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Biomimicry Applications in Agriculture to Benefit from Water Renewable Resources

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Abstract : ***With coping or imitating life or nature (i.e. Biomimicry) to our field we will benefit from billions of years' experience, to produce product can live forever in difficult or critical situation with no waste or maintenance. Studying the way of plants, animals or insects adaptation to live in deserts and arid regions may help in establish a like model for the purpose of achieving sustainable development of water. The study is aiming to develop a vision for water supply sustainability by imitating nature and living organisms in its critical arid regions (e.g. Egyptian deserts). It presents examples of biomimetic models to obtain water from its renewable resources such as rain, fog, dew and desalination of sea water to be provided to arid regions. It is concluded that Biomimicry is the only way to sustain future which can help in non-stop providing of water to arid regions. It is recommended to use natural or eco-friendly resources for the purpose of achieving sustainability and clean environment at the same time and Obtaining water, from its renewable existing resources, using Biomimicry techniques and encourage governments to follow and fund the suggested techniques of obtaining water for agriculture and rural purposes, especially in arid regions.***

Keywords: Biomimicry - water sustainability - Agriculture – arid regions

1. Introduction

Could I find any researchers who were consciously looking to organisms and ecosystems for inspiration about how to live lightly and ingeniously on the earth? Why would not copy nature? Could I work with inventors or engineers who were applying into biology texts for ideas? ; Some questions asked by Benyus, (2002) and Lee (2011).

With coping or imitating life or nature to our field we will benefit from billions of years' experience, to produce product can live forever in difficult or critical situation with no waste or maintenance.

The word Biomimicry was first appeared in 1982 and was scientifically generalized in 1997. The Biomimicry was presented as a "new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems" (Benyus, 2002). American Heritage Dictionary (2011) and Collins English Dictionary (2014) shed light on synonyms of the word mimicry as follows: imitation; impression; impersonation; copying; mimicking; parody; caricature; the act or art of copying; the practice or art of mimicking; the close resemblance of an organism to a different organism or to natural objects.

The word is derived from Bio which means life and mimesis, which means imitation or simulation. It is the approach of science that deals with technological and technical problems by studying nature and biology and imitating its strategy. Basically, it is the name of the scientific field which converts birds to airplanes.

Biomimicry is an innovation approach that aims at finding sustainable solutions for the challenges facing man by simulating patterns and strategies that were time tested by nature. Its goal is to create new products, operations and policies for a better adaptation on earth on the long run and enable people to find solutions derived from nature for a healthy planet (http://biomimicry.net.). Omran (2016) stated that deserts occupy about ninety percent of the area of Egypt; which are arid regions. Conversely, sustainable development aims at improving our life and conserving the environment by reducing the pollution load. In other words, sustainable development means thinking about saving resources and obtaining clean environment for the near and far future.

This clarifies the research's problem in the following questions:

Can nature offer suitable solutions to attain sustainable development?

- How can living organisms (e.g. plants; animals; insects) of arid regions adopt themselves and obtain water in such critical situation?
- How can we transfer or convert the biological adaptation to technology and techniques to achieve water sustainability in arid regions?

2. The Research Goals

Developing a vision of how to apply Biomimicry to solve the water deficit problem in arid regions. Suggesting reliable and applicable examples to obtain water, from its renewable resources, and protect the environment, at the same time.

3. Approach to Biomimetic Investigation

Biomimicry science can be applied when engineers and biologists work together to understand the mechanism of the living world then trying to apply that on humans in order to attain the highest environment and economic efficiency (Benyus 2002). The concept of hydromimicry is related to biomimicry. By analogy, hydromimicry is based on emulating water's natural patterns, rhythms, and behaviors in the design of human products, technologies, and management strategies (Marrin, 2011).

Strictly speaking, Biomimicry simulates the characteristics of other living organisms like animals, insects or plants and apply them in the form of different technology and technique that would enhance man's daily life. Ghazy, 2015 stated that: "the idea of any Biomimicry design comes from a certain human need in a certain living environment, which represents the different resources given by God to man in order to fulfill his different needs". Thereby, Biomimicry could be employed in achieving sustainable development of water in arid regions. However, sustainable development represents a challenge in all fields generally and in Agriculture and water supply especially, in order to consider the environmental values, operation methods and used materials. In other words, the research approach is depending on renewable water resources (e.g. rain; fog; dew; sea water desalination).

Ecodesign and technological transformation are considered as approaches that preserves clean environmental industry for different fields. (http://Wikipedia.org/wiki/). Swart (2014) suggested a research approach, can mimic the mechanisms at work in nature to produce architectural structures that can sustain themselves (i.e. water dam evolves into a kind of living creature or organism with a roof-like structure opening or closing according to the seasonal rainfall).

So, monitoring and studying nature as model, then simulating life, will help in creating ideas to be employed in inventing and developing strategies and techniques for the purpose of sustainable solutions for human technical problems.

Ghazy (2015) suggested steps to Biomimicry technology and techniques, which are: defining the problem and its context and finding organisms with a similar problem, see what they do, find many divergent organisms to see which has the best most relevant strategy and translates the best strategy to a buildable thing, preferred to be made from ecofriendly materials, to solve the problem.

The approach where designers look to the living world for solutions requires designers to identify problems and biologists to then match these to organisms that have solved similar issues. This approach is effectively led by designers identifying initial goals for design (Fig 1). (http://biomimicryarch.blogspot.com.eg).

Figure 1: Design spiral "design to biology approach

4. Applicable examples of Biomimicry in Providing Water to Arid Regions

First we should stress that sustainable development depends on:

1. Man responsibility to save natural resources.
2. Nature, with its different resources, is employed in serving mankind.
3. To achieve sustainability you must follow a technology that is investing the natural resources and transfer it to solve problems and facing the non-renewable resources.

Selected examples of connection between Biomimicry and water sustainability

Example 1: A prototype to collect dew and rain water

Figure 2: A model of CHAAC HA water system collector

A prototype to collect dew and rain water, called CHAAC HA water system collector, was suggested and designed by (Autodesk group, 2013). The prototype was affected by two natural structures: plant epidermis and web of the spider. The plant's epidermis is filled with trichomes, structures that retain water; also its foliage arrangement was copied. It has the function of collecting and storing water. It was developed with certain materials with specific characteristics. It complies with the features demanded by the challenge: flexible, waterproof and rapid cooling. The structural basis of the product will be built emulating the structural characteristics of the spider web. It will be made of bamboo sticks. It is very resistant and durable in addition of having the ideal dimensions for construction and biodegradable.

Example 2:- Harvesting Desert rain, dew and Fog

Fig. 3 shows some suggested designs and explanation how we can catch fog and dew.

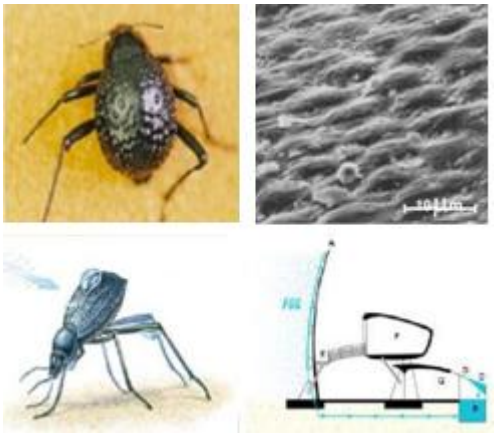

Figure 3: Fog harvesting beetle and it's like assembled device
(http://biomimicrysandiego.org; http://www.asknature.org/)

The Namibian Beetle raises its back into the air as fog rolls into its desert habitat. Bumps on its shell catch water droplets, which then run down chutes toward its mouth. The design of this fog-collecting structure can be reproduced cheaply on a commercial scale. Surfaces of wing covers on some darkling beetles gather water using nanoscale bumps and body position.

Example 3: Biomimicry and sea-water desalination
Fig 4 represents a natural water filter to be used in desalination of sea-water

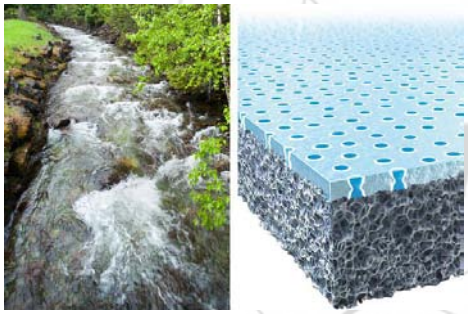

Figure 4: Nature's Water Filter (sea water desalination) (Research Office, 2015)

Sea water desalination is still extremely expensive, with reverse osmosis technology consuming a vast amount of energy. One solution being explored in Singapore, which opened its first seawater desalination plant in 2005, is biomimicry - mimicking the biological processes by which mangrove plants and euryhaline fish (fish that can live in fresh briny or salt water) extract seawater using minimal energy. Another new approach is to use imitate the selectivity of proteins in cell membranes (allows water to pass through cell walls while blocking out salts). The idea is using polymer-layering of traditional industrial films for the elegant complexity and energy efficiency of biological membranes (Research Office, 2015).

Sugessted stylisme of self-sufficiency country in water:
The stylisme could be employed in farms and houses at deserts and arid regions: It is a simulation of developed self filled water bottle (Fig. 5). Also, the idea of covering (with nanoscale bumps and body position and shape like specified beetle) the roof of houses in arid and hot areas (Fig. 6).

Figure 5: A like-beetle water botile
(https://encrypted-.com/-7H68bq8oqmlvFiQ)

Figure 6: A like-beetle african house
(https://encrypted-.com -XlOpx3yry).

People houses, green-houses and catchment areas suitable to irrigate open fields should be developed to imitate the beetle in its shape and naotextile, which prefered to be made using materials resist or tolerant to hot arid weather for longer durability. The harvested or collected water could be applied to the field directly or stored in tanks or surface wells to be given to the cultivated crops at the a sustain amount and interval. Such approuch not only help in providing sustainable water for deserts but also help in scheduling irrigation which is much better than rain Agriculture.

5. Conclusion

- Biomimicry may not be the easy way to sustain future, but it is the only way.
- Biomimicry could be employed in non-stop providing of water to arid regions.

6. Recommendations

- Using natural or eco-friendly resources for the purpose of achieving sustainability and clean environment at the same time.
- Obtaining water, from its renewable existing resources, using Biomimicry techniques.
- Encourage governments to follow and fund the suggested techniques of obtaining water for agriculture and rural purposes (e.g. establishing a model of country with water self-efficiency), especially in arid regions.

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Author Profile

Wail Omran received the B.S., M.S. and PhD degrees in Agricultural Science (i.e. Soil Science) from Department of Soil Science, Faculty of Agriculture, Menofia University in 1989, 1994 and 2001, respectively. Professional Career was as follows: Demonstrator - Assistant Lecturer – Lecturer – Associate Professor in Faculty of Agriculture, Menofia University. During 1997-1999, he stayed in Bio-systems Engineering Department, University of Hawaii, USA, to collect scientific data required for his PhD. Research Interests were using soil amendments and conditioners to improve poor and new reclaimed soils; soil water characteristic curve; salinity and drought stresses.