Leptocereus paniculatus

A Newly Discovered Cactus in Culebra and Puerto Rico Endemic to Dominican Republic

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Index

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Introduction:

On **May 4**, **2009,** after a visit to the **VMT Leptocereus grantianus** population in **Culebra to collect stem segments for reproduction planting of the species**, Carlos Pacheco, Technical Officer, USF&WA and by Omar A. Monsegur Rivera, Field Biologist, USF&WA continued to **Punta Soldado** to carry out a general site visit and review and observe the flora of the general area. While exploring the peninsula they first discovered a new population of a ***Leptocereus*** cactus previously unknown to exist in **Culebra** or Puerto Rico as of then unidentified as to species. The new cactus was discovered on the top of a shoreline ridge on the **Punta Soldado** peninsula that is located at the tip of the **Playa Sardinas II Ward** of the island of **Culebra**, Puerto Rico in the southern ridge hilltop facing the Caribbean Sea. During this first visit to the new unknown cactus population, they noted the possibility of having found a different cactus that was similar in appearance and growth habit to the **Leptocereus grantianus** but was different for its stems had many spines**.** Its spines were smaller than the significantly larger spines of **Leptocereus quadricostatus** the other cactus of the family known to exist in Puerto Rico**.** The search for the correct species name began then.

The* Leptocereus** *cacti were originally described in 1905 as a subgenus of the* ***Cereus *genus by Alvin Surgens. It was raised to a full independent genus status in 1920 by Nathaniel Britton and Joseph Rose.* ***Leptocereus*** is a bushy, treelike, at times, but generally sprawling vine-like or arching shrub, with spiny areoles, thin ribbed with notched margins, many jointed segmented cacti with tubular to bell shaped flowers usually white or pale green. In the ***Cactaceae*** family Leptocereus is a genus of, today, some 15 known species first discovered in Cuba. It is native

of Cuba, Hispaniola, Puerto Rico and Culebra, many native to Cuba.[1],[2] The **Leptocereus** name is derived from the Greek "***leptus***" which means thin from the ribs or slender blades of the stems and "***cereus***" meaning waxen or waxy for its luster. It is generally rare to encounter these species in cultivation.

The Geographic Location and Description of Culebra:

Culebra, Puerto Rico is a small Caribbean tropical island archipelago of the eastern platform belt of the Greater Antilles Arc in the West Indies, consisting of one inhabited main island and 23 smaller offshore cays of exceptional beauty and natural attractions. It is located 18 degrees and 19.01 minutes north of the Equator and 65 degrees and 17.24 minutes west of the Prime Meridian. The island enjoys a temperate tropical climate refreshed by the northeastern trade winds.

Culebra is volcanic in origin and its geography is characterized by steep hills, sandy beaches, reefs, small neighboring islands, bays, coves and inlets. The island is very scenic with combined views of sea, land and sky and beautiful coves and beaches. The island is located approximately 27 km (17 miles) east of the "big" island of **Puerto Rico**, approximately 19 km (12 miles) west of **St. Thomas, U.S. Virgin Islands (USVI)**, and approximately 14 km (9 miles) north of the island of **Vieques** on the ***Eastern Puerto Rico geologic platform foundation*** of the **Northeastern Geologic Platform Bank of the Greater Antilles Arc**. The **Puerto Rico Platform** extends from Mona Island on the western side of Puerto Rico to the USVI and British Virgin Islands (BVI) to the East. **Culebra** is approximately seven miles long by five miles wide (11 by 8 km) and occupies an area of approximately 11.6 square miles or 28 square kilometers (6,741 *cuerdas*). It has some of the most beautiful beaches of the world. However, predominantly it has shallow shoreline coastal zones behind its beaches and rapidly rises from coastal cliffs to a hilly topography. Its highest hills are **Monte Resaca** with an elevation of 650 feet (198 m) and **Cerro Balcón** with 541 feet (134 m) on the north side. The central hill of the **VMT** parcel is the highest elevation point on the southern side of the island, in the Playa Sardinas II Ward, with an elevation of 350 feet (107 m).

The **Puerto Rico Platform** forms part of the **Northeastern Geologic Platform Bank of the Greater Antilles Arc**. The **Puerto Rico Platform** has to the north the **Puerto Rico Trench**, which includes the deepest part of the **Atlantic Ocean**, with depths exceeding 8,400 meters, where the **Atlantic Plate** does in a southern movement oblique convergence-subduction under the platform with a left lateral strike slip faulting in a westerly direction of about 2 cm per year. To the south, beneath the **Caribbean Sea**, lies the **Muertos Trough**, where oblique under-thrusting in a northern movement of the **Caribbean Plate** occurs. The **Northeastern Geologic Platform Bank of the Greater Antilles Arc** boundary has active tectonics, resulting in high earthquake and daily seismic activity. The most hazardous activity is located a distance from **Culebra**.

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1 Britton, N.L. and Rose, J.N., 1919-1923, The Cactaceae, 4 Vols., Carnegie Institution, Washington, D.C.
n, D.C.

2 Edward F., The Cactus Family, 2001, pgs. 391-395, The Timber Press, Portland Oregon

Identification of Species:

I was first introduced to the new unknown cactus population on July 13, 2012 by Carlos Pacheco, Technical Officer, USF&WA., after he completed another visit to the **VMT Leptocereus grantianus** population accompanied by Ricardo Colon Merced, USF&WA Wildlife Biologist of the Culebra National Wildlife refuge to our property in **Culebra** in reference to a new **USF&WA Partner Program Cooperative Agreement. Fundación Mi Terruño** and **USF&WA** recently entered into a Cooperative Agreement to propagate two new populations of the **VMT Leptocereus grantianus and to plant 1,200 native and endemic dry forest species to reestablish over a five year period the historical tropical dry forest of Culebra in the protected VMT Ecological Corridor of the VMT property**. They invited me and my daughter Suzanne M. Dubón to observe the new cactus find in Punta Soldado. We proceed to the ridge top and were able to photograph and observed for the first time the new unknown cactus population. The new population was observed as growing on the cliff top with a mature sprawling population. It had many similar features to the **Leptocereus grantianus** except for its spiny content and during our conversation Carlos advanced that it might even be a subspecies or variation of the **Leptocereus grantianus.** The **Leptocereus quadricostatus** was dismissed due to the significant difference in the size and location of the observed spines in the stems of the two species.

With the observation mental notes and the digital photographic record, I proceeded to carry out research on the newly observed unknown cactus species both in my flora library and in the internet. Excellent written and digital photographic material is now available in large quantities over the internet. The size and spread of features of the spine of the ***Leptocereus*** different species was a significant differentiator in the effort to classify the newly observed cactus. The extended search was further complicated by published growth habit of a number of plants since the observed unknown cactus had a sprawling growth habit although the suspect specie plant tended to be more erect and larger.

A matching picture of a young stem of the ***Leptocereus paniculatus*** was the determinant classification trigger since it completely matched the observed and photographed stem and spine features of the newly observed cactus in **Culebra.**

A second visit to the cactus population site on the top of a shoreline ridge on the **Punta Soldado** peninsula was carried out by the author to measure the population, count and estimate the number of plants and to additionally observe growth, height, spine retention and feature change with age in the older stems and base stems as well as other general growth area and features to assist in classification and description.

Figure 1: Photo A Vllardebo

Internet Picture[3] of Leptocereus paniculatus that assisted in Classification

Description of Species:

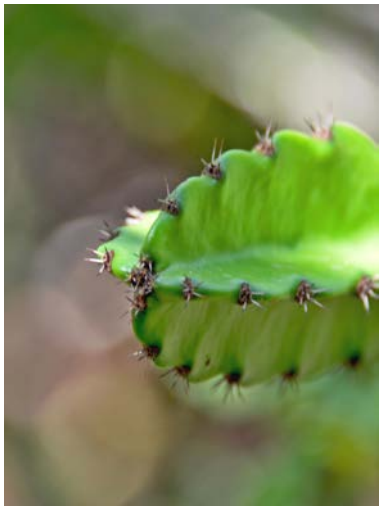
Leptocereus paniculatus **(Lamark) D.R. Hunt** was discovered in **Dominican Republic** and first described by Lamark in 1785 as ***Cactus paniculatus.*** The Latin meaning paniculatus describes its feature of "with the panicle branched from erect or at length nodding". It was later described by Nathaniel Britton and Rose in 1921 as Neobbottia ***paniculata,*** and in 1955 by Backeberg as a Neobbottia ***paniculata var humbertii***. it was finally classified as part of the **Leptocereus genus** in 1**99**1 by D.R. Hunt.

Leptocereus paniculatus[4] *has been described and photographed,* in **Dominican Republic***,* as a bushy, treelike, cactus known to have a much branched crowns that grow 6- to 10 m. (20-33ft.) high. The habitat setting of the treelike cactus is found in flat savanna type terrain with richer and deeper soils than those found in the rocky cliff top site in Culebra. That limits both rooting, nutrients and water retention so necessary for expanded growth.

[3] www.cactus-succulents.com, Photo a.villardebo
[4] Edward F., The Cactus Family, 2001, p. 393, The Timber Press, Portland Oregon

The mature population of the species recently found in ***Culebra*** in a rocky ridge is more sprawling vine like cactus, with ascending and erect stem branches both at the base and above, showing growth to about 3 to 4 meters in height with stems 3 to 6 centimeters (1.2 to 2.4 in.) in diameter. The new population was observed as growing over a rectangular extension of some thirty feet square on the cliff top with a population of around forty plants of different ages. Many are mature other seem much younger. Young shoots develop from mature rooted stems.The cactus bases of mature specimens are rounder and light gray-brown in appearance 6 to 12 centimeters (2.4 to 4.8 in.) in diameter at the base. It has no aerial roots.

The many jointed elongated stems without leaves are thin ribbed or angled and at times appear square. The stems have generally 4 prominent ribs and add height with new stems, distinctly notched and with broadly rolling scalloped edges. Ribs of the young joints are thinner and appear pointed at the tip. At the base of the rolling scalloped edges, small brown-felted areoles bear spines when young. At this stage, areoles, are dark- brownish tipped and yellowish when young and become grayish as the stem matures. They are persistent, needle like spines that are .5 to 1 cm long. Some spines disappear on more mature thicker ribs that have been gnawed by birds and animals.



Leptocereus paniculatus ***Leptocereus grantianus*** ***Leptocereus paniculatus***

The cacti plants appear vine-like but closer observation shows most plants independently support their stem structure. It has been observed free standing to at least up to three to four meters (10 to 13 feet) in this Culebra population.

The upper tips of the younger stems have spiny brown areoles up to the stem tip that are closer in distance and curved in the tip edges from where flower cephalia tubes develop.

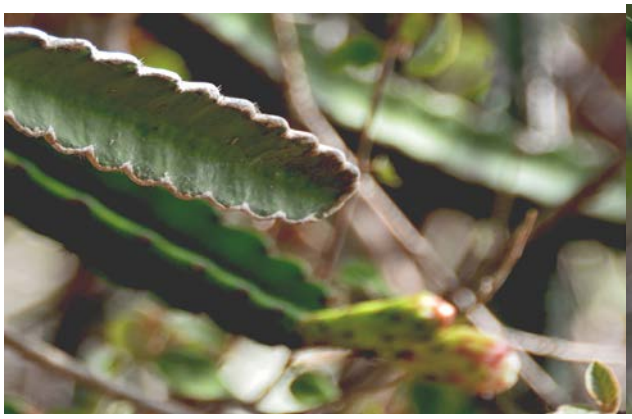
Cephalia flower tubes have been observed and photographed but actual open flowers have not been yet observed by the author on the ***Leptocereus paniculatus***. The specie's similar features of the cephalia tubes to those of the ***Leptocereus grantianus*** ***and description by others in the research literature,*** permits us to contingently describe the flowers as being of similar habit and feature as that of the ***Leptocereus grantianus*** including digital photographs of cephalia tubes with observed dry flowers on seeds as well as internet pictures.

Flowers are borne singly on terminal cephalia tubes. The tubes are three 3 to 6 cm long and about 1 to 1.5 cm wide. The terminal cephalia can be singly borne or form part of several flower stems borne at the edges of the tips of the rib stems. More than one flower tube can be borne from a single rib. The outer perianth segments of the flower tube are yellow-green, linear, and have similar small areoles-like scales notches like those of the rolling scalloped-edged top of the ribs. The flower tube opens to a campanulate ovary crown corolla that also displays the areoles-like scales notches around the crown.

The flowers greenish white-yellow or cream colored, oblong-ovate, obtuse to about 5 cm almost 2 inches long with many stamens and yellow anthers. The stigma lobes are several and small. The inner periath segments of the flower have a circular row of numerous white short corona filament hairs that radiate around the ovary crown and additional cream pollen anthers at the periath's central base with the two white taller styles having three radiating stigma all joined together in the ovary and surrounded in the corolla by two light yellow, cream-white concentric rows of 8 to 10 wider petals and about 8 to 10 petaloid sepals calys of the same color that combine around the crown at full flower opening.

The solitary flower is referenced as nocturnal with an extended early diurnal period of daily flowering. The flower emerges from the obconic (about 1 cm wide) ovary tube and opens at night from about 10 p.m. and remains open to about 10 a.m. This nocturnal flowering mechanism of the young flower, as well the brown-felted spot areoles around the crown, less than 1 millimeter long,. Bees and other insects provide the fertilization functions to the flower and ovary.

The green fruits develop as an oblong, subglubose to ellipsoid pod in the ovary of the flower-tube as the fertilized ovary shrinks the campanulate flowering crown, and grows and expands inside the cephalia tube to about 4 to 5 centimeters (1.5 to 2 inches) in diameter with a few of the original spine areoles of the flower-tube remaining around the fruit. The fruit produces numerous black seeds.



Ecosystems and Ecological Associations or *sub-ecosystem*:

Culebra enjoys a warm humid subtropical climate and its ecosystem may be described as a **Subtropical Dry Forest**, the driest life zone of the six zones present in the platform. **Culebra** has a dry season that extends from early spring to summer, except for hurricane events, and a wetter fall and winter with occasional rain events. There are no rivers or streams in **Culebra**. The island has dry drainage basins that activate during significant rain events. **Culebra**, contrary

to sections of **Vieques, St. Thomas, and St. John and well as in some of the BVIs**, does not have a subtropical moist forest area. Water and moisture has a significant impact on flora habitat composition.

Three distinct ecological associations or life zones are clearly identified within the **VMT** site. They are described as ***(i) the cliff association***, ***(ii) the dry forest association*** and ***(iii) the grassland association***. The three associations are interconnected as an ecosystem whole.

The ***cliff association*** is found in the extreme southern area of the property where steep seashore cliffs roll down to **Playa Cascajo**.

A particular characteristic of the **dry forest association**, that prevails throughout the interior hillside of **VMT**, is the low density and high separation between the small trees found in such terrain. Trees of some size and higher tree density may be noted generally in limited areas on the northern side of the site, particularly in drainage basins of the northern central hill and in some areas of the basin that drain southwest toward Fulladosa Bay in the southern half of the central hill of the **VMT** property.

A notable characteristic of the **grassland association** is the fact that it is manifested throughout a significant portion of the property; not only on top of the hills, throughout the central hill and southern and northern hill saddles and flat hilltop areas where the local vegetation was removed for cattle grazing, but also in areas where some trees have developed.

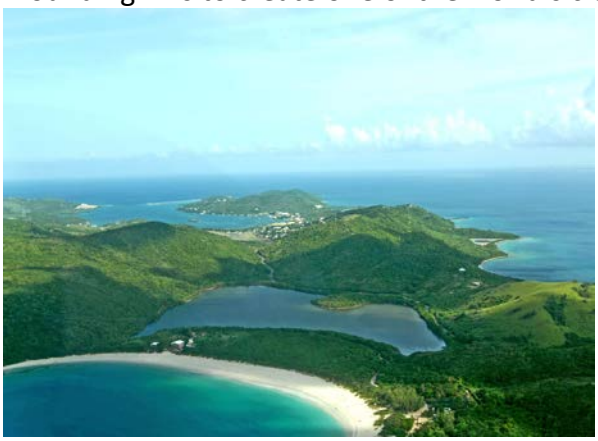
The coastal area of **Playa Cascajo**, in **VMT's** southern boundary, provides a proper habitat for coastal vegetation of the **Subtropical Dry Forest** zone of life. This coastal habitat is limited by the seashore's short depth and the immediate rocky cliff associations that are characteristic of the geography of the southern extension of the **VMT** site. The **Playa Cascajo** beach area is not deep or sandy and is covered by rocks or dead coral and crush shells ("cascajo").

The "*Cascajo*" designation for the beach area describes its fractured stone, dead coral and seashell ground cover in Spanish. Other areas of **Culebra** provide wider coastal habitat

extensions allowing for better development of coastal habitat plants within such areas and also allowing, in some sandy beaches, turtle nesting areas.

Culebra's Ecosystems, Ecological Associations and Sub-ecosystems:

Culebra enjoys a warm humid subtropical climate and its ecosystem may be described as a **Subtropical Dry Forest**, the driest life zone of the six zones present in the **Puerto Rico Platform. Culebra** has a long dry season that extends from early spring to the end of summer, except for hurricane event interruptions, and a wetter fall and winter with occasional rain events. **Culebra**, due to the lower elevations of its hills captures less moisture and rain events. In contrast to the more elevated sections of Vieques, St. Thomas, St. John and some of the BVIs, **Culebra** does not have a subtropical moist forest zone of life area or rainforest. This has a significant impact on its flora composition. Due to the limited rainfall there are no rivers or streams in **Culebra.** We can find a few drainage ponds naturally or constructed to control rain flows that also assist to control sedimentation and numerous dry drainage basins that activate during significant rain events. The drainage basins due to their function receive more water and retain creating a limited enhanced vegetation zone. This condition, except during hurricanes and sporadic significant rain events, reduces the regular low river-carried sedimentation transportation into the surrounding coast. This climatic ecosystem without river flows creates the conditions for **Culebra** to enjoy very clean beaches with crystalline water. The beach of **Playa Flamenco** in the northwest tip, for example, has the largest retention lagoon in **Culebra** created by its sand dune natural barriers into what was, originally, a longer shallow bay that naturally protects the beach and its water from the drainage and sedimentation of the surrounding hills to create one of the world's cleanest beach waters.



Ecological Associations

Very Clean Beaches

Ecological Associations:

As previously mentioned, Culebra is classified as a **Subtropical Dry Forest**, the driest life zone of the six zones present in the **Puerto Rico Platform**. Three distinct ecological associations are clearly identified within the **VMT** site. They are described as **(i) the cliff association, (ii) the dry forest association and (iii) the grassland or herbaceous association**. The three associations are interconnected as an ecosystem whole.

The **cliff association** is found in the extreme southern area of the property where significant seashore cliffs roll down to **Playa Cascajo**. This **cliff association,** as its names describes, is characterized by extreme cliff contours and narrow coastal areas.

Cascajo Beach Area

Cascajo Beach Cliffs Association

A particular characteristic of the **dry forest association**, that prevails throughout the interior hillside of VMT, is the low density and high separation between the small trees found in such terrain. Trees of some size and higher tree density may be noted generally in areas on the sides of the central hill of the site, particularly in drainage basins of the northern central hill and in some hillside basin areas that drain southwest toward Fulladosa Bay in the southern half of the central hill of the **VMT** property.

A notable characteristic of the **grassland or herbaceous association** is the fact that it is manifested throughout a significant portion of the **VMT** property; not only on the flatter top of the hills, throughout the central hill and southern and northern hill saddles and flat hilltop areas

where the local vegetation was removed for cattle grazing, but also in areas where some smaller invasive trees have reestablished themselves.

Herbaceous Associations

Herbaceous Associations

The coastal area of **Playa Cascajo**, in **VMT's** southern boundary, provides a proper habitat for coastal vegetation of the dry forest association. This habitat is limited by the seashore's short depth and the immediate cliff associations that are characteristic of the geography of the southern extension of the **VMT** site and **Culebra** generally. The beach area is not deep or sandy and is covered by rocks or dead coral and shells ("cascajo" in Spanish).

The "Cascajo" designation for the beach area describes its fractured stone, dead coral and seashell ground cover. Other limited areas of the island of Culebra provide wider coastal habitat extensions and even some sand dune areas allowing for better development of coastal habitat plants within such areas and also allowing, in some sandy beaches, turtle nesting areas.

Meteorology and Climatology:

Winds and Storm Events:

In general, the island of **Culebra** is subject to three wind patterns: (1) the prevailing **Caribbean trade winds** that blows at an average speed of 8 knots from the east-northeast November through January and from the East the rest of the year, (2) the **sea breeze** from the prevailing direction and (3) the **land breeze** that blows generally from the **Caribbean Sea** in the southeast side of the island, but is also known to blow from the equator to the south during the warmer months. Hurricane events produce an additional exceptional wind pattern that creates a changing counter-clockwise circular movement of wind of varying strengths, depending on the event, its speed, intensity, proximity and the direction of storm movement.

The Hurricane season extends annually from June to October with most storms occurring July to September. High energy storms cause significant damage to the property and infrastructure of **Culebra**. The storms originate off the western coast of Africa and generally move west or northwest direction tracking to the south, to the north or infrequently through Puerto Rico. Severe hurricane associated with el **Niño** weather influences from the Pacific ocean, occur every 10 to 20 years. The vegetation on the hillside also suffer damage from the strong winds and the coastal areas and beaches and sand bars suffer from the strong winds, higher se levels from storm surge, wave setup and storm wash. The beaches suffer flattening by reason of erosion and damage to the upper beach deposition of the lower beach away from the beach face. The trajectory also affects which side suffers more damage. However studies conducted following the passage of Hurricane Hugo that struck in September 1989 with its 140 mile per hour sustained winds indicate that the immediate post storm damage to beaches, sand deposits and corals is transitory and the beaches and corals recover. The studies conclude the fact of the recovery but the assertion that high energy storms may be needed to maintain the health of the delicate marine ecologies in the coastal areas.5 The vegetation was back on track and substantially recovered within two years except for the trees that were termite infested or uprooted completely.

The 1989 Hurricane Hugo storm that tracked northwest between St. Thomas and the east cost of Puerto Rico caused extensive damage destroying over 80% of wooden structures and homes in **Culebra**. The storm did considerable damage to hillside tree and bush cover. Approximately 100 of the 300 vessels that took refuge in the "hurricane proof" protected **Ensenada Inlet** were destroyed littering the shoreline The storm and waves lifted and transported a large VI ferry vessels that was on to the hill on the west side of **Fulladosa Bay** as some 70 feet above sea level. The wind rose available in the former Roosevelt Road Naval Station record an all-time high wind gust of 104 knots.

According to the wind rose available in the former Roosevelt Road Naval Base Airport and the St. Thomas Airport, the nearest official data published by the U.S. Weather Bureau, the wind in the proposed development site of **VMT** blows predominantly from the east around 40% of the

[5] Swab, Dr. Williams ,High Energy Storms Shape Puerto Rico Fact Sheet, USGS Coastal & Marine Ecology Program, hhtp://pubs.usgs.gov/fs/high-energy-storms/index.html

time and from the east-northeast 20% of the time. These two wind vectors represent the predominant wind direction 60% of the time. Windy days can produce wind bursts of up to 32 knots.

The trade winds generally blow from the east during the winter and from the southeast during the summer and in the evenings. The trade winds tend to refresh and cool the island surface and ambient temperature both during daylight and at night. The sea breeze and the land breeze generally blow in opposite directions. The counter movement from the southwest and the easterly counter flow cause inductive flows. Sea breezes are produced during the day due to the faster heating of the earth's surface on the island, which causes the cooler sea breezes to rise due to the inductive flow. During the evening, as the land cools, the circulation pattern is inverted. Limited precipitation ensues due to the lower elevation of the hills.

Temperature:

Culebra enjoys a year round tropical marine climate with gentle breezes. Temperatures in the main island of Puerto Rico generally become cooler with the elevation as we travel up to the central mountain range with slight temperature variances. In **Culebra,** the hills don't enjoy such microclimate differences due to their low heights. The **Culebra** hilltops will generally feel cooler due mainly to stronger breeze patterns and not real temperature differentials. During the winter season, the average temperature is 74 degrees Fahrenheit with November through April being the cooler months. During the summer season, from June to September, temperatures average 90 degrees Fahrenheit. Relative humidity averages 67% to 70% during the year but can fluctuate to above 80% during the wet seasons or during or after significant rain events. The more humid months are August to January.

Historical Precipitation or Rainfall:

There is general consensus that the late Pleistocene, Wikipedia defines it as "the geological epoch which lasted from about 2,588,000 to 11,700 years ago, spanning the world's recent period of repeated glaciations"6 was much dryer and as much as 8^{o}C cooler than today7 ." Relying on data from Curtis et al.20018 Lazell summarizes the last 8,000 years of precipitation as follow:

> "Precipitation increased dramatically to a peak about 8,000 ybp [years before present], when sea levels was about 20 m. below its current level. There followed a dry spell, with precipitation falling off to today's levels for about 800 years, then increasing to set the highest [during] Holocene, Wikipedia defines Holocene as "the geological epoch which began at the end of the Pleistocene (around 12,000 to 11,500C years ago) and continues to the present."9, record of about 7,200 ybp (ca. 8,200 radiocarbons ybp). There was

[6] http://en.wikipedia.org/wiki/Pleistocene
[7] Lazell,2005, Ibid. p. 108
[8] Curtis, J.,Brenner,M., and Hodell, D, Climate Change in the circum-Caribbean (late Pleistocene to Present) and Implication for regional biogeography. In Biography of the West Indies, 2nd Ed., 2001, Woods, C.A. & Sergile,F.E., eds. Pgs. 35-54, CRC Press, Boca Raton, Fla.
[9] http://en.wikipedia.org/wiki/Holocene

another drop to today's precipitations levels at about 6,000 ybp (ca. 7,500 radicarbons ybp). Then rainfall increased and continued to be high, right through the hypsithermal10 maximum, 6,000-4,000 years ago. The dramatic raise in sea level that brought the ocean up very close to today's levels, ca. 4,000 ybp, was not complemented by changes in precipitation: Conditions remained much wetter than they are now. About 1,680 ybp, a 500-year spell of rainfall (similar to ours today), a relative draught, began. Following the 500 year draught, rainfall increased sharply after 1,200 ybp and peaked in a brief pluvial-period centered about 1,000 ybp with conditions as wet as they were during the long Holocene span of 6,800 to1,680 ybp – and much wetter than now. Since that time climate has died down to what we live with today."11

Precipitation and Rainfall:

Precipitation on the island of **Culebra** is mostly of (1) **orographic nature**. When masses of air in sea breezes containing moisture pushed by **Trade Winds** are swept from the ocean onto land up the side of a higher hill, adiabatic cooling results and, ultimately, condensation and precipitation of short duration follows. The higher hilltop range in the north side of the island, by visual appreciation of cloud cover and precipitation events, seems to enjoy more rainfall during the year.

I have observed over the years that moisture clouds arrive to **Culebra** predominantly from the neighboring St Thomas in the northeast and during stronger easterly fronts or hurricane events from both the USVI and BVI. The masses of air in sea breezes containing moisture over the warmer ocean pushed by **Caribbean trade winds** are first swept from the ocean onto land on the neighboring higher elevations of St Thomas where they produce rain events. This generates moisture laden clouds that are pushed again by the same **trade winds** and continue to travel south westerly over **Culebra.** Its highest hills are **Monte Resaca** with an elevation of 650 feet (198 m) and **Cerro Balcón** with 541 feet (134 m) on the north side of the island. The higher elevation of these northern hills of **Culebra** have a cooler condition that allows them to receive slightly more rain than the lower elevations of the southwestern side but during the two rainy season, first in, May and next in September to November, many rainfall events reach the **Punta Soldado** side and southwestern shores of the island accumulating some rain and moisture.

There are two additional mechanisms responsible for rainfall in the Northeastern Caribbean: the (2) **tropical wave currents** coming from the east and the (3) **cold fronts (or "troughs")** coming generally from the northeast from the North Atlantic area of the North American Continent. **Caribbean trades winds** are refreshing and **the cold fronts (or "troughs")** from the North Atlantic area generate more winds and cooler temperatures in **Culebra** and its surrounding waters. The cold fronts events bring a northwesterly wind pattern that travels in southeasterly direction over the island pushing the moisture laden clouds from the neighboring **Caribbean** islands and St. Thomas away from **Culebra** to the **Cuenca de Vieques** channel south of **Culebra.** The cool air and ocean wave action that accompanies the front, cool both the

[10] A climatic phase in the early to middle part of the Holocene (q.v.)-lasting several thousand years-when conditions were appreciably warmer than today, is called *hypsithermal*. http://www.springerreference.com/docs/html/chapterdbid/4549.html
[11] [11] Lazell,2005, Ibid. p. 108-09

island's ocean water and land. This cooler climate and coastal water temperature annual climate period coincides with its dry season from January to April.

It appears that a phenomenon similar to the one that occurs in the Galapagos Islands in the Pacific Ocean is repeated in **Culebra** annually. In Galapagos the prevailing climate effect of the cool Humboldt Current causes the shores of the southern islands to be bathed in cool waters, chilling the air and creating unusually cold conditions for equatorial islands. During this period, rain is scarce on the coastal regions. Only plants that can survive long periods of time without water can establish and develop in these climatic conditions. In **Galapagos** every seven years the pastern is reversed, when the cooler Humboldt Current is interrupted by the **El Niño** climate phenomenon, which drives warm waters that are normally sent westward by wind and the Earth's rotation, toward the shores of South America and the **Galapagos Islands**. The **El Niño** inducted warm seas bring very heavy rainfall to the **Galapagos**. In **Culebra** the rain pattern impact of the cooler waters and **cold fronts (or "troughs") from the North Atlantic area** appears to occur annually. The **El Niño** phenomenon changes wind and temperature patterns that warm the waters of the Caribbean Sean and South Atlantic Ocean around the Equator with consequent changes in weather and climate patterns in the Caribbean Sea area and the southern Atlantic Ocean to the north. The **El Niño** inducted warmer climate and ocean waters also change the intensity, direction and frequency of annual Hurricane Events from July to October in the West Indies and the Gulf of Mexico.

Culebra's rainy season extends from September to November. Rainfall also usually occurs during the month of May followed by a dryer summer. This dry summer rainfall pattern is disrupted, by the annual hurricane or tropical storm season that lasts from July to October. During the hurricane season rain events depend on the direction, intensity and speed of travel.

Culebra, however, is considered to have a dry tropical island climate due to **extended dry seasons and low total annual accumulated rainfall**. The mean annual precipitation in **Culebra** averages 842 mm (84.2 cm) or 33.55 inches of rain annually.12 In 1994, the **USFWS' Recovery Plan** estimated mean annual precipitation was 975 millimeters (or 38.38 inches).13 However, rainfall in **Culebra** can range from a low of 16 inches recorded in 1967 to a high of 59 inches recorded in 1942.14 The greatest amount of rainfall was 27 inches recorded in May of 1979.15

A 2009 publication by Dr. Jose A Colón, who served as Director of the San Juan Office of the U.S. Weather Service for 23 years, provides a higher annual rainfall estimate. The publication indicates that "the data for a period of 19 years of the island of **Culebra** – located some twenty five miles from Fajardo – **indicates an annual rainfall of 41.5 inches or 1,054.1 mm**. The rainy season extends from May to November with less rain in June and July and a dry season from

[12] Geoffrey M. Bonnin, Deborah Martin, Bingzhang Lin, Tye Parzybok, Michael Yekta, David Riley, 2006: *NOAA Atlas 14*, ***Precipitation-Frequency Atlas of the United States***, *Volume 3 Version 4.0: Puerto Rico and U.S. Virgin Islands*. Silver Spring, Maryland, p. A.4-20.
[13] 1 inch = 24.5 mm
[14] Ordnance and Explosive Waste Search Repot [OEW], Feb, 1995, **USACE Defense Environmental Restoration Program**, Project No. I02PR006802, p. 8
[15] Ibid

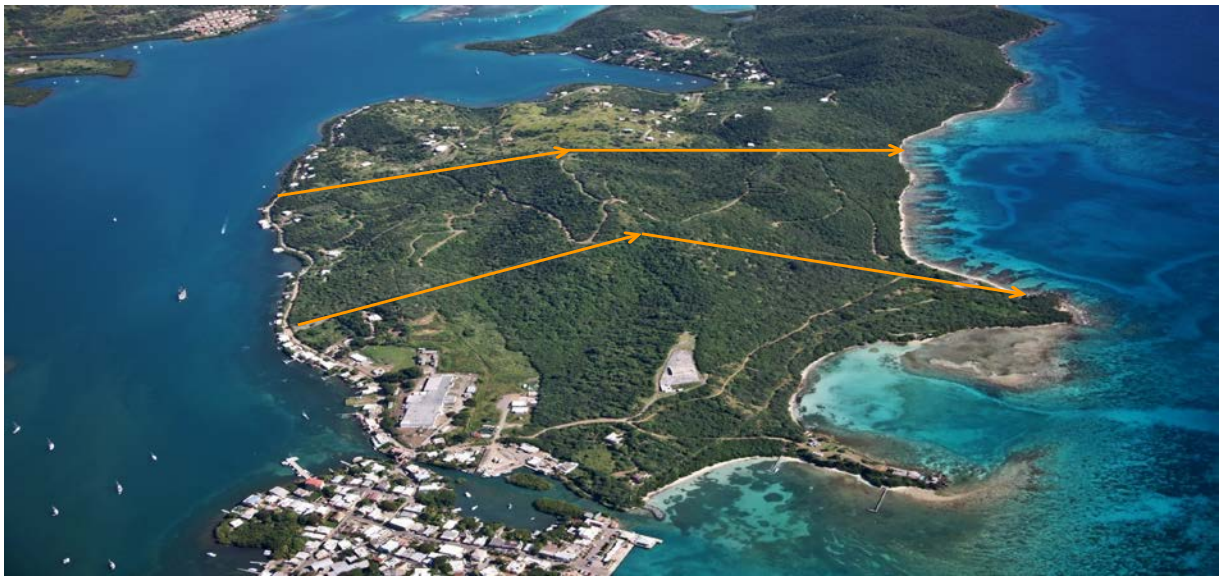
January to April."[16] (Translated from the original in Spanish) During 2013 we did an informal measure at **VMT** of some 39.5 inches.

The VMT Ecological Corridor ["Villa Mi Terruños Conservation Corridor"]:

Villa Mi Terruño is a ***model ecologically sustainable project of advanced master planning***, proposed on a **104 *cuerdas***[17] land site. It is located on three hills at the center of the **Playa Sardinas II Ward** in the **Punta Soldado** southeastern peninsula-like extension of the island of **Culebra**. It is located on three hills at the center of the **Playa Sardinas II Ward** extension in the southeastern peninsula of the island between the **Ensenada Honda Inlet** to the north and **Playa Cascajo** on the **Vieques Sound** of the **Caribbean Sea** to the south.

Villa Mi Terruño Location in Central Hill of Playa Sardinas II Ward

Aerial View of the VMT Site



The **Villa Mi Terruño** site sits in the middle of the ***southeastern urban development expansion belt*** from the town of **Dewey. VMT is a sustainable development that sponsors a non-profit foundation, Fundación Mi Terruño Inc. ("FMT")** dedicated to sustainable community development and improvement and the ecological, scientific and educational research and conservation of the local marine and land flora and fauna.

VMT is not a 104-cuerda development, as incorrectly alleged by some. As a matter of fact, the 28-cuerda portion of the site where the *Leptocereus grantianus* cactus grows is currently zoned **R0–1-C**, which permits the construction of two (2) homes per *cuerda* or 56 homes in total. All but three (3) of these **56 homes** were "relocated" from the **Playa Cascajo** drainage basin and the development rights transferred to the less sensitive areas of the property, thereby extending the **VMT Ecological Corridor** to protect the endangered cactus species and the **Cascajo Beach** coastal area drainage basin. The proposed ***comprehensive design guidelines of the*** project's Master Plan for the proposed long term recreational development will only

[16] Colon, José A. (2009). ***Climatología de Puerto Rico***. La Editorial, Universidad de Puerto Rico: San Juan, p. 123 and Figure 43.

[17] **One (1) *cuerda* = 0.971 acres**.

gradually develop ***33.7 cuerdas*** of land over a period of 15 to 20 years. P.R. {Panning Board Regulations do not permit fragmented proposed Master Plans and require the entire site to be master planned regardless if the original long term plan will be entirely developed for financing or economic demand reasons. The remaining ***70 cuerdas will be set-aside and protected*** in perpetuity by title transfers and conservation easements. **Such an extensive set aside to protect the natural environment is unique to VMT and generally unknown in propose development projects of this type.**

The original master plan was revised and the **VMT Ecological Corridor *concept incorporated***, after site visits and formal recommendations of the **USFWS** and **DNER,** to reduce the original conceptual size of the project. This was achieved by relocating and eliminating several of the proposed housing sites from the central hill areas by transferring the home sites in side clusters toward the outside margins of the proposed project site. The revision also included grouping some proposed sites closer together into clusters to minimize possible impacts upon the remaining portions of sensitive undisturbed natural habitat areas, to allow or enhance the area and continuity of the proposed green corridor and to relocate and transfer the proposed residential use to the previously disturbed cattle grazing areas.

The **VMT Ecological Corridor** extends from the **Playa Cascajo** beachfront on the southern side of the property of the **Playa Sardinas II** peninsula to the northern lower hill sides fronting on the **Ensenada Honda Inlet** area. The **Master Plan** proposed that approximately **70 *cuerdas*** be conserved and not developed. This significant protection of the flora and fauna ecosystems for future generations in the most sensitive environmental biota areas of the **VMT** proposed site is most uncommon in development circles. The voluntary set aside proposed by the **VMT *comprehensive design guidelines*** was adopted by the Planning Board of Puerto Rico and made **mandatory** when it approved and authorized the **VMT "Consulta de Ubicación"** or Master Plan in its Resolution of December 2010 and again in its more detailed approval in December 2012. ***The VMT Ecological Corridor includes the Leptocereus grantianus cactus and Hylocereus trigonus habitat areas.***

Villa Mi Terruño
Culebra, Puerto Rico
Culebra Resorts Associates II S. en C. por A., S.E.

July, 2014 Rev. Site Plan

110 residential units within 69 structures
64 parador rooms
15 rooms within 5 camp cabin clusters
1 service area

Leptocereus grantianus concentrations

Virgin Island Boa suitable habitat

Set-Aside Land

Common Open Space (outside parcels, lots and roads)	39.14 cuerdas
Half cuerda out of single family homes	18 cuerdas
"uncleared" land inside single family homes' impacted half acre (avg. 900 sm/lot)	8.5 cuerdas
"uncleared" land inside other lots (min).	4.46 cuerdas
Proposed total Set-Aside Land	***70.10 cuerdas***

The **Green Valley Area** between the central hill and lower south hill that a pristine developed dry tropical forest area.

Green Valley Looking Toward East SE

Mature Tree C Cover Area Inside Green Valley

Propagation of Plants:

The VMT Ecological Corridor protected habitat area will be used to plant new populations of the newly discovered *Leptocereus paniculatus* to propagate new population growth areas in perpetuity within the conservation corridor.

FMT personnel will be carrying out the establishment of two ***Leptocereus grantianus* and one *Leptocereus paniculatus*** populations in the **38 cuerda contiguous reserve corridor of the VMT Ecological Corridor** in collaboration with the USF&WA pursuant to a cooperative agreement under the Partners Program. In addition 1,200 new trees will be planted over five (5) year period to reestablished the original dry tropical forest of **Culebra** in the **VMT Ecological Corridor.2**