BIOMIMICRY OF GREATER CLUB RUSH (SCIRPUS GROSSUS L.F) AND WATER MIMOSA (NEPTUNIA OLERACEA LOUR): WETLAND PLANTS INSPIRING INNOVATIVE MODULAR DESIGN

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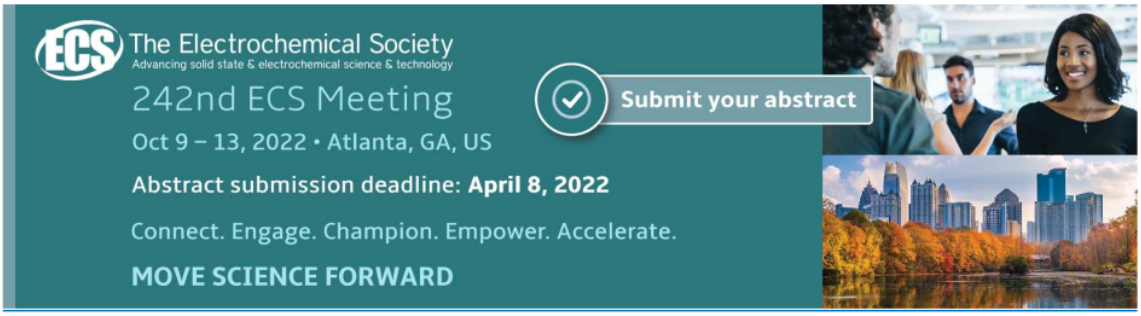

Biomimicry of greater club rush (*Scirpus grossus* L.f) and water mimosa (*Neptunia oleracea* Lour): Wetland plants inspiring innovative modular design

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Abstract. Intersection of three, terrestrial, aerial and aquatic ecosystems create a rich biodiversity and abundance ecosystem services, wetlands. A study of the Greater Club Rush and Water Mimosa, which are aquatic plants, as provision services has grown well and mosaic ornamented in shallow swampy land, has been carried out in 2021. This research aims to elucidate those plants capability to adapt of flooding situation and may inspire us about basic industrial prototyping products. For those, we calculate population density, basal area, height, biomass, bending moment and cut the stalk section to find out multi-folded a stalk like-stem. Also, we measure the length of leaves and weight of aerenchyma. The result shows the stalk of the Greater Club Rush is very possible to stand still to reduce the speed of flooding water, and Mimosa capability to floating it stem and branches as guaranty for photosynthesis in high tide water. In conclusion, those two plants have strongly possibility to adapt in flooding condition and inspiring us as a natural master copy of floating creative industrial modular designs to overcome the fluctuation of water level in the era of climate change, multi-folded walls and Tsunami floating capsules.

Keywords: wetland plants, provision services, mimicry, bioinspiration, sketch.

1. Introduction

The ones flora like plain green carpets inside the fringe of water and land is a strong indication of a fertile wetland. The Greater Club Rush stands nevertheless, strongly defend from the exposure of wind and flooding water. They developed well and occupied large massive areas within the low floodplain, dominating and intervening the native plant regions. With stand of approximately 1.5 to 2.0 meters, this plant reduces wind strain, and with sturdy leaves changed stems, also creates robust fences filtering garbage floating within the water.

Within the dry season, with almost no rainy days, no flooding, the Water Mimosa develops nicely and blooming, yellow flowers. Its branches grow from the main stem at some stage in flooding. Stem and branches will create a parenchyma modified air spongy blanket, aerenchyma which emerge a bouyancy. This apparatus is the approach to keep away from sinking leaves. There it has the opportunity to preserve photosynthesis.

This research elucidates properties of the more Greater Club Rush and Water Mimosa in helping their live flood adaptability as a suggestion about natural sensible of the vegetation, that they may inspire us to create mimicking product prototypes, multi folded wall and floating modular.

2. Methods

Desk study of literatures about wetland services, distribution of grass, sedge, rush initially collects about biomimetic and biomimicry information. Then, field survey to observe both the Greater Club Rush and Water Mimosa was observed in-situ at three Districts, where situated in freshwater wetland. We marked plots were setups with size 10 x 10 meters, and replicated at ten different places for counting of population density and measuring basal area for estimating the percentage of the occupied regions, as the ideas adopted and modified from Hayes et al. [1]. We balance the wet and dry weight to find out the relative water content of this plant, also measuring the length. We chemically analysed the plant using NaOH and KMnO4 to dialysis a natural fibre from the greater club rush and calculated Cellulose, Hemicellulose and Lignin concentration relative for comparing benefit to other wetland grass. We drew and ideated devise of these two plants to visualize their morphological figures, which bring possible solution for stand against the water current, as inspired by Lestari [2], and by Elena and Elina [3]

3. Results and Discussion

Through the technique of evolution, nature has advanced an extended history of experimentation where the fittest species live to tell the tale even as species that fail to conform quickly decline and become extinct. They stimulate to nurture creativity by way of looking past traditional manners and strategies and embracing interdisciplinary thinking so one can form the ideas of the future.

3.1. Greather Club Rush

Our observation on Club Rush shows that this grass grows well both flooding and inundated lands. Its height varies from 1.5 to 2.0 meters, stands in colony with a strong “stem” (a bundle of leaves), no branches, with a distance of 10 to 15 cm to each other stems. The stems have about 12 – 15 cm2 basal area and occupied 70 – 85 % area. The population is about 70 – 80 stems per square meter. We can see the density of this grass in the Figure 1

(a) (b)

Figure 1. The population (a) and density (b) of the greater club rush.

We can imagine there are 700.000 – 800.000 stems-like of this grass per hectare, that strong stand alike a huge fence. Totally, there are about 40 hectares Club Rush in our sampling area and about 450 hectares wetland grass ecosystem at this landscape. This grass reduces the speed of flooding and filter floating rubbish from the water. It causes a different result of flood situation in early 2021, flash flooding in upper river brings landslides, displacement of sedimentation, removing trash and damaging settlement, while flooding in down-stream just affect the fluctuation of water surface. The locals just create a new stair at the same home to response the increase water level.

The result of dissecting the strong “stem” of this grass shows that there is a multi-layers of young leaves, in three folded together tightly. Together, It has a lower bending energy, as well as shear energy

downward. This information may confirm to the reason why this grass can endures with water pressure. Some characteristic of the club rush show at Table 1, as follows:

Table 1. Dimension of the Great Club Brush.

No	Substrates	n	Average	
			Value	Unit
1	Cellulose	5	36.1	%
2	Hemicellulose	5	41.2	%
3	Lignin	5	10.9	%
4	Wet weight	5	66	%
5	dry	5	33,8	%
6	Heigh	5	195	cm individu^{-1}
7	Wet weigh	5	285	g individu^{-1}

The phenotypic character of this grass inspires us to adopt multi-layer folded as a model to create a simple prototype that possible for industrial products, such as folding door, multi-folded bullet proof, swing folded wall-pillar, rotary turbine. Those products may start with simple prototypes, models which mimic a simple natural structure like the Club rush folded leaves, and then they technically be developed more complex and sophisticated products through imitate biomimicry process [4].

With the kinds above of literature and experience, we thought about how people study to build a structural system that is more efficient, inventive, sustainable, and in extensive by emulating the shape, form, and function of nature, biomimetic. Biomimetic is not a novel method of adopting biological concepts, but it is now empirical. It requires some form of regularization, ideally introduced as a set of standard rules if it expands on recent accomplishments and serves our technological civilization. Biomimicry aids in the resolution of complicated human issues, aids in the resolution of complicated human issues [5].

Biomimicry offers an opportunity to mitigate risk to local ecosystems and directly draw on them for inspiring and creating design guidance, shifting from narrow damage control towards regenerative design, by drawing on locally-attuned design strategies that are adaptive, resilient and multi-functional. It was investigated what conceivable creation techniques can be planned in collaboration with nature and design. It will feature how the guarantee of biomimicry takes an alternate shape concerning development, manageability, and society [6]. The result has demonstrated enlightening and complicatedly woven with the aims of the plan, helping people by cooperating with nature and science [7].

Figure 2. Multi folded layer in 3D shape simulation.

There are five design principles to guide people who practising ecological engineering. The principles are: design consistent with ecological principles, design for site-specific context, maintain the independence of functional design requirements, design for efficiency in energy and information, and acknowledge the values and purposes that motivate design. Such structures are a reaction to the growing

need for engineering exercise to offer for human welfare simultaneously as on the identical time shielding the plants surroundings from which items and services are drawn.

3.2. Water Mimosa

Neptunia oleracea, Genus comes from Neptune, lord of the ocean, the Genus commonly perceived in English as water mimosa or delicate neptunia, is a pantropical nitrogen-fixing enduring vegetable. Gliding plant stems frequently structure thick tike the foliage mats, and as an obtrusive water-going weed of water. Furthermore, enormous carpets may frame those stifle streams, resulting in controlled water acceptance of the way things are, diminished water quality, decreased fish leisure activity, and loss of a couple of submerged and local wetland vegetation.

During the harvesting of this plant from the water lake, the woman and children get extensive contact with the plant, and they may risk skin problems such as hand and legs dermatitis (eczema). This plant has the potential health risk of these aquatic vegetables, as daily food consumption is unclear. Any risk assessment must consider the possible dangers of the remediation process itself. However, the locals have commercially used water mimosa, where it is farmed in ponds and harvested as vegetables, as well as in Cambodia estimated that 20% of the total daily vegetable consumption of Phnom Penh comes from these aquatic vegetables.

In Thailand and Vietnam, this plant is identified as the transmission of Fasciolopsisbuski, a giant intestinal fluke that can cause Fasciolopsiasis symptoms. Such as ulceration, haemorrhage and abscess of the intestinal wall, diarrhoea, and may eventually cause death. Fasciolopsisbuski is commonly . where these aquatic plants grow and is a common problem in these countries.

Figure 3. Water Mimosa grow suitable floating with aerenchyma.

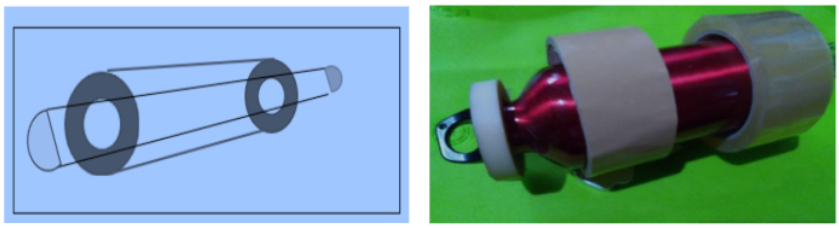
The water mimosa is a fast-growing plant that consists of multi-layered root epidermis and has high biomass, Verdure usually creates a terrible part as 6" tall. However, stems will unfurl inside the water to 3-5' extent. Stems are clad with bi-pinnate, good, mimosa-like delicate leaves that are close up when contacted. Essential leaf sections have 8-40 little rectangular flyers coordinated in inverse sets. This Minuscule greenish-yellow plants are thickly packed into padded orbicular inflorescences that sprout in the mid-year. The finish is level cases (to - 2" extended) much of the time noticed becoming prostrate in wet soils near the water's feature or coasting on the water in especially in any case water regions. Aerenchyma (spongy white air-carrying out tissue that offers stems buoyancy) forms on stems floating in the water but do now not shape on stems developing on the land.

Biomimicry aids in the resolution of complicated human issues, With the kinds above of literature, people study to build a structural system that is more efficient, inventive, sustainable, and inexpensive by emulating the shape, form, and function of nature. Biomimetics is not a novel method of adopting biological concepts, but it is now empirical. It requires some form of regularization, ideally introduced as a set of standard rules if it expands on recent accomplishments and serves our technological civilization.

Table 2. Dimension of water mimosa.

Samples N	Stemp without aerenchyme			Stem with aerenchyme	
	Length (mm)	Diameter (mm)	Density (gmm^{-3})	Diamemeter (mm)	Density (gmm^{-3})
1	150.0	8.5	1.3	13.0	0.7
2	128.0	9.5	1.2	14.0	0.7
3	135.0	9.5	1.4	13.5	0.7
4	120.0	8.0	1.2	14.0	0.7
5	125.0	8.5	1.3	14.5	0.8
Average	131.6	8.8	1.3	13.8	0.7
Min	120.0	8.0	1.2	13.0	0.7
Max	150.0	9.5	1.4	14.5	0.8

Biomimicry offers an opportunity to mitigate risk to local ecosystems and directly draw on them for inspiration and design guidance—shifting from narrow damage control towards regenerative design by drawing on locally-attuned design strategies that are adaptive, resilient and multi-functional. It was investigated what conceivable creation techniques could be planned in collaboration with nature and design. It featured how the guarantee of biomimicry takes an alternate shape concerning development, manageability, and society [7]. The result has demonstrated enlightening and complicatedly woven with the aims of the plan.



(a) (b)

Figure 4. Simple sketch of the branch and its aerenchym (a) nd a model of its possible product, a simple floating tubular mimics water mimosa (b).

Biomimicry offers a chance to relieve hazard to neighbourhood biological systems, yet to straightforwardly draw on them for motivation and plan direction—moving from slender harm control towards a regenerative plan by drawing on privately adjusted plan procedures that are versatile, strong, and multi-useful. No much people yet are aware of a way to engineer systems that offer humans the life–helping systems, that plant ecosystems produce at no cost. Therefore, ecological engineers need to incorporate ideas arising from complicated system research, which include emergence, scaling, self–enterprise, and unpredictability, into their conceptual version of an environment to successfully layout, manage, or restore such systems. Stenvinkel et al said for every 'burden of lifestyle, we should ask ourselves 'How did nature solve this?...[8].

Ecological engineering represents the harmonizing of ecology and engineering design, and as such, can have its most exemplary contribution in converting how a method is practiced in all disciplines. For example, ecological engineering may be described as light control that joins human design an environmental self-layout, so that they may be collectively symbiotic. At present, there may be no demonstrated opportunity to preserving the viability of Earth. Regardless of its mysteries and hazards, Earth remains the handiest recognized home that may maintain existence. Ecological engineering is the design of sustainable systems consistent with ecological principles, which integrate human society with its natural environment for the benefit of both [9].

Voltaire, "Originality is nothing, however really apt imitation". From ants to timber, nature gives several models [10] that could assist construction managers to develop new answers to complicated systems and techniques. As such, construction educators can be able to improve their curricula and assist nurture the creativity of their students by way of looking past conventional approaches and techniques, and embracing interdisciplinary questioning as a way to shape the thoughts of destiny.

Reconciling ecological resilience with engineering resilience; reconciling useful necessities, tolerances, self-enterprise, and succession; exploring the connection between strength, information, and complexity; figuring out how exceptional to address uncertainty; determining what values have to inspire layout; growing ecological engineering curricula; and setting up expert certification.

Twenty years after the human-overwhelmed age of the Anthropocene fostered ideas and designs, undoubtedly somewhat neutralize. Since that time, people and human innovation turned into an overwhelming component inside the biosphere, as it would never be demonstrated all things considered previously [11], the security of the biosphere as an essential piece of practical advancement requires the association of different sciences and cultural gatherings, the dangers and negative outcomes of innovation, to which the preparatory standard specifically responds, can eventually be limited [12].

4. Conclusion

Greater club brush and Mimose may also act as a nature's fashions which then imitates or takes the idea from these designs to clear up human troubles, like a solar cellular inspired by means of a leaf. This plant life gives beneficial models that may be used in technological know-how and engineering ideas to remedy human troubles, follow the concept of biomimicry. This exploration adds to existing information, whether a biomimicry approach can add to the age of practical developments. It fills the hole, chiefly in writing and, in one way or another, in proper testing regarding the advantages of utilizing biomimetic ideas to the board rehearses. At last, this paper about biomimicry isn't simply a fundamental examination of science. In any case, science research adds a layer of intricacy and makes the entire interaction fulfilling. In conclusion, this paper has introduced an entire system for expanding the ability of the scholarly community, and industry areas and to carry out a biomimetic place-based collaboration at certain scale of purposes.

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