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BIOMIMICRY: NATURAL SYSTEMS IN SITU ANALYSIS AIMED TO RAIN WATER HARVESTING

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Abstract. Water is a valuable natural resource for life, but the poor management is making it scarce. This lack of care has created a series of social and technical problems, including the difficulties to distribute it to individual homes, particularly in Mexico. In order to solve such problems, it is necessary to find alternatives for its harvesting, care, distribution and use; allowing to reduce social stress, as well as allowing for a better water stewardship. One option is using Biomimicry and design as tools to find innovative, sustainable solutions. The conclusions of this current research project show how two different Mexican plants of notable importance, in economic and even gastronomical terms, had been analyzed through the eyes of the Biomimicry in order to extrapolate possible solutions of water harvesting and distribution. The aim of this paper is to discuss the results of such analyses.

Introduction

Population growth has put a considerable pressure upon Mexico's water supply, diminishing it in some regions of the country. The study of Biomimicry has less than 15 years of study, as a discipline aimed to analyses and study natural systems to emulate its characteristics and translate them into designs that can solve needs in a sustainable way. Using the latter to solve the former, it can be said that a possible way to harvest water from the environment to help the water supply; is using as inspiration of the way in which some plants native from Mexico's dry regions obtain water from the environment in an efficient manner. This is possible since these plants have evolved to extract water micro particles and keep them in their inner reservoirs.

Methodology

In order to carry out this study, the researchers took plant samples from different regions of the country: State of Mexico, Guerrero and Chiapas. Afterwards, those samples were dissected, dried and analyzed in order to understand how these plants manage to harvest and keep the water within. In order to do this, the project follows the Biomimicry principles laid out by Janine Benyus [1], the main biomimicry researcher. These principles are: Identify, Interpret, Discover, Abstract, Emulate and Evaluate.

Results and Discussion

The plants are identified as systems and the qualities the research is looking for are labeled as cases. The first thing to do is to establish what *cases* or needs are going to be researched and studied with the proposed plants. This is explained in Table 1 as follows:

Table 1. Identification and analysis strategy.

Case	Activity	Strategy	System to be researched
1. *Water Retention*	Search for natural systems that carry out each case	Search for water retention	Nopal Maguey
2. *Water Harvesting*		Search for dew	Nopal Maguey
3. *Water Accumulation*		Search for environmental water condensation	Nopal Maguey

In Table 2, it is presented a brief summary of the plants or *systems* analyzed and the results of such analysis.

Tabla: N° 1. Estrategia para identificar.

Plant	Description	Results
Common Prickly Pear Cactus	It is a member of the Plantae Kingdom, classified as Magnoliophyta (Angiospermae), Order: Caryophyllales Family: Cactaceae Subfamily: Opuntioideae Tribe: Opuntieae Genus: Opuntia A very common plant in Mexico, its inhabitant is located in the entire American continent, particularly in dry zones. [2] See figure 1	Ninety percent of its composition is water. Excels as water container since its external layer does not allow any liquid thanks to its texture, a very useful ability in dry zones. As well, its needles help to gather moisture and dew from the environment. It has to be noted that a cactus can remain sliced for six months and still preserve up to 60% of its water. [2]
Maguey	It is a member of the Plantae Kingdom, classified as Amaryllidaceae. [2] Clade: Angiosperms Clade: Monocots Order: Asparagales Family: Asparagaceae Subfamily: Agavoideae Genus: Agave Located in arid and semi-arid zones of Mexico. Its family is composed by more of 120 species as used to brew mezcal, a traditional alcoholic beverage See Figure 2	The maguey is a great water catcher in any of the three cases, since its branches and leaves catch and carry water towards the inner body. When dry it can be used in different handicrafts. The concave shape of its leaves help to have a more efficient water collection. [2]

Figures 1 Common Prickly Pear Catus

Figure 2 Maguey .

One of the tests consisted in taking a prickly pear cactus with a weight of 460 grams. It was grinded and then dehydrated, leaving us with a total weight of 50 grams. This is approximately equivalent to 10% of organic material and 90% of extracted water. It is remarkable to notice how much water one of these plants can hold up and for how long. The same procedure was carried out with a maguey's leaf and it held similar results. It has to be noted that in the maguey's case, its ability to collect water depends more on the shape of its leaf, which is curved as in a receptacle, allowing the dew and the water product of the rain (if that's the case) and the condensation to run down towards the roots.

As a result, it was found that prickly pear cactus excels to solve *case 1* and *case 3* due to its great capacity to hold gathered water. This is a result of its internal structure that is similar to a web (see figure 3), allowing for much needed to space to hold water in a minimum of space.

Figure 3. Internal structure of a dried Prickly Pear Cactus.

In the case of the maguey, it excels at the three cases. The most meaningful result for this plant is how it's concave leaf shape work as canals to transport water towards the inner body of the plant and the roots. As well, its fibers showed exceptional strength, something already used in the Mexican textile industry.

Conclusions

It has to be mentioned that developing awareness about proper water stewardship is not only for benefit of human population but for the environment in general and as such, it is necessary not only to find new solutions to harvest it and give it to regions where it is hard to obtain. It should be avoided to pollute it with agents difficult to eliminate such as oil, soap, detergent or chemical

agents. In Mexico, the plants used for this research project are traditionally considered as an important resource in economic and food terms, as well as a base for several traditional beverages. Now, this study allows looking at them from another perspective, as inspiration for water collection and management technology, sustainable, cheap solutions to meet an important need, without a further environmental impact and with the aim of improving the quality of life of the population.

In the case of the plants analyzed in this project, it has been founded that they are viable examples of how to develop an artificial prototype for water collection. The next steps for the project are to develop models and prototypes to test their viability. This last proposition will be the next stage in the research project, to be carried out in the present year.

References

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