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PLANTA

MAGAZINE

Cover story

Polyspora dassanayakei

Polyspora dassanayakei (දසනායකගේ මිහිරිය) is an endemic tree confined to montane forests and a relatively rare species which has been named in honour of late Prof. Emeritus M.D. Dassanayake.

BOTANICAL SOCIETY
DEPARTMENT OF BOTANY
FACULTY OF SCIENCE
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This volume is dedicated to

Prof. Emeritus Maliyasena Dhammadasa Dassanayake

for his tremendous involvement in Botany especially in the field of Plant Systematics in Sri Lanka.

Prof. Dassanayake has contributed significantly as a co-principal investigator to study Sri Lanka's flora project initiated by Prof. B. A. Abeywickrama.

This project was supported by the Smithsonian Institution, USA, in collaboration with the Department of Agriculture, and the University of Peradeniya, Sri Lanka. His dedication to this project, accomplished without modern technology, demonstrated his academic competence. He was keenly engaged in fieldwork, identifying new plant species, sharing his expertise with fellow researchers, and showing enthusiasm for plant taxonomy.

This monumental project spanned over 26 years and resulted in the publication of the 15-volume "Revised Handbook to the Flora of Ceylon," documenting the taxonomy of flowering plants and ferns. Following new plant species were named to honour Prof. M.D. Dassanayake for his involvement in the Botany of Sri Lanka.

Gordonia dassanayakei Wadhwa e& Weeras. Wadhwa & Weeras. (1996). In: M. D. Dassanayake & W. D. Clayton, eds., Revised Handb. Fl. Ceylon 10: 392

Polyspora dassanayakei (Wadhwa & Weeras.) Orel, Peter G. Wilson, Curry & Luu Nordic J. Bot. 30: 50 (2012),

Aponogeton dassanayakei Manaw. & Yakand. Phytotaxa 275: 235 (2016)

EDITOR'S NOTE

The PLANTA magazine was reissued in 2022 after a long quietness with a fresh look. Following the successful launch of our new digital issue in 2022, we continue to enjoy the unique experience that digital reading offers. Many of you have already written to share thoughts on the digital issue and to suggest ideas for future stories. From an economic point of view, it made sense to publish the magazine digitally once again this time as well.

Traditionally, the magazine featured articles, poems, drawings, and more, primarily contributed by students. As the senior editor of this magazine, I continued this tradition by expanding the scope to include submissions from students, staff members of the universities, and professionals in the fields of plant sciences. The goals of these changes were to provide readers with a broader perspective by sharing diverse insights and knowledge. This collective effort also helps identify students with various soft skills, enabling us to guide and develop their abilities.

I thank everyone who contributed providing articles, poems, drawings, and more. Finally, I deeply appreciate the committee members' solid support, dedication, and commitment to making this issue a success.

Senior Editor
Senior Prof. (Mrs.) Pushpa Damayanthi Abeysinghe
Dept. of Botany
Faculty of Science
University of Ruhuna
July 31, 2024

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SINHARAJA RAINFOREST

Sinharaja Rainforest, nestled in the heart of Sri Lanka, is a UNESCO World Heritage Site that stands as a testament to the unparalleled biodiversity and intricate plant ecology found within its lush boundaries. Covering approximately 8,864 hectares, this tropical rainforest is a living laboratory for scientists and a haven for nature enthusiasts.

Diversity Unveiled

One of the most striking features of Sinharaja is having an extraordinary plant diversity. This small area boasts an astonishing array of flora, with estimates suggesting over 3,000 plant species, many of which are endemic to Sri Lanka. The rainforest is a living museum, showcasing the succession and adaptation of plants over years.

Endemism and Rarity

Sinharaja is a sanctuary for rare and endemic plant species. Some examples include the iconic Sinharaja fern (*Cyathea sinuata*) and countless orchid varieties. Dipterocarpaceae shows an endemism of more than 90% . *Depterocarpus zeylanicus*, *D. hispidus*, *Garcinia hermonii, Xylopia championii, Mesua nagassarium, Loxococcus rupicola, Atalantia rotundifolia, Caryota urens, Calamus sp.,* etc. The presence of these unique plants highlights the ecological significance of the region, as it serves as a refuge for species found nowhere else on Sri Lanka.

Canopy Chronicles

The rainforest's dense canopy, which reaches heights of up to 45 meters, creates a thriving ecosystem where various plant species compete for sunlight. Epiphytes, such as orchids and ferns, find a foothold on tree branches, while lianas climb their way to the top. The vertical stratification of vegetation is a key aspect of Sinharaja's plant ecology.

Article by,
W.H. Ravindra Dayan
SC/2021/11876

CANISTEL
(Pouteria champechiana)

Canistel (*P. champechiana*), known locally as Ratalalawalu in Sri Lanka, is a tropical fruit introduced to the country from Central or South America. Today, it can be found in many areas such as Kurunegala, Kalutara, and Ratnapura. The genus Pouteria includes approximately 235 species, several of which bear edible fruits. Notable examples are *P. campechiana*, *P. viridi*, and (Kunth) Baehni.

Often referred to as eggfruit, amarillo, yellow sapote, sapote borracho, or zapote, these names reflect its texture and color more than its flavor. The deep yellow flesh of canistel is dense, smooth, and slightly dry, resembling a cooked egg yolk.

The *P. champechiana* tree is notable for its open canopy, light brown mature bark, and abundant latex. It typically grows between 3 to 7.5 meters (10 to 25 feet) tall, with spreading branches and alternately clustered leathery leaves. The leaves are usually oblanceolate, measuring 10–30 cm in length. The tree produces small, fragrant white flowers that often appear in clusters. The fruit of the canistel varies in form but is generally oval, measuring 5–12.5 cm (2–5 inches) long, and is orange-yellow in color. Rich in nutrients, canistel is an excellent source of vitamin A, vitamin C, and potassium.

Vitamin A is crucial for maintaining healthy eyesight and skin, vitamin C boosts the immune system and supports healthy skin, hair, and nails, while potassium is essential for maintaining healthy blood pressure and heart function.

Research on *P. campechiana* leaves and seeds has identified six compounds: protocatechuic acid, gallic acid, quercetin, myricetin, myricetin-3-O-α-L-rhamnoside, and myricetin-3-O-β-galactoside. The canistel fruit is versatile and is used in various foods such as ice cream and biscuits. It is also utilized in beauty products and medicine due to its nutritional and medicinal properties. Grown-in-home gardens, the canistel tree adds aesthetic value and contributes to a diverse fruit basket for growers. Its high vitamin C content and other health benefits make it a valuable addition to any diet.

The canistel is more than just another fruit. Because of its rich nutritional profile and wide range of uses, this tropical delight continues to gain popularity, offering both health benefits and culinary versatility. . Whether enjoyed fresh or in various dishes, canistel is a vibrant and nutritious choice for fruit lovers.

Written by :
Pramudi Kamburawala
University of Ruhuna
SC/2020/11284

UNVEILING THE SECRETS OF FLOWERING PLANTS

Flowers are the most beautiful creature in the world which is gifted by Mother Nature. Every plant cannot produce flowers. Any of a major group of higher plants that produce flowers, fruits and seeds in a close ovary are called as flowering plants.

These plants are called “Angiosperms”. They have some responsibilities to do. The major role of the flowering plant is plant reproduction. Flower is the main part of a tree which is responsible for plant reproduction. Pollination is the major way of sexual plant reproduction.

Pollinators are attracted by showy petals and sepals, nectar guides, shape, size and color of the flowers. Seed production and fruit production are the other functions of flowering plants.

Flowering is a complex biological process. Photoperiodism, age, temperature, environmental conditions, and vernalization are the main requirements in the flowering mechanism. Photoperiodism can be described as a response to the variances in day length that enables plant to adopt seasonal changes in their environment.

There are two types of plants according to photoperiodic responses. They are short-day plants and long-day plants. Short-day plants require long periods of darkness and long-day plants require short periods of darkness. The darkness must receive uninterruptedly.

They are day-neutral plants. This mechanism prevents the immature plants from responding to inadequate day length. The internal clock is another parameter which controls the flowering.

It is known as an “endogenous oscillator”. Four sets of genes are expressed in dawn, morning, afternoon, and evening which regulate the internal clock. Those genes need light as an external stimulus. This process is mainly containing six steps.

They are detection of light, absorption of light, Initiation in signal transduction, changes in gene expression, physiological responses, and integration of formation. Photoreceptors play a major role in this procedure.

Vernalization is the process by which certain plants require exposure to a time period of cold temperature. This condition can be seen in the plants in temperate regions. This method led to the acceleration of the flowering process. Also, this process contains similar steps to the photoperiodism.

There are a lot of hormones responsible for the flowering mechanism. They are Gibberaline, Auxins, Cytokinin, Abscisic acid, Ethylene and Jasmonates are some of them. Among them, some accelerate the flowering while some are delaying the flowering.

Water availability, nutrient availability, and soil pH are some of the external environmental factors that influence on flowering. In conclusion, there are a lot of theories and complex mechanisms under the flowering process. They are interconnecting environmental conditions and internal physiological processes with gene expression. All of these theories are created by nature. Most of them are hidden from the human eye. All of these theories are based on the existence of life on the Earth.

So, by revealing these secrets will enhance our appreciation of the nature and it will also help our applications in agriculture, horticulture, and ecosystem management.

H.M. Sandunika Ishani Kumari
SC/2020/11283

" Nature's Symphony with Bees "

In gardens green, where science gleams,
The bee and flower, dance in dreams
Petal's fold, and pollen's flight,
Hold secrets of herbal might

Through microscopes, with eyes so keen,
Nature's puzzles, slowly seen
In bees and blooms, we find the key,
To life's sweet fragrant mystery

Chlorophyll's grace, in leaves so green,
Reveals the wonders seldom seen
Photosynthesis, miracle grand,
Life's cycle, firmly stands

Bees and flowers, in bonds they share,
A tale of science, beyond compare
In partnership, we learn anew,
Nature's feast, vast and true

In botany's light, bees take flight,
Guiding us through nature's sight
In buzz and hum, they reveal the way,
To secrets of nature's grand display.

M.R.Sewwandi
SC/2021/11905

Nature's Toxic Beauty Flame lily

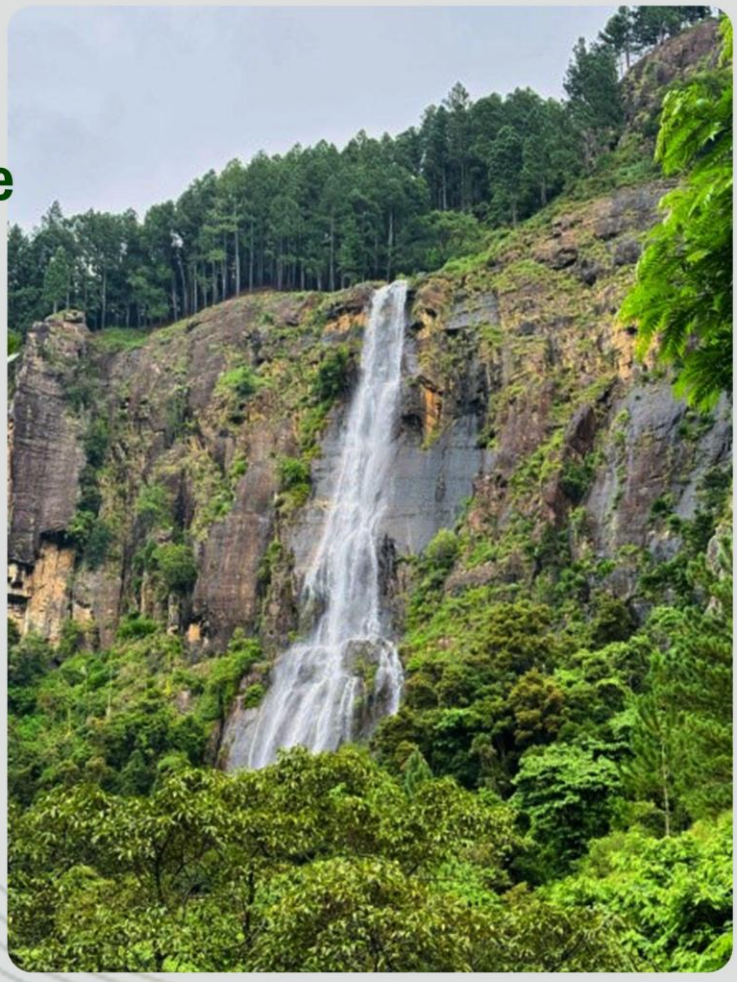
Blooming in all its glory as the name suggests, flower of *Gloriosa superba* is instantly attractive thanks to its vibrant red and yellow colours. This flame lily is also known as Fire lily, Glory lily, Creeping lily etc. Widely spread in Africa and Asia, all parts of this herbaceous perennial especially the underground tubers and seeds are extremely poisonous due to colchine and other related alkaloids. Despite this, Gloriosa is highly valued for its medicinal importance.

Name : K.M.B.L.Dharmasiri
SC No : SC/2019/10940

Waterfalls are showing mystery and beauty of nature Bambarakanda fall

A tropical un-trodden water falls which humidifies the air as well as keep the environment cool and irrigate the forest while support to maintain the biodiversity.

Name : K.G.A.D.Wimalasena
SC No : SC/2020/11321



Greenery Inside
Turning Your Living Space Into Green

Much of the scenic beauty of nature has been replaced by densely populated areas that sprawl for miles from urban centers. This visual pollution affects us all and leaves us longing for a closer connection with nature. In our busy lives, stress is everywhere. We often don't have the time to enjoy nature or the space to grow plants. But what if we could bring nature inside our homes? **"Greenery Inside"** is all about turning your living space into a green, peaceful place.With a little care, you can create a personal green oasis indoors. **Indoor plants** make this possible.

Figure: Examples of some popular indoor plants

Let's learn how to grow and take care of indoor plants successfully. These simple steps can put you on track for thriving indoor plant happiness

Choose Healthy indoor plants

- Always buy from plant vendors you know and trust.
- Check them thoroughly for signs of good health such as normal-sized growth, well-formed leaves or buds, well-anchored stems and, overall colour and appearance.
- Avoid plants with droopy or, wilted leaves, soggy soil, mushy stems or small and shrivelled growth.

Potting mixture

- The choice of a high-quality potting soil mix is key to your plant's health and happiness.
- The potting mixture can be varied according to the plant species.
- Common potting mixture for indoor plants

  Coco Coir – 3 parts
  Vermiculite - 1 part
  Compost - 1 part
  Perlite – ½ part

Fertilize Indoor Plants Regularly

- A high-quality fertilizer feeds plants and soil, creating an environment for sustained, vibrant growth.
- At planting, feed your new houseplant with a complete fertilizer.
- If the overall plant colour become slighter green, fertilize every two weeks.
- If the new growth is dark green but the leaves are small and internodes seem longer than on the older growth, decrease the fertilizer rate.

Provide Adequate Humidity

- Many popular houseplants are native to tropical climates.
- Signs that your houseplants suffer from low humidity **include leaf curling and yellowing, bud drop, brown leaf tips and susceptibility to pests.**
- To keep your plants healthy and happy, you can increase humidity in these easy ways:
- Spray water, a few times per day. Create a humidity tray by filling a saucer with small pebbles or polished stones, group plants together.

Water indoor plants properly

- Improper watering is the No. 1 cause of indoor plant damage and premature death.
- Under-watering causes wilting, loss of leaves and flowers, and brown leaf tips.
- Overwatering results in wilting, yellow or black leaves and fungal diseases such as root rot.
- Before you water, **do a quick check with a moisture meter or do it the old-fashioned way: Stick your finger down into the soil.**

Light and space

- Plants get energy for growth through a process called photosynthesis
- Some houseplants need less light than others, but even low-light indoor plants grow weak and spindly without the light they need.
- As a general rule, plants that need high light do well in front of southern-facing windows.
- Place medium-light plants in east-facing windows or 2 to 3 feet away from high.

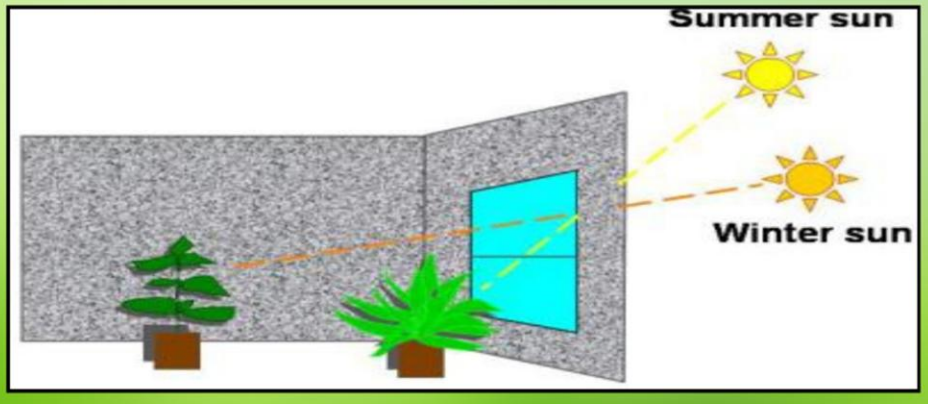


Figure: Within your home, changes in natural light penetration occur with the season

Groom, Prune and Re-pot as Needed

- Grooming and pruning your houseplants keeps them neat and attractive.
- Regularly remove any dead foliage and spent flowers with herb scissors or pruning shears.
- Every year or so, check houseplants for signs that they need re-potting.
- The signs can include slowed growth and roots growing out of drainage holes or above the soil line.

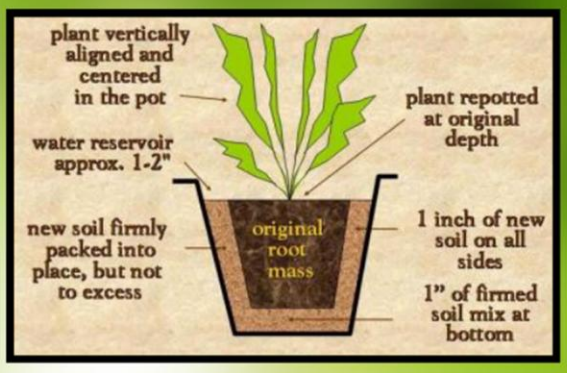


Figure : Properly re-potted indoor plant

Mealy bugs

Spider Mites

Control Pests

- Houseplant pests such as **mealy bugs, scale insects and spider mites** can wreak havoc on your indoor garden.
- It is important to check weekly for signs of infestation.
- If you find pests, isolate the affected houseplant immediately to safeguard the rest of your plant family.
- When using insecticides, follow label instrutions

Life time of indoor plants

- On average, indoor houseplants last 2-5 years.
- After that, plants stop thriving and it's best to invest in another plant

By following these tips on how to grow and take care of indoor plants, you can impress your family and friends. These plants clean the air, lift our spirits, and make your homes look beautiful. Remember, the best indoor plants are the ones you love to grow and enjoy.

So it's time to turn your home inside into green.

D.K.S.S.Kahawathaha
SC/2018/10419

Source : https://www.pennington.com/all-products/fertilizer/resources/8-steps-to-growing-a-healthy-indoor-garden-anytime

Lichens: Nature's Symbiotic Partners

Have you ever seen a lichen? Most of you may have seen them but are unaware they are lichens. Would you believe me if I told you that lichen is not a single organism? Did you know that these miniature plant-like organisms perform many important ecological and economical functions?

Lichen is a symbiosis of a fungus and one or more partners, called photobionts. The photobiont may be an alga and/or cyanobacteria. The fungus is the dominant partner giving most of its characteristics to the lichen. Fungi are eukaryotic organisms classified as heterotrophs. Algae are a diverse group of photosynthetic, eukaryotic organisms belonging to the kingdom Protista. In a symbiotic association both the organisms are benefited from each other. So in lichens, the photobiont produces simple sugars by photosynthesis and fungi obtain their carbon source in simple sugars and grow.

In contrast, fungi provide protection and absorb mineral nutrients and water for algae.

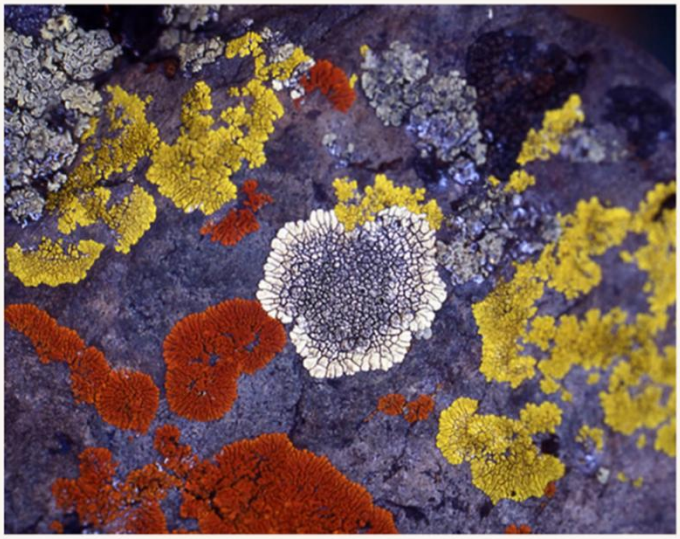
Lichens can thrive in some of the harshest environments on Earth, from icy mountaintops to scorching deserts. They are abundant growing on trees, rocks, soil, houses, tombstones, and hanging from branches in rainforests. It is estimated that lichens cover 6–8% of Earth's land surface. There are about 20,000 known species of lichens as well. Lichens show relatively slow growth and they are long-lived. Lichens absorb water and chemical nutrients from the air as they do not have roots.

There are three main lichen body types: **crustose, fruticose, and foliose**.

Crustose lichens form a crust over a surface and adhere tightly to a substrate. Crustose lichens can be seen in different colors like sunny yellow, orange, red, green, and gray.

Fruticose lichens can be hanging or upright and may be hair-like, cuplike, or shrubby in appearance.

Foliose lichens have two easily distinguishable top and bottom sides. They have flat leaf-like lobes.



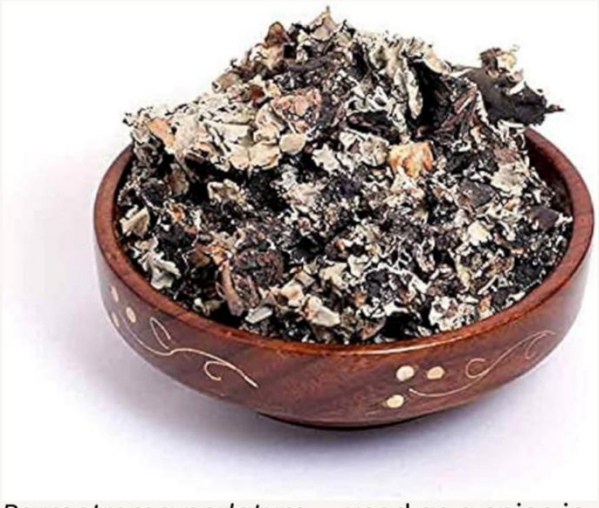
Many colorful crusts on a rock.
Source - U.S. Forest Service

Fruticose lichen -*Ramalina subleptocarpa*
Source - U.S. Forest Service

Fruticose lichen - *Cladonia fimbriata*
Source - U.S. Forest Service

Foliose lichen - *Pseudocyphellaria rainierensis*
Source - U.S. Forest Service

Lichens have been utilized in traditional medicine for a long time. They are most commonly used for treating wounds, skin disorders, respiratory and digestive issues, and obstetric and gynecological concerns. Lichens have a cultural history of use as a food. *Parmotrema perlatum*, commonly known as the black stone flower, is a species of lichen used as a spice in India. Edible lichens are fried, boiled, and pressure-cooked by Chinese people. Many colorful chemicals found in lichens are used to produce dyes.



Parmotrema perlatum - used as a spice in popular rice dish biryani, meat and vegetarian dishes in India

When considering the ecological background lichens contribute to the soil formation and growth of new vegetation. Many birds use lichens for nest material. From an environmental point of view, lichens can be used as an indicator of air quality. As lichens have no specialized protective barriers, they readily absorb contaminants. Therefore, with the air pollution lichens will not be able to grow. By looking at the number and type of lichens present in various locations, scientists can determine how clean or how polluted the air is. With these beautiful living creatures, the natural environment becomes more colorful and fascinating. So it is amazing to know the multifaceted importance of lichens.

However, these wonderful creatures are in series threat . Air pollution, habitat modifications, rock–climbing, mining, climate changes, and species invasion are responsible for the destruction of lichens in this era. Hence designing effective conservation strategies to protect lichen species has become an urgent need.

W.K.K.G. Wickramarathna
Botany Special Part 2
SC/2018/10346

Cradle of Tides: Ode to Mangrove Majesty

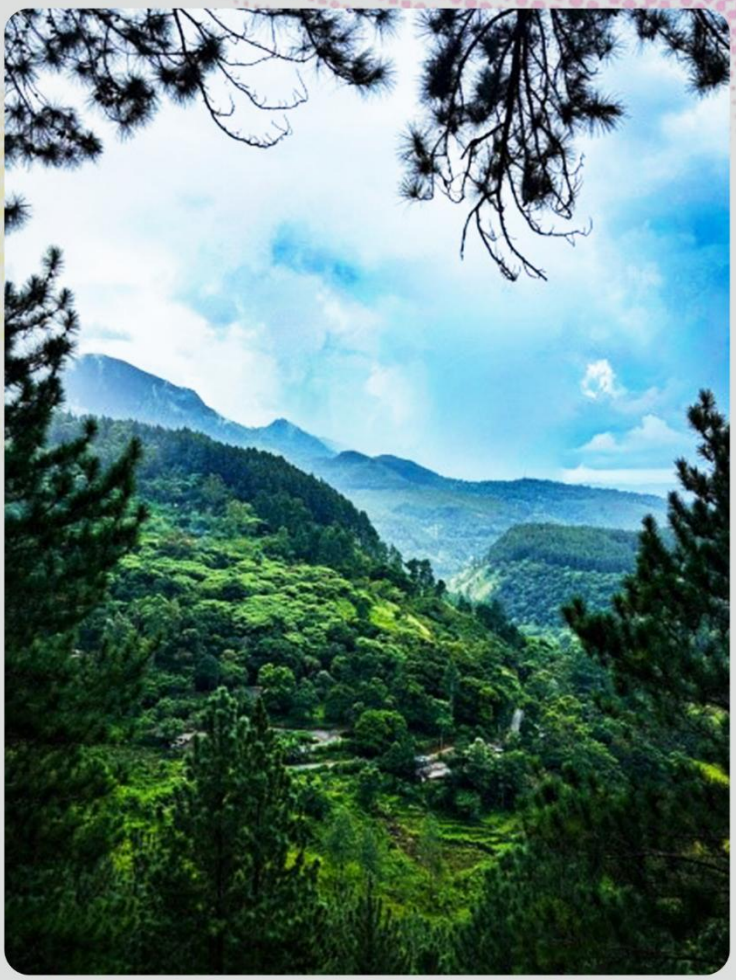
Under the canopy's verdant sway,
Where mangroves thrive and creatures play,
In the cradle of tides, whispers arise,
A symphony of nature beneath azure skies.

Roots intertwine, a labyrinth below,
Where life takes root and secrets flow.
In mud and salt, resilience found,
In mangrove majesty, a sacred ground.

Herons glide on wings of grace,
In silent dance, they find their place.
While crabs scuttle in the shadow's embrace,
And fish dart by in a watery chase.

With each ebb and flow, a rhythm unfolds,
In mangrove majesty, nature's tales untold.
So let us cherish this sanctuary true,
In the cradle of tides, where dreams renew.

Sulochana Rebeira
BSc. Sp (Botany). Hons.
"Batch 2008"



A blue sky framed by green

Name : T.D.D.K.Thanreewaththa
SC No : SC/2020/11800

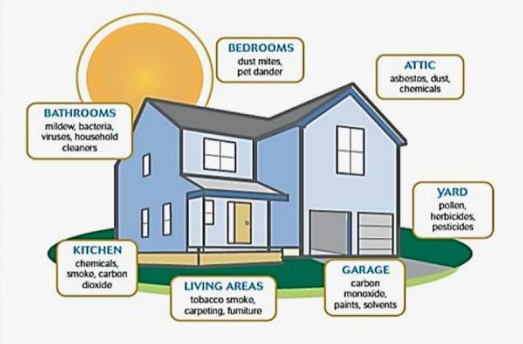
The sun's first light kiss tells the nature about silent stories of dawn.

Name : Hiruni Sooriyandara
SC No : SC/2020/11329

Heroes who protect us from the invisible threat of indoors.

Modern life has distanced us from the embrace of the natural world. Consequently, we are encountering numerous difficulties. Indoor air pollution is a one of these difficulties. According to world health organization, household air pollution was responsible for an estimated 3.2 million deaths per year in 2020. However, nature offers a remedy for us to mitigate this situation. That miraculous solution is indoor plants

Indoor air pollution is created by the release of harmful pollutants inside. These can include fine particulate matter, carbon monoxide, and various other toxins.
Many things cause indoor air pollution such as Cooking stoves, Cleaning products, Mold, Pet dander, fragrance, tobacco products etc.



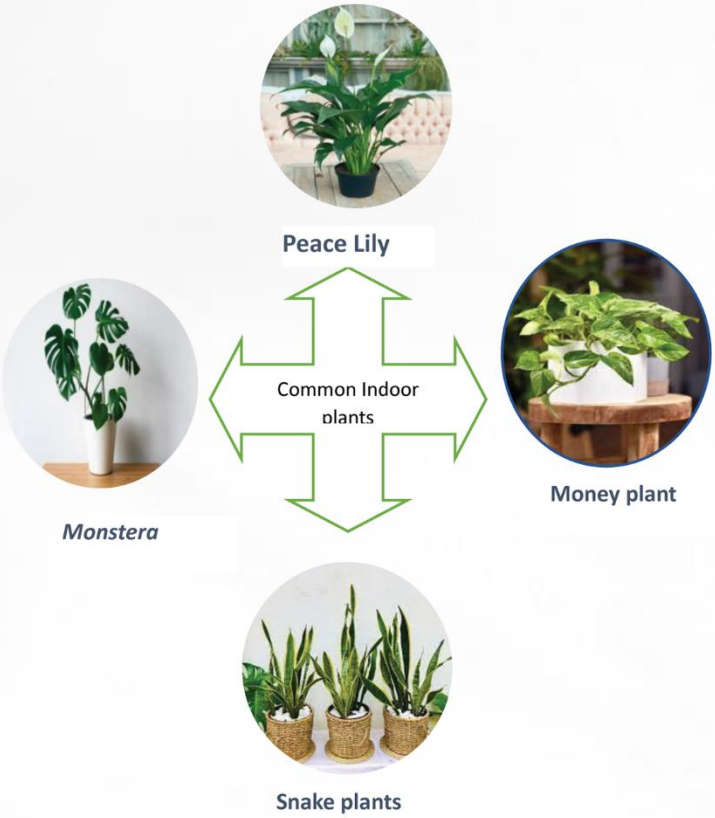
Burning fuels indoors for cooking and heating is a concern, especially in energy-efficient homes where airtight conditions can cause stagnant air and high pollutant levels.
Also, we use so many cleaning products in our day-to-day life. These chemical products release toxic fumes, which can be harmful when inhaled.

Some chemicals contained in cleaning products have been linked to a variety of health problems, such as respiratory infections, asthma, and cancer.
In addition, many cleaning products contain volatile organic compounds (VOCs) that can easily evaporate at room temperature. When VOCs are released into the air, they can cause various health diseases.

The combined impact of ambient and household air pollution is linked to 6.7 million premature deaths annually in 2020, household air pollution caused an estimated 3.2 million deaths annually, including over 237,000 deaths of children under 5.

In this case, Indoor plants offer one of the most effective solutions for reducing indoor air pollution.
Indoor plants are any plant adapted for growing indoors. They grow under less water supplementary and less sunlight. They can be grown indoors in colder climates in portable containers or miniature gardens.

Peace Lily, Snake plants, monstera plants, Ariane fern, Cactus and money plants are some common indoor plants in Sri Lanka.



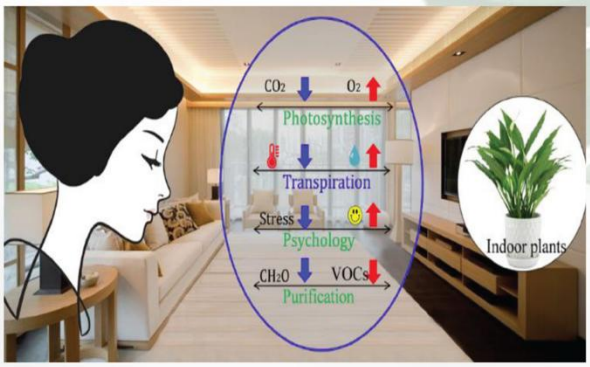
These plants help reduce air pollution in various ways. Plants serve as an efficient environmental cleaning system through a process known as "phytoremediation," which employs various techniques to remove pollutants from the environment. Indoor plants are considered natural air filters as they purify the air through methods such as absorption, dilution, precipitation, and filtration.

A well-known process carried out by plants is photosynthesis, in which they clean the air by taking in carbon dioxide and releasing oxygen. Another process, respiration, involves plants absorbing oxygen and releasing carbon dioxide.

Additionally, plants can purify the air by removing pollutants such as carbon dioxide, volatile organic compounds (VOCs), carbonyls, particulate matter, organic compounds, nitrates, sulfates, ammonia, calcium, ozone, and carbonates.

According to research 35% lower concentration of VOC was found in a classroom with plants compared to the same classroom without plants.

Indoor relative humidity (RH) is considered an important factor influencing the interactions between humans, viruses, and plants. Recommended indoor humidity levels for human comfort typically range between 30% and 60%, but maintaining a humidity level between 40% and 60% can help prevent viral transmission. Research has shown that plants can absorb tiny airborne water vapor particles and thereby improve indoor humidity.



The diagram about basic roles of indoor plants in human health and comfort.

Removing pollution	Indoor plants	Removing rate	Parts of plant
Formaldehyde	*Chlorophytum comosum L.*	88% in 24 h	Shoots
	Chamaedorea elegans	6.5–90%	Leaves
Carbon dioxide	*Syngonium podophyllum*	Up to 60% in 40 min	Unknown
	Ficus Alii ; Dracaena Compacta ; PhilodendronScanden;Philodendron Scanden; Dracaena	Up to 50% in 6 months	Unknown
Ethylbenzene	*Zamioculcas zamiifolia*	95% in 72 h	Cuticles and stomata
	S. trifasciata,Sansevieria hyacinthoides	90%	Wax
Xylene	*Golden pothoses*	38–40 v $h^{-1}m^{-3}$	Unknown
	Zamioculcas zamiifolia	95% in 72 h	Leaves

Table : The efficiency and species of indoor plants about removing pollutions

Additionally, compared to places without plants, places with indoor plants provide a healthier environment and reduce the risk of exposure to airborne diseases.

The other most important thing is studies have shown that indoor plants can improve focus, decrease depressive moods and lessen symptoms of anxiety.
According to those studies plants reduced tension and anxiety by 37%, depression by 58%, and anger and hostility by 44%.

There are many benefits that we can get by planting indoor plants in homes, office rooms and all other indoor places. The advantages mentioned above are only few.

So, why don't we turn to the natural protectors that Mother Nature has provided?"

Recourse from the World Health Organization.

Shashikala Hettiarachchi
SC/2022/12667

DISCOVERY OF NEW ORGANELLE 'NITROPLAST': A NEW HOPE FOR AGRICULTURE BEYOND SYNTHETIC FERTILIZERS

In 2024, a significant breakthrough was achieved by researchers at the University of Rhode Island, Institut de Ciències del Mar in Barcelona, University of California at Santa Cruz, and the Massachusetts Institute of Technology. In 1998, they discovered the first known nitrogen-fixing organelle, the '**nitroplast**' in a eukaryotic cell, solving a decade-long mystery. Furthermore, the discovery marked an important revolution in plant biology with profound implications for achieving Sustainable Development Goal 2, ensuring food security and promoting sustainable agriculture, by 2030. This organelle is believed to promise a sustainable alternative replacing the synthetic nitrogen fertilizers currently being produced by the Haber-Bosch process which accounts for 1.4% of the global CO_2 emissions, water pollution, and soil degradation. Here, this article explores the biotechnological potential of nitroplasts in transforming agriculture and crop production in Sri Lanka, highlighting the benefits, challenges, and future directions of this groundbreaking discovery.

Importance of nitrogen in agriculture

Nitrogen is an essential nutrient for plant growth and development, yet it is often a limiting element in the soil. Most plants cannot directly utilize atmospheric nitrogen (N_2), constituting ~ 78% of the Earth's atmosphere. Instead, they rely on nitrogen in the form of ammonia (NH_3) or nitrate (NO_3^-), which they assimilate from the soil. However, nitrogen deficiency has become one of the common problems in agriculture, causing stunted growth, reduced yields, yellowing of leaves, etc. To address this problem, farmers shifted to using synthetic nitrogen fertilizers, which significantly boosted crop production over the 20th century. However, the excessive use of these fertilizers has led to several environmental and economic challenges including eutrophication and depletion of inland water sources, soil degradation leading to reduced natural fertility, greenhouse gas emission (CO_2, N_2O) during production and application processes, and expensive production cost that are unbearable for farmers in developing countries.

Endosymbiosis and discovery of nitroplasts

The endosymbiotic theory of eukaryotic cell development proposed by the evolutionary biologist Lynn Margulis in the 1960s was fiercely challenged and rejected by 15 academic journals before being published in *The Journal of Theoretical Biology* in 1967.

Opposed to the Neo-Darwinist consensus, which explains genetic mutations and natural selection as primary drivers of evolution, 'endosymbiosis' is a rare, but a major driver of the evolutionary process where one organism lives inside another, often resulting in a mutually beneficial relationship. This phenomenon is widely regarded as a key mechanism behind the origin of complex eukaryotic cells. The first and second endosymbiotic events happened billions of years ago, leading to the development of mitochondria and chloroplasts as vital organelles within eukaryotic cells. Mitochondria, the powerhouse of cells, is believed to have originated from a symbiotic relationship between an ancestral eukaryotic cell and a proteobacterium. Likewise, chloroplasts which perform photosynthesis in plant cells, are thought to have evolved from cyanobacteria that early eukaryotic ancestors engulfed. Over time, these endosymbionts transferred much of their genetic material to the host cell's nucleus, becoming integral components of the cell rather than independent organisms. This integration provided the host cells with enhanced metabolic capabilities such as producing ATP through aerobic respiration in mitochondria or fixing inorganic carbon to glucose in chloroplasts harnessing solar energy.

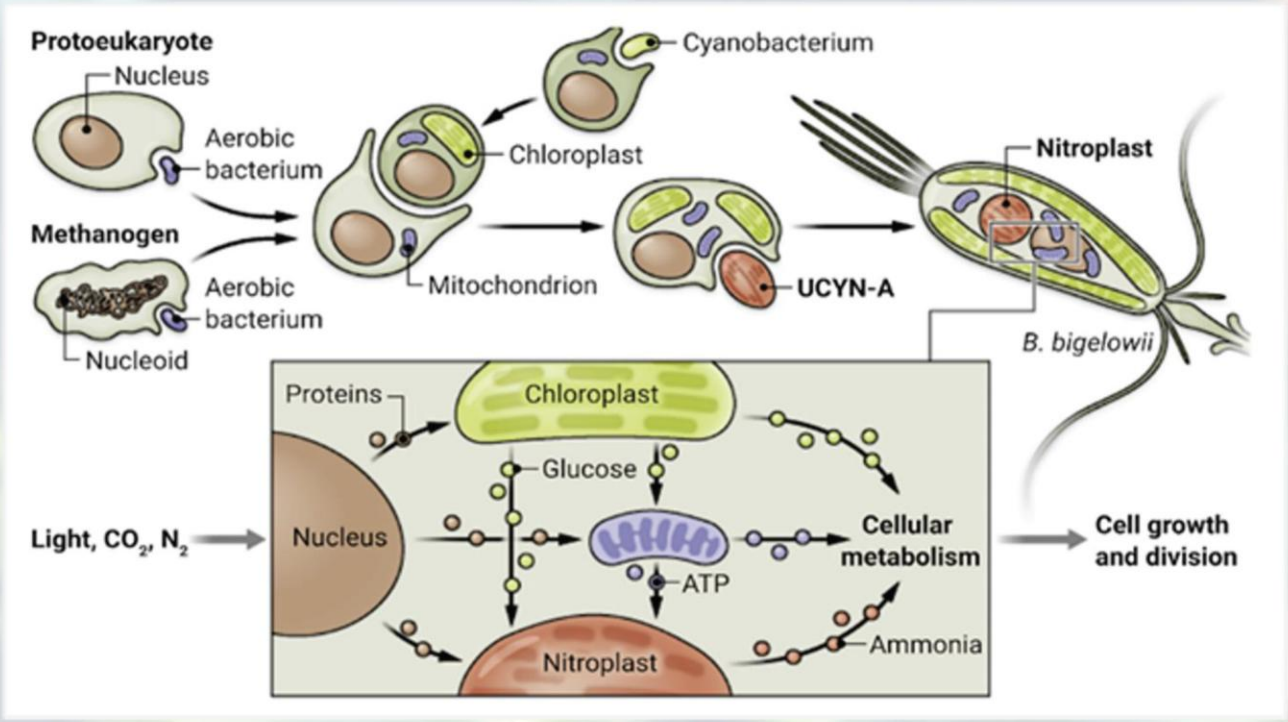


Figure 1: Evolutionary transition of organelles: mitochondria, chloroplasts, and nitroplasts from endosymbiotic bacteria to the eukaryotic cell *Braarudosphaera bigelowii*. The utilization of ATP, glucose, and ammonia synthesized by these organelles, along with other external compounds, results in cell growth and division.

Recently, ~100 million years ago, the cyanobacterium *Candidatus atelocyanobacterium thalassa* (UCYN-A) became an endosymbiont of the unicellular microalgae *Braarudosphaera bigelowii* in marine environments. Over time, UCYN-A closely integrated with its eukaryotic host, evolving from an endosymbiont into a nitrogen-fixing eukaryotic cell organelle now known as a nitroplast. This transformation marked a significant evolutionary milestone of third endosymbiosis, making *B. bigelowii* the first known nitrogen-fixing eukaryote, and this discovery of UCYN-A as a nitroplast expanded the capability of fixing atmospheric nitrogen from prokaryotes to eukaryotes. Most nitrogen-fixing bacteria can regulate dinitrogen use when fixed nitrogen sources are available in the assimilated form, reducing the high energetic cost of the process. In contrast, UCYN-A can fix nitrogen gas into ammonium even in nutrient-rich environments as it has lost its regulatory genes. In return, the host supplies UCYN-A with carbon-fixed energy photosynthetically by its chloroplasts. Another interesting fact is that the size ratio between UCYN-A and their hosts remains consistent across different UCYN-A sub-lineages, like the volume ratio dynamics between organelles (chloroplasts and mitochondria) and their host cells in various eukaryotic phytoplankton. Furthermore, this size ratio supports balancing the gaining and exchanging of resources (Figure 2).

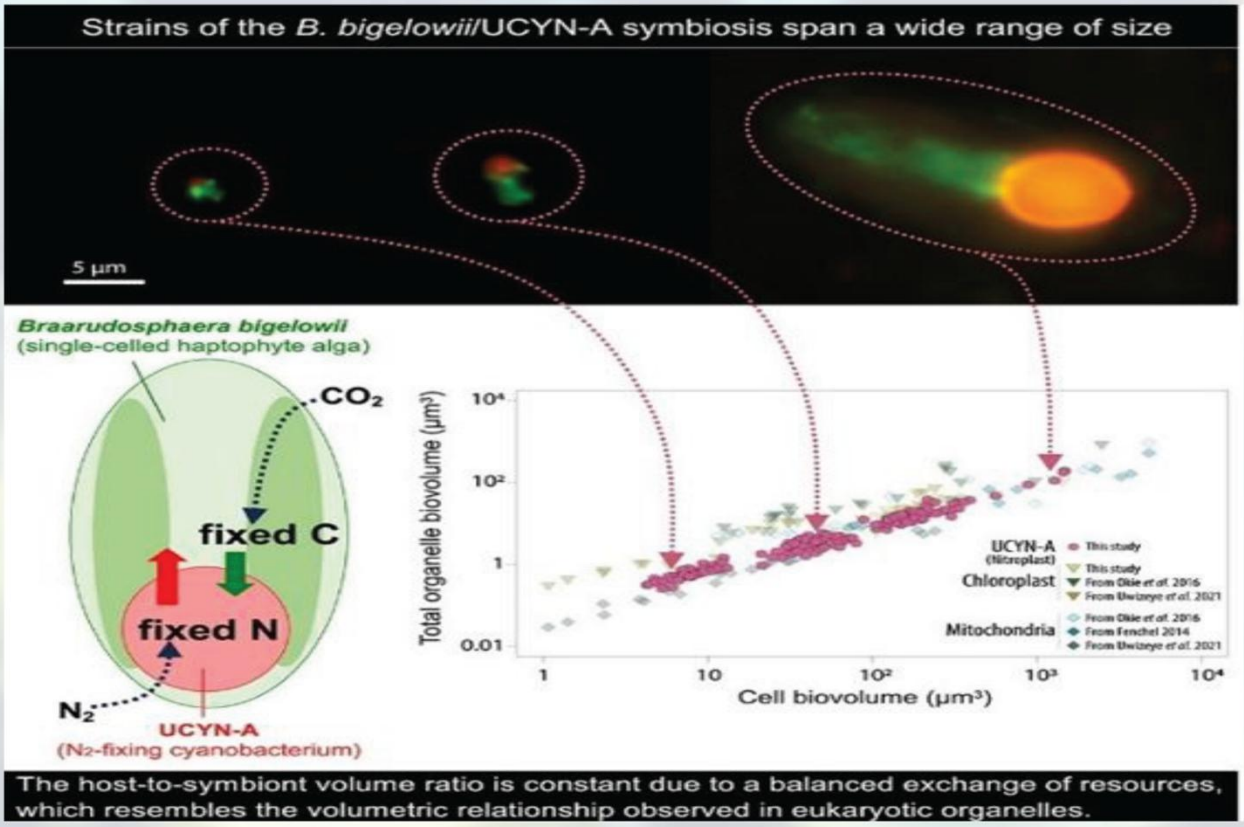


Figure 2: The size relationship between UCYN-A and their symbiotic partner cells is consistent with the size relationships between other organelles and their hosts.

Future application potential in engineering crop plants

Our knowledge and understanding of naturally evolved endosymbiotic nitrogen-fixers in the environment such as rhizobia in legumes and cyanobacteria in unicellular microalgae is essential for developing the concept of engineering nitrogen-fixing organelles into crop plants. For instance, bacteroids, as one of the most extensively studied endosymbionts that are specialized nitrogen-fixing forms of rhizobia found in legume root nodules, serve as a primary model due to their natural nitrogen-fixing capacity and nutrient exchange with host plants. However, these bacteroids cannot transfer to the next generation during cell division. They show varying nitrogen fixation efficiencies depending on their morphology, with elongated and branched forms in peas and peanuts being more efficient than undifferentiated forms in beans and cowpeas.

Bacteroids can undergo structural changes to optimize nitrogen fixation and facilitate nutrient exchange. Comparative genomic and transcriptomic studies have provided insights into the genetic basis of host specificity and the interactions between bacteroids and host plants. Interestingly, the coordination between cyanobacteria UCYN-A and *B. bigelowii* shows a more stable and intimate relationship in contrast to the relationship between bacteroids and legume hosts, suggesting the potential for transferring such stable nitrogen-fixing capabilities to non-leguminous plants. Thus, this makes new avenues for developing models/synthetic organelle like the function of nitroplast organelle coupling with photosynthesis to obtain the energy required for N_2 fixation.

Looking at Sri Lankan context

In Sri Lanka, agriculture significantly contributes to the national GDP and meets the population's food requirements. However, aside from the available lands for cultivation, the lack of fertile soil has limited crop production. As a result, the country depends significantly on imported inorganic

fertilizers to boost crop yields, with about 59% of these imports being urea, which addresses the nitrogen needs of plants.

Unfortunately, in 2021, the country's agriculture sector encountered significant difficulties due to the ban on synthetic fertilizers. This banning of synthetic fertilizer alone resulted in a substantial decline in crop productivity, notably causing a significant drop in tea production causing an economic loss of around USD 425 million. Additionally, there was a 20% reduction in rice production, further exacerbating the country's food security issues. In this context, **'Nitroplast organelle' could be an answer to revolutionizing agriculture in Sri Lanka.** Thus, novel research ideas should concentrate on adapting nitroplast organelle to the particular crops used in Sri Lanka, such as various varieties of rice, maize, pulses, and tea plantations, and making them resistant to the various agroclimatic conditions in the nation.

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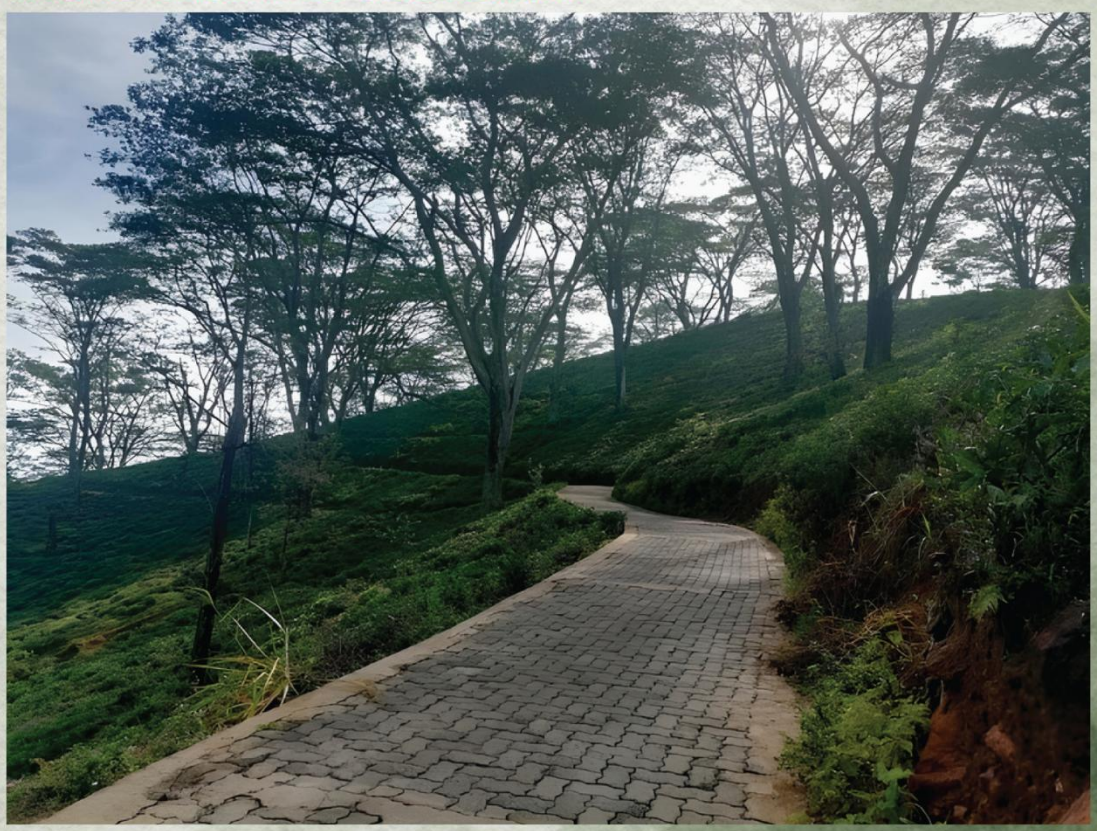
Live green.. Love green.. Be green..

Anupama Sewwandi
SC/2020/11207

In every walk with nature, one receives far more than he seeks.....

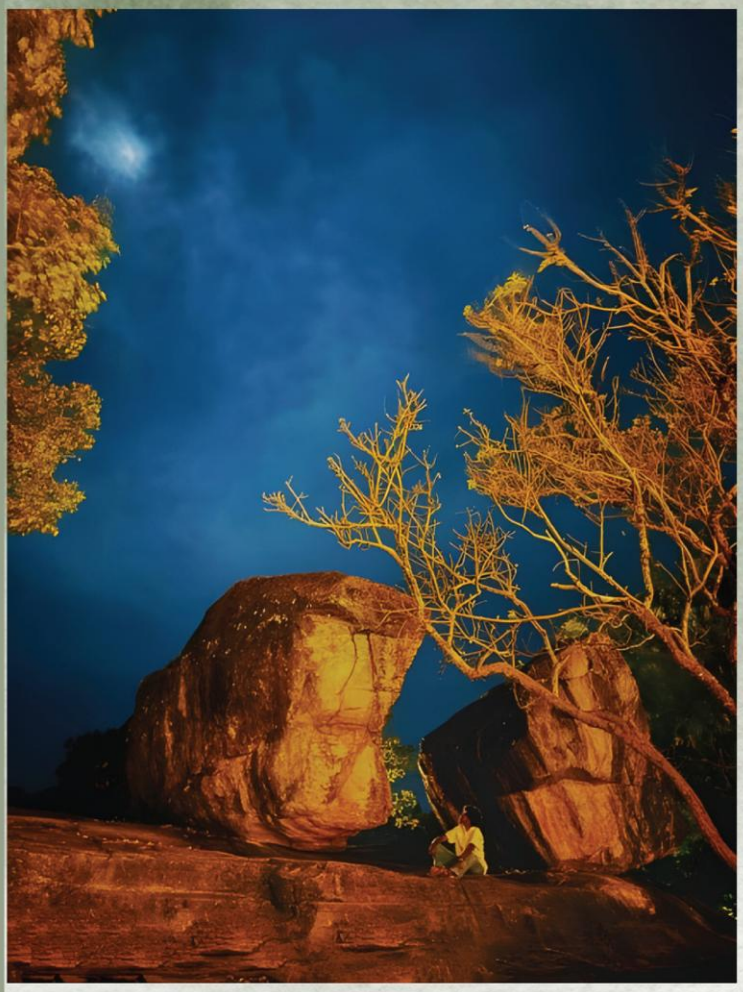


Hasini Nawarathna

Green Life

Away from mother's arms
Born on a new field
Little by little waking up
Oh! See the today's sun
As the days, weeks and years pass
A great age man to the world
With green glitters to everyone
Feels a free breath with cools
Be a home to many no paying
Wordless to say the endowment
That is life to safe.....

K. A. Jithmi Devindi
SC/2021/11974
44th batch



The movement, nature touches your soul is like a divine meditation

T.D.D.K Thanreewaththa
SC/2020/11800

The enchanting splendour
Beauty of Southern province
Purple princess

I.W.P.J Chathuranga
SC/2019/10953

Liposomal encapsulation of herbal bioactive substances for food applications

Historically, herbs have significantly impacted trade, culture, medicine, and cuisine worldwide. Indeed, herbs are essential items in kitchens across the globe giving uniqueness to cultural dishes. The effects of herbs in foods are appealing in many aspects. Specifically, incorporating herbs enhances the aroma, flavor, and preservation of foods. While numerous herbs are used for culinary purposes worldwide, ginger and turmeric are used mostly in Sri Lankan cuisine. Herbal bioactive substances, such as extracts, essential oils, and phytochemicals, including those of ginger and turmeric, have exhibited augmented potency once encapsulated in liposomes. Liposomal encapsulation of herbal bioactive substances is beneficial particularly since those encapsulated liposomes may be used as a substitute for chemical preservatives, colorants, or flavors, scorned by health-conscious consumers, in food.

A liposome has a spherical structure with a lipid membrane and an aqueous interior. The lipid membrane's major lipids are polar lipids, such as soy lecithin, egg yolk lecithin, or purified phospholipids. The minor lipidic component that modulates the membrane's fluidity is usually cholesterol. Liposomes made of edible lipids show enhanced stability, slow or controlled release, bioactivity, bio-accessibility, and bioavailability of encapsulated substances. These properties have enabled the liposomal extracts/ essential oils, and phytochemicals of herbs such as ginger and turmeric with active ingredients to perform better in food systems compared to their free counterparts. Thus, liposomal encapsulation is a promising strategy for developing bioactive ingredients to incorporate into food. In a nutshell, liposomal encapsulation enables the formulation of foods and nutraceuticals with enhanced attributes by incorporating herbal bioactive substances.

Ginger (*Zingiber officinale Rosc.*), belonging to the family Zingiberaceae and genus Zingiber, is a herbaceous plant with numerous bioactive compounds and bioactivities, antioxidant and antimicrobial being the most significant for food applications.

The major phytochemicals of the ginger underground rhizome are phenolic compounds and terpenes. The phenolic compounds include gingerols such as 6-gingerol, 8-gingerol, and 10-gingerol. On prolonged storage or exposure to heat, gingerols turn into their corresponding shogaols. On hydrogenation, shogaols may turn into paradols. In addition to gingerols, shogaols, and paradols, antioxidant compounds including 6-dehydrogingerdion, gingerenone-A, quercetin, and zingerone are found in ginger. The major terpenes found in ginger are α-curcumene, α-farnesene, β-bisabolene, β-sesquiphellandrene, and zingiberene, and these terpenes constitute the major phytochemicals present in ginger essential oil. Ginger extracts and essential oils are potent antioxidant agents. Also, ginger contains numerous phytochemicals, providing a broad antimicrobial spectrum against different microorganisms in foods. For instance, ginger shows antimicrobial potential against foodborne pathogens such as *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli* O157:H7, and spoilage microorganisms such as *Aspergillus spp*., and *Fusarium spp.* In addition to its antioxidant and antimicrobial properties of ginger, it is known for numerous other bioactivities including anti-inflammatory, anti-cancer, anti-diabetic, and anti-obesity effects.

Liposomal encapsulation ameliorates the properties of ginger extracts and essential oils. On liposomal encapsulation, the ethanol extract of ginger has shown augmented antioxidant potential compared to the free extract. Furthermore, liposomal ginger extract can prevent the oxidation of sunflower oil. These findings indicate the aptness of liposomal ginger extracts as food additives against oxidative damage.

Like the ginger extract, ginger essential oil has shown improved antioxidant capacity. Also, liposomal ginger essential oil has exhibited smart release in simulated gastrointestinal conditions protecting the encapsulated species against harsh conditions. Moreover, the liposomal ginger essential oil has displayed reduced cytotoxicity and UV stability. Interestingly, the liposomal encapsulation of ginger bioactive agents has enhanced various bioactivities beneficial to human health. Thus, liposomes can be considered a promising carrier of ginger bioactive substances for food and nutraceutical applications.

Turmeric (*Curcuma longa Linn.*) is a herbaceous plant belonging to the family Zingiberaceae and genus Curcuma. The major bioactive phytochemicals of the underground rhizome are curcumin, bisdemethoxycurcumin, and demethoxycurcumin, collectively known as curcuminoids, which show numerous important bioactivities such as antioxidant, antimicrobial, and many more. Curcumin, the most potent curcuminoid, possesses impressive antioxidant activity. Also, curcumin exhibits antimicrobial properties against food-borne pathogens and food spoilage microorganisms such as *Listeria monocytogenes, Staphylococcus aureus, Salmonella typhimurium*, and *Escherichia coli* O157:H7. Advantageously, encapsulated curcumin displays antibacterial and antifungal activities against foodborne pathogens and food spoilage microorganisms like *Escherichia coli, Yersinia enterocolitica, Staphylococcus aureus, Bacillus subtilis, B. cereus, Aspergillus niger, Penicillium notatum, and Saccharomyces cerevisiae*. Apart from antioxidant and antimicrobial activities, curcumin possesses numerous bioactivities, such as anti-cancer, anti-diabetic, and anti-obesity, beneficial for health.

Liposomal encapsulation has improved the attributes of curcumin, making it more advantageous for food applications. Curcumin-encapsulated freeze-dried liposomes after agglomerating with cornstarch have shown better flowability, non-cohesiveness, reduced chewiness, enhanced softness, and improved color distribution in the cake. Further, liposomal curcumin has shown better antioxidant activity retention in cookies during baking. Favorably, the sensory attributes of the liposomal curcumin-incorporated cookies have shown scores comparable to regular cookies. Also, incorporating liposomal curcumin in tofu has revealed increased retention of antioxidant capacity. Numerous studies suggest that curcumin-encapsulated liposomes enhance stability, antioxidant properties, and bioavailability making them suitable for foods including functional foods, and nutrient delivery systems.

As mentioned previously, liposomes exhibit numerous advantages, enhancing the properties of encapsulated substances. Despite the impressive advantages, liposomal encapsulation has some drawbacks, including the high cost of lipids and the difficulties in producing homogeneous liposomes in bulk. Nevertheless, the exploration for cheaper lipids usable in liposome formulation and the development of methods that allow the preparation of bulk quantities of liposomes have paved the way for using liposomes in food systems feasibly.

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Sunflowers are nature's way of saying, "keep smiling!"

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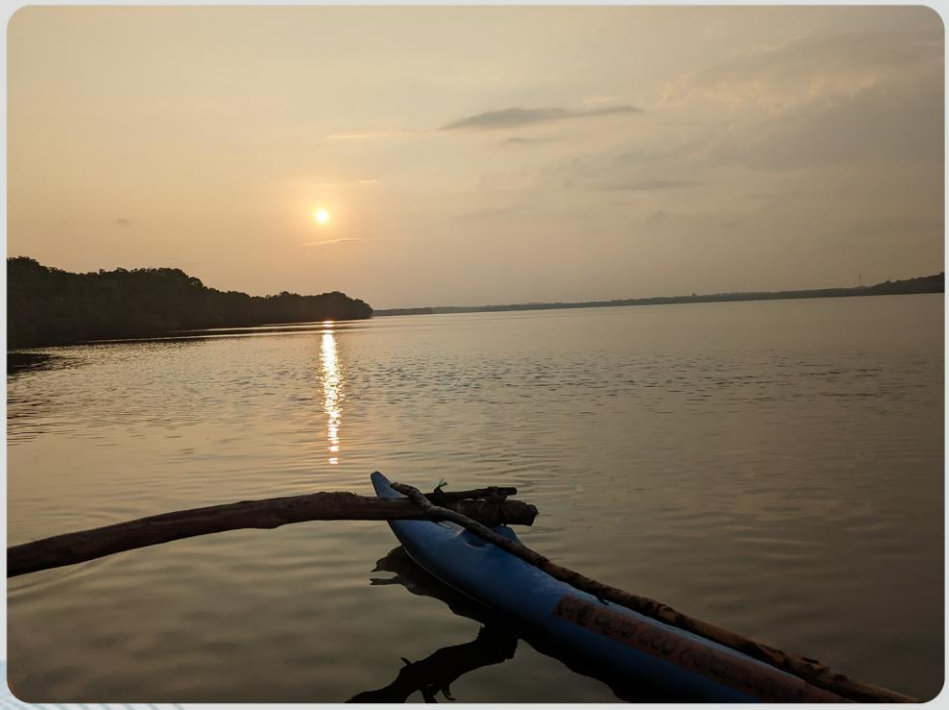
Botany Special Year I

A boat rests in stillness as the sunset paints the lagoon.



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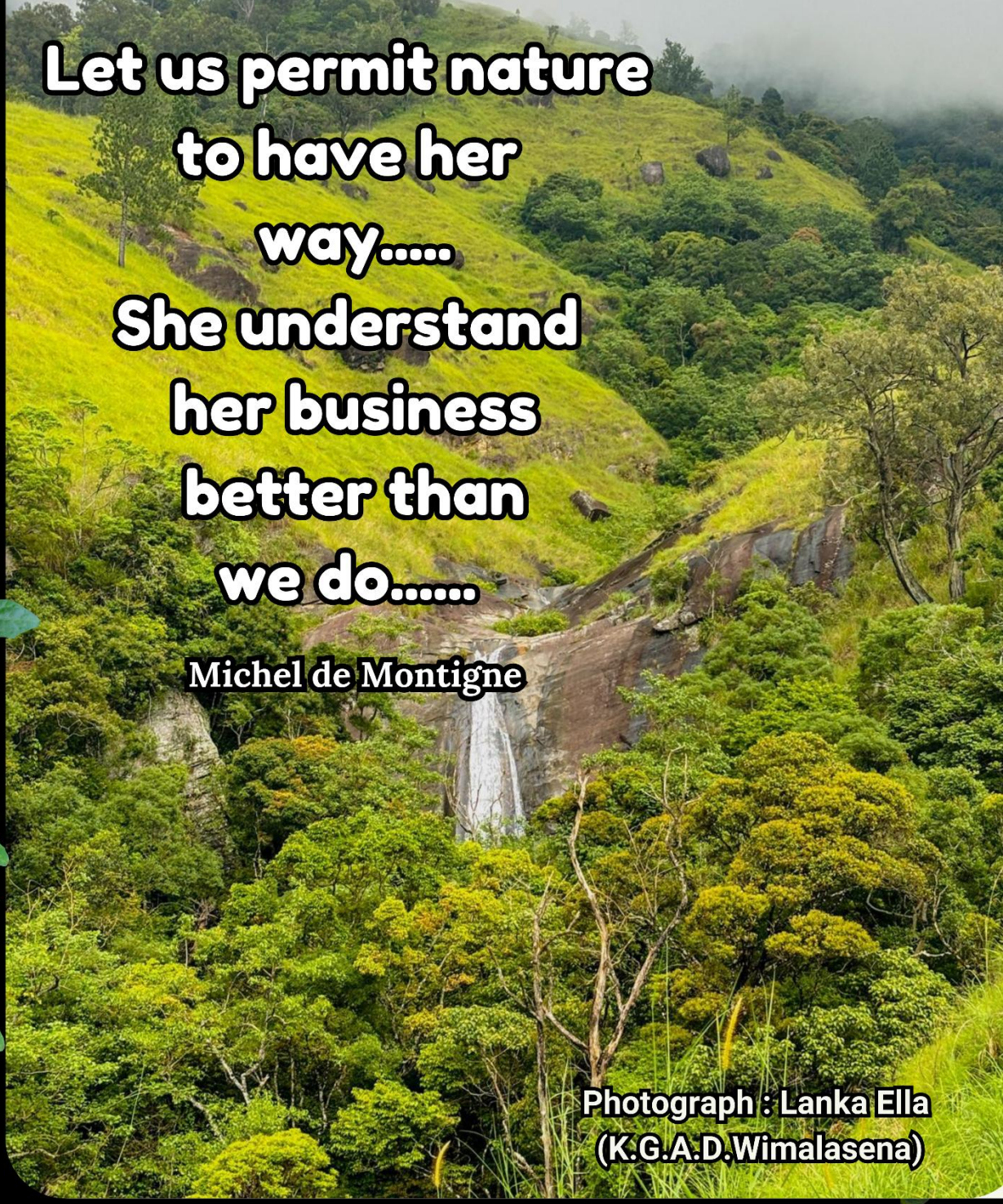

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