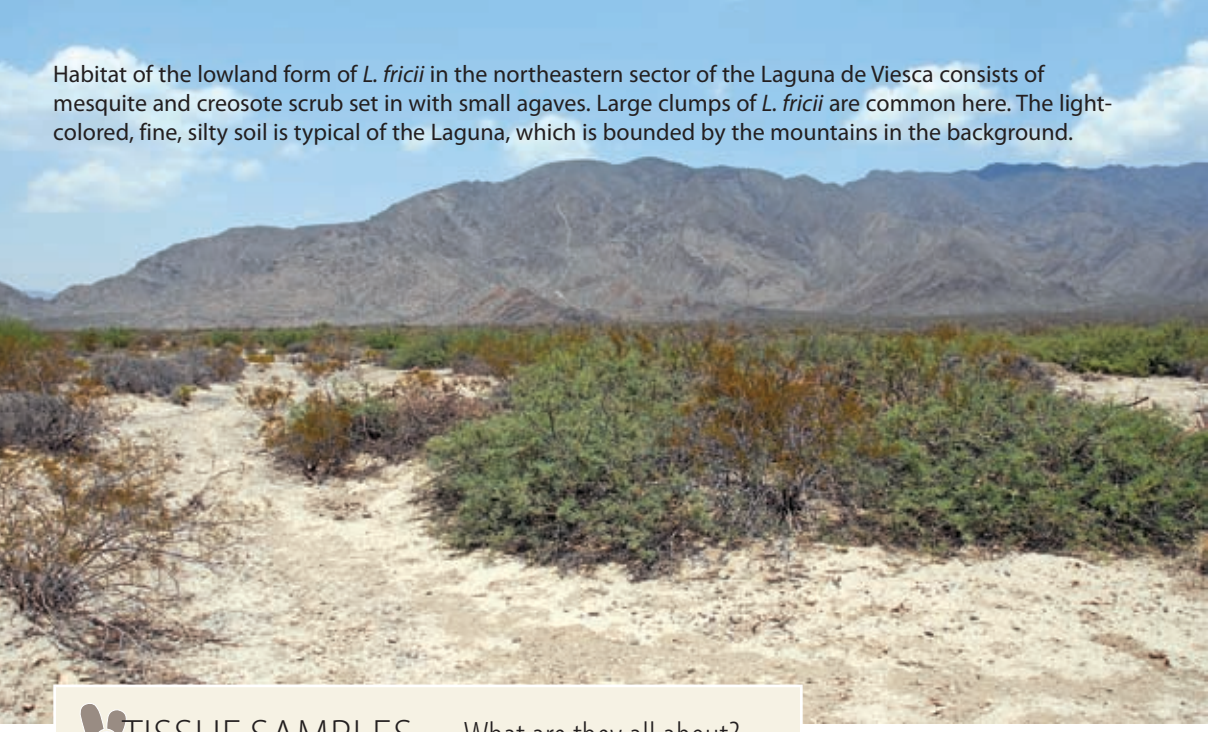
including the taxonomically contentious *L. fricii* and *L. koehresii*, which are not yet accepted as valid species by the Anglo-American oligarchy of cactus taxonomy[3]. The ultimate objective was to extract DNA from the tissue samples and use it to generate genetic data that we believe will constitute the substance of the first thorough study of the molecular systematics of the genus *Lophophora* (but more on that later).

The next morning we were up at dawn, hiking across the broken terrain toward our quarry. But as we reached the point where our Chihuahuan *Lophophora* should have been, none could be found. The habitat was perfect, but all we saw were shovel-shaped holes under *Larrea* nurse plants where peyote plants had been dug up, roots and all. The absolute thoroughness of the spoilers who dug the plants was amazing. We could find no remaining *Lophophora* plants—not even a seedling—in several hours of searching in ever-widening spirals from the GPS waypoint. Poachers had removed every one.

Coahuila

Admitting defeat in Chihuahua, we exchanged some dollars for pesos, filled the tank with diesel, and moved on to the Laguna de Viesca in southwest Coahuila. Taking Highway 45 southeast past the Bolsón de Mapimí to Gómez Palacio, then east around Torreón to the town of Matamoros, we arrived about midnight and stayed in

▼ On the northern side of the Laguna de Viesca, in silty mesquite-agave flats, a much different form of *Lophophora fricii* forms large clumps by repeated lateral branching of the original stem and its branches. The branching process starts when a plant with a single crown reaches the size of a large saucer. Then branches (consisting of small crowns) begin to erupt from the areoles at the perimeter of the parent plant's crown. When the new branches reach a certain size, they put down their own tap roots, making them independent of the parent plant that produced them, and then they begin to branch in turn. The result, which probably takes several decades to manifest itself and has no obvious endpoint, is a large clump of dozens of more or less connected plants, ranging in size from new branches that may be no more than a centimeter in diameter, to very large 21-ribbed plants that may exceed 10 cm across.



Habitat of the lowland form of *L. fricii* in the northeastern sector of the Laguna de Viesca consists of mesquite and creosote scrub set in with small agaves. Large clumps of *L. fricii* are common here. The light-colored, fine, silty soil is typical of the Laguna, which is bounded by the mountains in the background.

TISSUE SAMPLES— What are they all about?

DNA, the genetic material found in all living organisms, carries all the information that makes the organism what it is and enables it to function and reproduce. Because the sequences of bases in DNA inevitably change over time by such processes as mutation and natural selection, different sequences often develop in populations inhabiting different geographic areas. We can therefore get an idea of the degrees of relatedness among individuals from different populations by examining and analyzing their DNA sequences.

The first step in such a study is to collect tissue samples from which to extract the DNA. In humans this is relatively simple, as DNA can be easily extracted from cells that can be painlessly scraped from inside the mouth. In many plants, leaf tissue is suitable for DNA extraction. But cacti (wouldn't you know?) are more difficult. It's not that there is any shortage of DNA in cactus tissues. *Au contraire*, there is abundant DNA in the stem, particularly in those subdermal green cells where DNA is busy choreographing photosynthesis. The problem is that cacti also produce large quantities of mucopolysaccharides (yes, that's the same *muco* as in *mucus*), which give the inner stems of cacti their sliminess. Molecular biologists dread these long, branched chains of sugars, because they behave like a net and entangle the DNA in the test tube. DNA is therefore rather difficult to isolate from the primordial cactus goo.

One way of minimizing the problems associated with the cactus-stem polysaccharides is to use liquid nitrogen to disrupt the tissue in the lab. But that assumes that one has access to liquid nitrogen. Another option is to use *tepal* tissue instead of stem tissue. But that assumes that one will find flowers in the field. A third recourse is to collect the *epidermis* of the stem. The epidermis of *Lophophora* is exquisitely thin, so that in a sample the size of a thumbnail one may get only a milligram or two of dried epidermis. But we have found that enough to yield sufficient DNA for analysis.

Our strategy was to collect tissue samples from ten plants per population, with the constraint that we would not sample any plants located less than 10 meters from plants already sampled. The intent of this 10-meter minimum distance rule was to exclude plants most likely to be related as parents and progeny. Having selected a plant for sampling, the person doing the sampling would cut (with a clean knife blade) a piece of tissue about the size of a thumbnail and weighing 100–200 milligrams from the crown (the above-ground part of the stem) of the plant. The tissue sample was then placed in a snack-size zip-lock plastic bag labeled with the code for the location and the specimen number. The samples were carried in my backpack until we returned to the truck, whereupon they were transferred to an ice chest, where they remained cooled until we reached the lab where the DNA was extracted. A photo was taken of each cactus from which a sample was taken, and notes were made of the plant's physical measurements and habitat description, including companion plants.

the magnificent Motel La Vaquita (the Little Cow Motel), whose sign portrayed a small, happy, black and white cow. After the manager ascertained that we wanted the room for the whole night, he gave us the key in exchange for 140 pesos (about $12.50). The room boasted a window air conditioner (which meant you opened the window if you wanted relatively cool night air to come in from outside), a most welcome shower, and a television, on which we watched the news until we fell asleep.

At dawn the next day we drove to Viesca, a small city at the end of the paved highway heading southeast out of Torreón. Viesca is home to known populations of *Lophophora fricii*[4], and because this species is the subject of taxonomic controversy[5], I considered it important to obtain tissue samples for DNA analysis from one or more of the populations in the town's vicinity. In fact there are populations of very un-*williamsii*-looking lophophoras at several spots around the perimeter of a geologic feature known as the Laguna de Viesca[6], a dry depression that can become an ephemeral shallow lagoon during the rainy season. We collected tissue samples from one spot in the mountains on

the southwest side of the Laguna and from another in the silty mesquite-creosote-agave flats on its northeastern perimeter.

These plants are notably different from typical specimens of *L. williamsii*. In stem morphology, in particular the flattened tubercles, the "diffuse" boundaries between adjacent ribs, and the horizontal "double chin" basal folds around the stems of the larger plants, Laguna de Viesca plants are more similar to *L. diffusa* than to *L. williamsii*, which normally shows sharply demarcated, raised ribs, with no horizontal folds of tissue running perpendicular to the ribs around the base of the stem. And where *L. williamsii* is normally found growing in frank limestone or calcareous soils, *L. fricii* plants from the southwest side of the Laguna were growing from crevices in a hard type of limestone unfamiliar to me, and those from the northeast side of the Laguna were growing in loose, silty, alluvial soil, with no apparent limestone influence. Chemical differences are known from phytochemical work done on these species as well. The predominant alkaloid in *L. fricii* is (non-hallucinogenic) pellotine, the same as in *L. diffusa* and *L. koehresii*—not mescaline, the most abundant peyote alkaloid in *L. williamsii*[7].

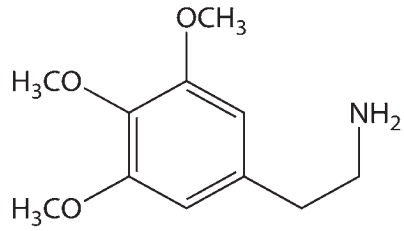
The two populations of *L. fricii* we sampled are also strikingly different from each other. One is a rock-loving, montane population; the other occurs in loose alluvial soils of lowland flats. In the montane population the plants are predominantly solitary (single-stemmed); in the bed of the laguna, the mature plants are largely

▲ *Lophophora williamsii* flowering on the south slope of a limestone mountain near Cuatro Ciénegas, Coahuila. The color and morphology of these plants, as well as the limestone mountainside they inhabit, are virtually identical to plants and habitats in Trans-Pecos Texas.

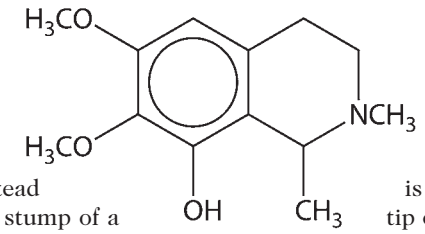
▼ On the northern slope of a limestone mountain north of Saltillo, *Lophophora williamsii* is found under nurse shrubs, cryptic and partly covered with fallen leaves from the nurse shrubs. There were mature peyote plants here, but they were neither large nor abundant, suggesting that this population had been harvested in the not-too-distant past. That is hardly surprising, given the easy access provided by the major highway connecting Saltillo and Monterrey.

caespitose, forming clumps approaching a meter in length. Although we were unable to find flowering plants under the parched conditions we encountered in late May, further differences may yet be revealed: it will be interesting to see if there are substantial genetic differences between these two populations, separated by only about 30 km but markedly distinct in their chemistry, morphology, and habit, as well as their habitat.

Mescaline



Pellotine



Nothing beats the exhilaration that comes with new heights of accomplishment, such as when we managed three flat tires in one day. The first one was occasioned by yours truly looking at the scenery of a small hill arising unexpectedly out of the flats of the Laguna de Viesca, instead of looking at the road. A little stump of a long-dead mesquite tree on the side of the dirt road was sufficient to stab a gaping sidewall puncture in the right-front tire. That left us with a shoddy spare tire on the road and a forever-useless flat in the bed of the truck. Not thrilled with the prospect of a second flat and no functional spare in this remote corner of Coahuila, we decided to head for the big city of San Pedro to buy a new tire. We ended up buying two, but attempts to locate a used wheel for my old truck, so as to have two mounted spare tires rather than one, met with failure.

As we started back to the Laguna de Viesca an impressive storm arose—no trace of rain, but the afternoon sky was dark with dust. We stopped at a roadside vegetable stand and fought the wind and grit until we found refuge in the shack of the vendor, whose cantaloupes were marvelously sweet and juicy. A particularly strong gust brought dust into the shack as we were devouring our sample slices. The vendor smiled and observed, "These violent dust storms are the thundershowers of San Pedro."

We got our second flat on the sharp gravel road back to the Laguna. That puncture was a small, repairable hole in the tread, and we decided to wait until the next day to fix it. An hour later, as sundown approached, we stopped to camp for the night and heard the hiss of our third flat tire. Fortunately, Robert had brought a small air pump that ran off the DC of the truck's electrical system, and the next morning, with the help of one of those pressurized products that squirts white goo in a tire to plug a leak, we were able to reach a ranch house where they had a bicycle pump that filled the wounded tire with enough air to get us back to the nearest *vulcanizador*.

Our next stop was Cuatro Ciénegas, a lovely oasis in central Coahuila, where it was relatively easy to locate a healthy population of *L. williamsii* from the list of localities in the UNAM database. The plants were growing in crevices and on natural terraces along the slopes of limestone hills, and morphologically and ecologically they were indistinguishable from plants that occur in west Texas. This is not surprising when you consider that Cuatro Ciénegas is only 250 km from the southern tip of the Big Bend.

Our next stop was on the northern outskirts of Saltillo, on Highway 40 in the direction of Monterrey. *L. williamsii* was not abundant at this site, but in the course of an hour and a half we were able to collect stem tissue samples from ten individuals separated from each other by a distance of at least 10 meters. Most of the plants were found growing under nurse shrubs and were partially obscured by leaf litter. In the more northern regions of its range *L. williamsii* shows an absolute preference for the south slopes of hills and ridges[8]. At the lower latitude around Saltillo, in contrast, the plants occurred on both northern and southern slopes, interspersed with some fabulous specimens of *Ariocarpus retusus*.

That night in Saltillo we met the bus to collect one of my former students, Lia Carrasco, who joined us for the rest of the trip, to be continued in Part 2: "*Zacatecas, San Luís Potosí, Nuevo León and Tamaulipas.*"

References

1 Bye RA. 1979. Hallucinogenic plants of the Tarahumara. *J Ethnopharmacol* 1: 23–48. **2** Lumholtz C. 1902. *Unknown Mexico*. Scribner's Sons, New York. **3** Anderson EF. 2001. *The Cactus Family*. Timber Press, Portland, Oregon. **4** Habermann V. 1975. Two red flowering species of *Lophophora*. *Cact Succ J* (US) 47: 123–127. **5** Anderson EF. 1996. *Peyote, the Divine Cactus*. 2nd ed. University of Arizona Press, Tucson. **6** Bohata J, Myšák V, Šnicer J. 2005. Genus *Lophophora* Coulter. *Kaktusy* (Special 2): 1–45. **7** Štarha R. 1997. Appendix IV, Chemický rozbor rodu *Lophophora*, pp 85–90 in Grym R. Rod/Die Gattung *Lophophora*. Vydavateľstvo Roman Staník: Bratislava. **8** Terry M. Personal observation.