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PROTECT NATURE

S R I L A N K A

VOLUME 05 | 2026



ZOOLOGISTS' ASSOCIATION OF UNIVERSITY OF PERADENIYA
DEPARTMENT OF ZOOLOGY, FACULTY OF SCIENCE



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Cover page: Toque Macaque: *Macaca sinica* (Linnaeus, 1771)
Captured at Wilpattu National Park, Sri Lanka

&

Last Page: Ocean Wonders

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PROTECT NATURE | SRI LANKA

Volume 05 | 2026

EDITOR'S NOTE...

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*“What you do makes a difference;
Et you have to decide what kind of difference
you want to make..”*
~ Jane Goodall

Welcome to the 5th volume of PROTECT NATURE | Sri Lanka,



When we first set out to document the natural world, our goal was simple: to bring the breathtaking beauty of the wild into sharp focus. Five volumes in, that mission has evolved into something far more urgent. We are no longer just observers of nature; we are chroniclers of its survival in an era of unprecedented change.

In this issue, we look closer at the delicate threads that hold ecosystems together. We explore the quiet resilience of our coastal defenses, the hidden migrations traversing our forests, and the microscopic battles fighting for ecological balance. Nature is not just a scenic backdrop to the human story, it is the very foundation of it. Every species, from the apex predator prowling the canopy to the smallest pollinator navigating a concrete jungle, plays a critical, irreplaceable role.

Yet, alongside the wonder, we must confront the reality of our footprint. The wild is retreating, and the time for passive admiration has passed. As you turn these pages, we hope you are not only captivated by the vibrant photography and the stories of survival but also moved to action.

We hold the pen for the next chapter of our planet's history. Let us ensure it is a story of restoration, coexistence, and profound respect for the wild.

Pubudu Premasinghe

ACKNOWLEDGEMENTS

The publication of “Protect Nature Sri Lanka” (Volume 05) stands as a collective testament to the passion, dedication, and unwavering commitment of the undergraduates and academic community of the Faculty of Science, University of Peradeniya.

We extend our deepest, heartfelt gratitude to Head of the Department of Zoology Prof. Suyama Boyagoda, Patron of the Zoologists’ Association of University of Peradeniya (ZAUP), for her gentle leadership, steady encouragement, and continuous mentorship that guided this volume from a mere vision to a completed reality.

We are profoundly grateful to Ms. Chathurika Munasinghe, Senior Treasurer of ZAUP, whose kind guidance, constant support in coordinating the editorial process and dedicated efforts in reviewing, editing, and proofreading the manuscripts helped to steer this publication forward.

We wish to officially recognize and honor the lecturers Dr. Piyumali Perera, Dr. Gajaba Ellepola, Dr. Nuwandi Pathirana and Mr. Kumudu Wijesooriya of the Department of Zoology who generously volunteered their precious time, scientific rigor, and editorial expertise to review, edit, and proofread the manuscripts, ensuring the highest standards of scientific accuracy and integrity.

We also wish to express our sincere appreciation to all the academic and non-academic staff members of the Department of Zoology. Your enduring support, background assistance, and encouragement created a thriving environment for our students.

Finally, this magazine belongs to the students. We extend our deepest thanks to every writer, poet, cartoonist, and photographers from the 19th, 20th, 21st, 22nd and 23rd batches. Your contributions have provided a powerful voice for the wild, inspiring us all to look deep into nature and cherish the precious living heritage of Sri Lanka.

HOW TO NAVIGATE THIS ISSUE

A Guide to Our Interactive Elements

TABLE OF CONTENTS

DYNAMIC TABLE OF CONTENTS
Click any article title to jump directly to its starting page

THE RETURN ANCHOR
Click the yellow box in the top-right corner of any page to return to the Table of contents

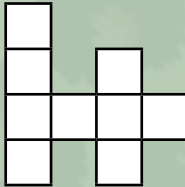
Table of Contents



SPECIES IDENTIFICATION
Hover your cursor over any yellow dot in the galleries to reveal its name

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Click to explore a featured academic profile





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You can type answers directly into the puzzle fields on your screen

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To fully enjoy interactive features we kindly recommend downloading this magazine and opening it using Adobe Acrobat Reader on your laptop or desktop computer.

TABLE OF CONTENTS

01	03	05	07
Earthly Echoes: Voices of the Wild	Minds at Play	Deep Blue & Hidden Realms	Ancient Wisdom & Cosmic Horizons
02	04	06	08
Fragile Frontiers: The Conservation Crisis	Through the Lens	Bio-Synthesis: Science & Survival	Sovereign Wild: The Living Legacy

TABLE OF CONTENTS

Editors Note	III
Acknowledgements	IV
How to Navigate this Issue	V
Table of Contents	VIII
Earthly Echoes: Voices of the Wild	
Language in Nature: How Animals Communicate in Complex	10
Firefly Messages: The Language of Light in Sri Lankan Nights	12
Grace in Gray	14
Calotes calotes	15
Canine Cognition: Do Our Dogs Think Like Us?	16
Sealed with Trust: The Extraordinary Parenting of the Sri Lanka Grey Hornbill	18
The Evolution of Venom: Nature's Most Potent Weapon	22
Through the Lens: Gallery I	24
Fragile Frontiers: The Conservation Crisis	
Coexisting with Giants: Understanding and Mitigating Human–Elephant Conflict in Sri Lanka	30
Silent Forests: The Decline of Sri Lanka’s Endemic Birds	34
Tears of Pollution	38
Protect Nature Sri Lanka.....	39
Trampled Paths and Tired Souls: The Hidden Costs of Wildlife Tourism in Sri Lanka	40
The Unseen Struggle: Sri Lanka’s Hog Deer.....	44
Human Elephant Conflict in Sri Lanka: Challenges and Solutions.....	48
Minds at Play	
The Bio-Logic Puzzle	52
Deep Blue & Hidden Realms	
Unsung Heroes of the Ocean: The Seagrass Ecosystem	56
The Dominion of Jellyfish	58
Song of the Sea	64
Nature’s Care, Our Responsibility	65
The Hidden World of Sri Lanka’s Endemic Shrub Frogs	66
Marine Toxins to Medicines: How Ocean Life Inspires Drug Discovery	70
Guardians of the Paddy Fields: The Role of Amphibians in Pest Control.....	72

Through the Lens: Gallery II	74
Bio-Synthesis: Science & Survival	
Genetically Modified Crops and the Biome: Navigating Agricultural Productivity & Ecosystem Balance	80
Did You Know	87
Zombie Ants: How Fungus Hijacks Ant Behavior for its Own Survival	88
The Role of Biotechnology in Cleaning Up Pollution	92
How a Photosynthetic Organism Became the Deadliest Pathogen Humankind Has Ever Seen.....	96
Zoopharmacognosy: How Animal Behaviour is Guiding Biomedical Science	100
Silent Messengers: Biological Language of Environmental Change	104
Through the Lens: Gallery III	106
Ancient Wisdom & Cosmic Horizons	
The Biological Foundations of Astrobiology: Exploring the Universe Through the Lens of Biology.....	112
The Role of Indigenous Knowledge in Sustainable Development	116
Monsoons Lullaby.....	120
Reflections of the Carps.....	121
Avian Adaptations and Their Applications in Engineering Design	122
The Story of “Neluma”, The Big Male Leopard of Nelum Vila, Wilpattu, Sri Lanka	126
Biodiversity: The Web of Life	128
Breaking Free from Plastic	132
Through the Lens: Gallery IV	136
Sovereign Wild: The Living Legacy	
Guardian of The Green Sri Lanka: Protecting Sinharaja, Sri Lanka’s Living Treasure	142
Why We Need to Think Like Ecologists: Balancing Humans and Nature	146
Parasites in Wildlife Conservation: Friend or Foe?.....	150
Importance of Integrating Genetic Knowledge into Animal Biodiversity Conservation	154
Masters of the Night: An In-Depth Look at Nature’s Aerial Acrobats	158
Migratory Marvels: How Birds Navigate Across the Globe	162

LANGUAGE IN NATURE

How Animals Communicate in Complex Codes

From dawn choruses in rainforests to ultrasonic clicks under the ocean, the natural world is alive with voices. Communication is not merely a human trait, animals across the phylogenetic spectrum possess sophisticated systems for exchanging information.

These signals can warn of danger, attract mates, coordinate hunting, maintain social bonds, and even deceive competitors. Although not “language” in the human linguistic sense, animal communication represents a rich and evolving field at the intersection of zoology, behavior, neuroscience, and evolutionary biology. Today, advanced acoustic tools, ethology, and computational models are revealing just how complex non-human communication truly is.

Biologists define communication as the transfer of information from one individual to another that influences behavior or physiology. Animals use a remarkable variety of signalling modalities:

- **Acoustic signals** — bird songs, whale calls, primate vocalizations
- **Chemical cues** — pheromones in insects and mammals
- **Visual displays** — courtship dances of birds-of-paradise, cephalopod color changes
- **Tactile communication** — grooming in primates, antennal touching in ants
- **Vibrational signals** — seismic drumming in spiders and mole-rats

These systems are shaped by ecology, social structure, and evolutionary pressures. Communication, in essence, is a survival strategy.

Birdsong is one of the most studied animal signalling systems. Research has demonstrated that certain species possess syntax-like structures, where the order of notes carries meaning. For instance, Japanese great tits (*Parus minor*) combine calls into ordered sequences that alter receiver behavior, a structural resemblance to human grammar (Suzuki et al., 2016).

Furthermore, young songbirds learn vocal patterns socially, similar to how human infants acquire language. This process involves auditory learning circuits in the brain, making avian species valuable models for studying speech development and neurological disorders (Mooney, 2014).

Whales and dolphins inhabit sound-dominated environments where vision is limited. These marine mammals have evolved highly developed acoustic communication systems such as:

- **Humpback whales producing long, evolving patterned songs linked to social communication.**
- **Dolphins using individualized signature whistles akin to names (Janik & Sayigh, 2013).**
- **Sperm whales communicating in rhythmic “codas” that vary by social clan, forming cultural dialects (Cantor et al., 2019).**

These findings challenge the idea that complex cultural traditions are uniquely human — song birds

cetaceans display traditions passed across generations.

Ants, bees, and termites use chemical codes to organize millions of individuals. Pheromone trails guide foragers, alarm chemicals trigger defense, and queen pheromones regulate reproduction. Honeybees complement chemical cues with the famous waggle dance — a symbolic spatial communication system that conveys the direction and distance of food sources (von Frisch, 1967).

This dual communication strategy underpins complex colony-level intelligence and resource efficiency.

Primates, especially great apes, offer insights into the roots of human language. Vervet monkeys produce distinct alarm calls for different predators — leopards, eagles, snakes — and group members respond appropriately (Seyfarth et al., 1980). Chimpanzees and bonobos use gestures, vocal cues, and facial expressions to coordinate social and cooperative behaviors. Some apes have learned symbolic communication systems, although their capacity for generative grammar remains debated.

Cumulative research suggests that the foundations of language — intentional signalling, learning, shared reference, emotional nuance — predate humans.

Understanding animal communication is not just intellectually fascinating — it has

urgent implications. Noise pollution disrupts whale communication; deforestation alters bird song transmission; climate change threatens acoustically sensitive amphibians. AI-assisted eco-acoustic monitoring and machine-learning decoding tools now help biologists monitor endangered species and behavioural responses in real time.

By decoding nature’s languages, we may protect species before they fall silent.

Animal communication is neither primitive nor random — it is complex, purpose-driven, culturally diverse, and evolutionarily rich. From ant pheromones to whale dialects, nature holds a spectrum of communication systems that rival aspects of human language. As technology advances, so does our ability to understand these hidden codes. In studying them, we uncover not only the intelligence of wildlife but also the evolutionary threads tying human cognition to the natural world. Language, it seems, is not unique — it is a continuum across life.

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Aloka Sarathchandra
S/19/212

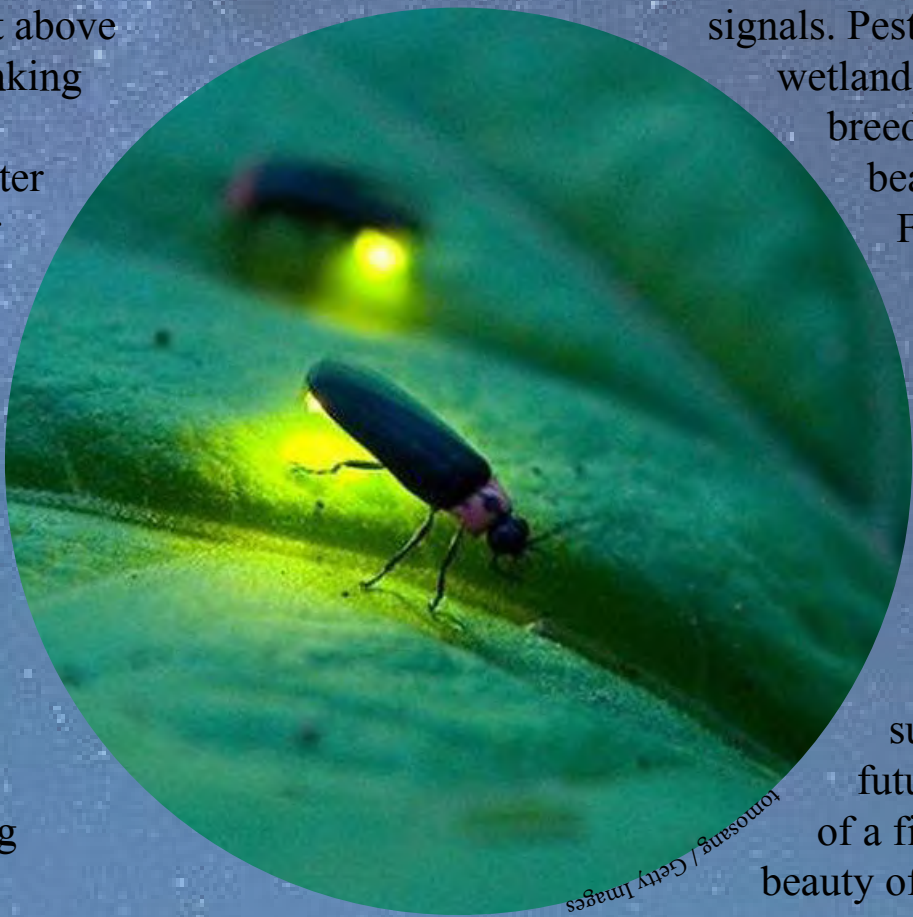
Firefly Messages

The Language of Light in Sri Lankan Nights

On warm evenings in Sri Lanka, tiny sparks float above paddy fields, marshes, and village gardens, blinking like stars come down to earth. These glowing insects, fireflies, are not just a childhood delight but master communicators, using flashes of light as a secret code for survival.

Each firefly species has its own unique rhythm of light signals. To us, the flashes look like random twinkles, but to fireflies, they are conversations: males signal to attract females, rivals warn each other, and predators are deterred by sudden bursts of light. This incredible form of communication is powered by a chemical reaction between luciferin and oxygen in their abdomens, producing a glow that is almost highly efficient, far superior to any human-made light bulb.

However today, fireflies face serious threats. Expanding cities bring light pollution, drowning out their delicate



signals. Pesticides in farmlands poison them, and the destruction of wetlands and natural habitats removes the spaces where they breed and thrive. Their disappearance is not just a loss of beauty but it signals deeper damage to our ecosystems. Fireflies are indicators of clean water, healthy vegetation, and balanced biodiversity.

Protecting fireflies is simple but powerful. By reducing unnecessary artificial lighting, preserving wetlands, and supporting organic farming, we can give these glowing messengers of the night a chance to thrive.

Fireflies are more than insects; they are nature's storytellers, lighting up the night with messages of love, survival, and warning. By protecting them, we ensure that future generations in Sri Lanka can still witness the magic of a firefly-lit night which is a living reminder of the fragile beauty of our natural world.

Navodya Ranathunga
S/20/222

High above the forest
sea,
She sits in calm serenity.
Soft grey cloak,
the sky her throne,
Queen of quiet,
all her own.

Wind through fur, a
whispered song,
She's watched these hills
her whole life long.
No crown she needs,
no jewelled grace,
Just wisdom shining
from her face.

GRACE IN GRAY

Sri Lanka Grey Langur
(Photographed at
Vadahiti Kanda Temple,
Kataragama)



Chalani Munasinghe
S/19/111

Calotes calotes, commonly known as the Green Forest Lizard or Green Garden Lizard, is one of the most striking agamid lizards found in Sri Lanka and parts of southern India. It is mainly arboreal, inhabiting forested areas, home gardens, and shaded plantations. It is often seen basking on tree trunks or branches. This species is recognized for its vivid green coloration, which provides excellent camouflage among foliage, and for its ability to slightly alter its shade in response to temperature, stress, or social interactions.

Calotes calotes exhibits clear sexual dimorphism. Males are larger, more robust, and show brighter coloration and a prominent spiny crest along the neck and back than females. During the breeding season, males develop a bright red or orange head and throat with a bluish-green body. Their heads are also broader and more angular. Females, on the other hand, remain dull green or brownish-green with less distinct crest development, allowing them to remain well-camouflaged while nesting or avoiding predators.

The breeding season generally occurs during the warmer months (around March to July in Sri Lanka). During this period, males become territorial and aggressive, performing head-bobbing, push-ups, and color displays to attract females and intimidate rivals. After successful mating, the female digs a small hole in moist soil or leaf litter to lay a clutch of 6-12 eggs. The eggs hatch after 6-8 weeks of incubation, and the hatchlings are independent from birth, resembling miniature adults in shape and color.



Calotes calotes

Savindu Karavita
S/20/083

Living with dogs often makes us wonder what goes on in their minds. When your dog solves a puzzle, waits patiently for a treat, or looks intently into your eyes, is it thinking like a human? Recent advances in canine cognition research give us a clearer, fascinating view of how dogs perceive the world and how their thinking compares to ours.

A Shared Social World

Dogs have evolved extraordinary social skills by living alongside humans for thousands of years. They understand human gestures, follow gaze direction, and can anticipate human intentions even without visual clues. Such abilities hint at a primitive “theory of mind,” the capacity to imagine what others are thinking, though evidence shows dogs do not fully grasp complex concepts like false beliefs, something humans master by toddler age.

The Intelligence Factor

Dog cognition is often described by a general intelligence factor, or ‘g-factor’, similar to humans. Dogs that perform well in one mental task such as memory or problem-solving usually excel in others, showing coordinated mental abilities. This intelligence varies by genetics, health, and early experience. Yet, tests show no

strong cognitive difference by sex or breed in middle-aged dogs, highlighting environment and development as significant factors.



Neural Insights into Canine Perception

Brain imaging research reveals dogs focus mainly on actions around them rather than objects or people, unlike humans who prioritize recognizing people and items. This difference likely reflects their evolutionary adaptation to interpret dynamic social cues and movements.

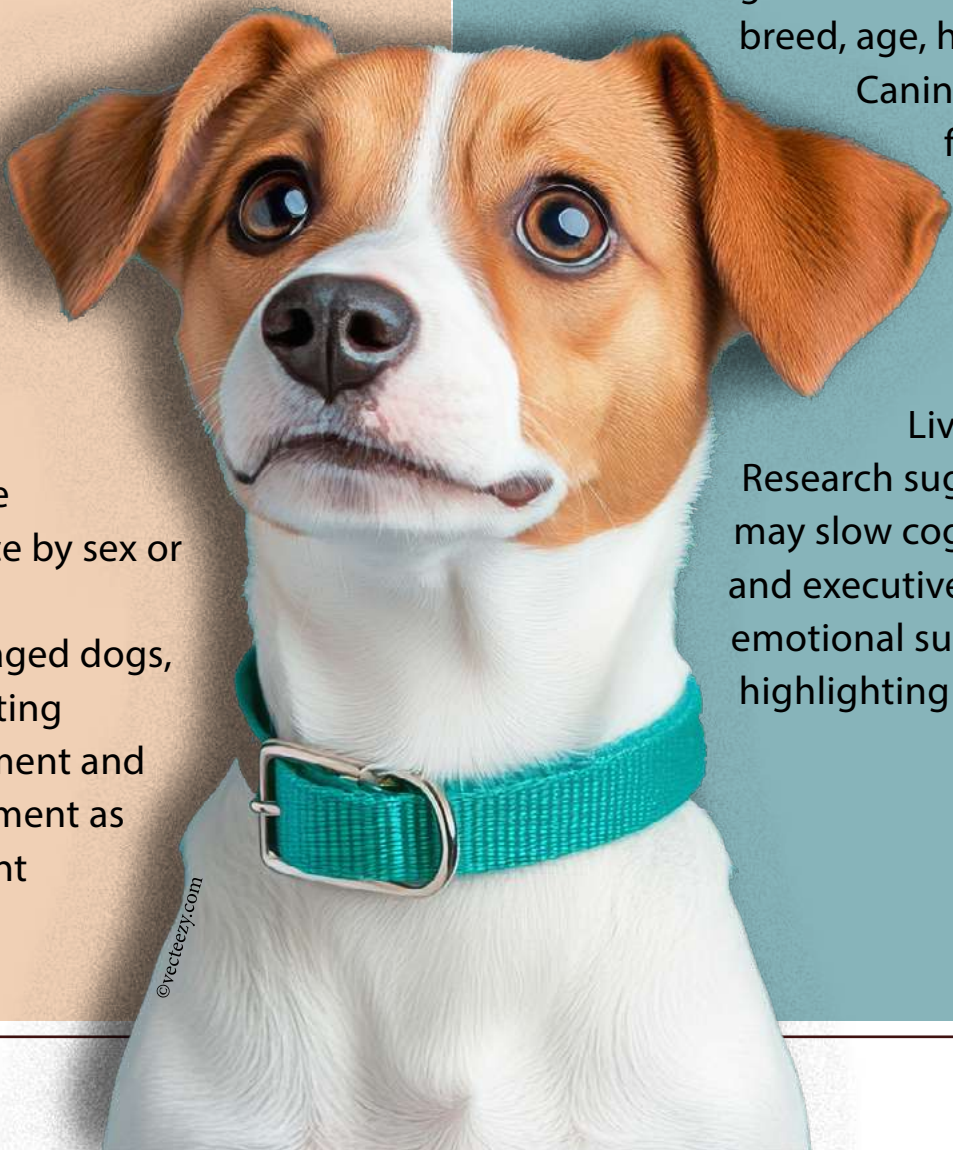
Individual Differences and Cognitive Development

Cognitive abilities vary significantly among dogs based on breed, age, health, and upbringing. Facilities like the Duke Canine Cognition Center study thousands of dogs, finding that breed and background matter but early socialization and experiences crucially influence cognitive growth.

The Human-Dog Cognitive Bond

Living with dogs might have reciprocal benefits. Research suggests pet ownership especially dog ownership may slow cognitive decline in humans, improving memory and executive functioning. This is potentially due to the emotional support and social engagement dogs provide, highlighting a shared journey of mental enrichment.

Kushari Geethma
S/19/033



DO OUR DOGS
THINK LIKE US?

CANINE COGNITION

SEALED
WITH
TRUST

The Extraordinary Parenting of
the Sri Lanka Grey Hornbill
Ocyceros gingalensis



Beak touching by both before mating >>

Abstract

The Sri Lanka endemic most unique the avian world. behavioural emphasizing Lanka’s field provides an environmental this

Grey Hornbill (*Ocyceros gingalensis*), an frugivorous bird, demonstrates one of the and cooperative parental care strategies in This review explores its nesting ecology, adaptations, and ecological importance while conservation implications in the context of Sri declining forest habitats. Through integrating observations and published studies, this article overview of how trust, cooperation, and interdependence are embodied within species’ breeding ecology.

1. Introduction

The Sri Lanka Grey Hornbill (*Ocyceros gingalensis*) is an endemic member of the family Bucerotidae, primarily distributed across the island’s wet and intermediate zones. It is easily recognized by its distinctive grey plumage, long curved bill, and distinctive calls that echo through dense forest canopies. Beyond its ecological importance as a major seed disperser, the species exhibits an extraordinary reproductive behaviour where the female is sealed inside a nesting cavity for months, a strategy that demonstrates extreme cooperation between partners (Wijerathne & Wickramasinghe, 2018). Understanding this remarkable nesting adaptation provides in-sights into avian evolution, sexual division of labour, and the species’ ecological dependence on mature forests.

2. Nesting Ecology and Behaviour

The breeding season of the Sri Lanka Grey Hornbill typically extends from March to July. Pairs select natural cavities in mature trees, generally 5–15 meters above ground (Wijewardana et al., 2024). After choosing a cavity, the female enters and the entrance is sealed using a mixture of mud, fruit pulp, and droppings, leaving only a narrow slit. This barrier allows the male to deliver food while protecting the nest from predators. Inside the sealed cavity, the female lays two to three eggs, incubates them, and undergoes a complete flight feather molt. The male exclusively provides food, ensuring the survival of both the female and the chicks. After approximately 70–90 days, when space becomes restricted, the female breaks open the seal and assists in chick rearing until fledging (Wijerathne & Wickramasinghe, 2018).

3. Adaptive Significance of Nest Sealing

Nest sealing in hornbills offers several adaptive benefits that enhance reproductive success. Firstly, it provides effective protection against predators such as snakes and monitor lizards. Secondly, it may help maintain a stable microclimate within the nest cavity, optimizing conditions for egg incubation. Finally, this strategy maximizes energy efficiency, as the confined female dedicates full attention to incubation and chick care while the male focuses on provisioning. However, this specialization also renders the species highly dependent on the availability of large, cavity-bearing trees (Wijewardana et al., 2024).

4. Feeding Ecology and Seed Dispersal Role

The Sri Lanka Grey Hornbill is predominantly frugivorous, feeding on fruits from genera such as *Ficus*, *Syzygium*, and *Cinnamomum*, alongside small arthropods (Wijerathne et al., 2023). As a primary seed disperser, it plays a vital role in maintaining forest diversity and regeneration. The bird's selective feeding behaviour ensures the dispersal of a variety of plant species, promoting genetic diversity and forest sustainability. Its wide-ranging movements across fragmented landscapes also facilitate seed transport between forest patches, making it a key agent in ecological connectivity.

5. Conservation Implications

The survival of the Sri Lanka Grey Hornbill is closely tied to the presence of old-growth trees with natural cavities. Deforestation, selective logging, and habitat fragmentation have significantly reduced suitable nesting sites. Recent studies have documented hornbill pairs adapting to artificial nesting structures, such as metal pots, in urban settings as a behaviour that reflects both resilience and ecological stress (Wijewardana et al., 2024). Effective conservation strategies should include the protection of mature forests, restoration of native tree species, and implementation of artificial nest-box programs in fragmented areas. Community-based monitoring and public engagement in hornbill conservation can further strengthen efforts to safeguard this species and its ecological role.

6. Reflection and Conclusion

The breeding ecology of the Sri Lanka Grey Hornbill represents a remarkable example of trust, adaptation, and evolutionary precision. Its sealed nesting strategy is not only a biological marvel but also a symbolic reminder of the interdependence between species and ecosystems. Understanding such behaviours deepens our appreciation of ecological complexity, while for society, it underscores the urgent need to protect forest habitats. The story of the hornbill teaches us that resilience and cooperation, both in nature and humanity, are key to survival.

Nest feeding by the male bird >>



<< Searching around before entering the nest with food



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(Image Source : <https://doi.org/10.1155/2018/9509785>)

Bhagya Jayasekara
S/19/202

Nature is the constant battlefield where survival depends on adaptation. Among the countless strategies animals have developed to defend themselves or capture prey, venom stands out as one of the most remarkable and potent weapons. The evolution of venom is not only a fascinating subject in zoology but also a critical tool for understanding predator-prey interactions, biodiversity, and even human medicine.

Venom is a specialized biochemical cocktail of proteins, peptides, and enzymes, injected into another organism through fangs, stingers, spines, or other structures. Unlike simple poisons that must be ingested or absorbed, venom is an active tool delivered with precision to subdue prey or deter predators. Its effects can range from paralysis and tissue destruction to pain, confusion, or even death.

Scientists believe venom evolved independently multiple times across different groups of animals, a phenomenon known as convergent evolution. Snakes, spiders, scorpions, centipedes, cone snails, jellyfish, and even some mammals like the platypus, possess venom.

This independent evolution demonstrates that venom provides a strong survival advantage in diverse environments. Venom may have originally evolved from digestive enzymes or other proteins already present in an animal's body. Over millions of years, natural selection has fine-tuned these compounds into complex venom systems perfectly suited to each species' ecological needs.

Venom serves multiple purposes depending on the species such as, predation - many

snakes and cone snails use venom to immobilize or kill prey quickly, reducing the risk of injury during hunting. Defense - Scorpions, bees, and wasps use venom to protect themselves from larger threats. Competition - some animals, such as male platypuses during breeding season, use venom

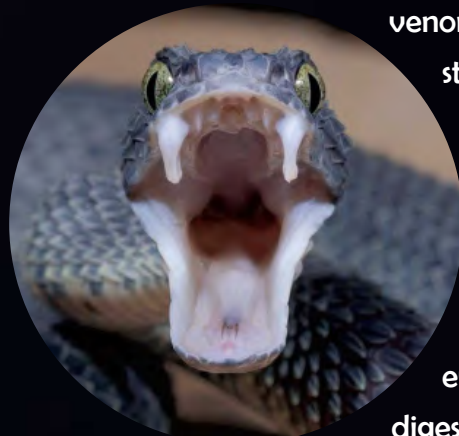
While, venom can be deadly, it has also become a source of life-saving medicines. Researchers study venoms to develop

treatments for hypertension, blood clots, chronic pain, and even cancer. For example, the blood pressure drug 'Captopril' was derived from the venom of a Brazilian pit viper. Cone snail toxins are being tested as powerful painkillers, offering relief where traditional drugs fail.

The story of venom is also a story of resistance. Prey animals often evolve defense against venom, such as mongoose resistance to cobra venom or ground squirrels' partial immunity to rattlesnake venom. This ongoing arms race drives the continuous evolution of more potent venoms and more effective defensive adaptations, shaping ecosystems in subtle but powerful ways.

against rivals. Not all venoms are the same. Each species has a unique venom "recipe," reflecting its lifestyle and prey. Snake venoms, for example, may contain neurotoxins that attack the nervous system, or hemotoxins that destroy blood cells and tissue. Cone snails produce a mix of hundreds of toxins that act almost like a chemical "hypodermic cocktail." This diversity means venom can evolve rapidly, allowing animals to adapt to changing prey defenses or environmental conditions.

THE EVOLUTION OF VENOM - NATURE'S MOST POTENT WEAPON



<< Gamma Cat Snake (*Boiga trigonata*)
©Kumudu Wijesooriya

Danushika Senevirathne
S/20/163





© Subudu Premasinghe





Coexisting with Giants

Understanding and Mitigating Human–Elephant Conflict in Sri Lanka

Human–elephant conflict (HEC) is one of the most prominent and widely recognized forms of human–wildlife conflict, largely due to the conservation importance of the Asian elephant (*Elephas maximus*). The species is currently classified as endangered, with HEC contributing significantly to its population decline. Asian elephants are considered both umbrella and flagship species. As an umbrella species, they require large home ranges that overlap with those of many other species, meaning that protecting their habitats benefits a wide array of wildlife. As a flagship species, they attract considerable public attention and resources, which can be directed toward broader conservation efforts. Addressing HEC is therefore critical not only to safeguard this keystone species but also to mitigate the negative effects of conflict on human livelihoods.

Elephants can cause substantial damage to crops, infrastructure, and property, leading to significant economic and social stress for rural communities. Although Sri Lanka is a small island, it supports a human population of approximately 22.4 million and around 10% of the global wild elephant population (Santiapillai et al., 2010). It has been observed that when both human and large animal populations reach high densities, their coexistence becomes increasingly incompatible. While human population growth is a major factor contributing to HEC, it is not the only cause.

Across Asia, only about half of elephant habitats consist of large, unfragmented areas capable of supporting stable populations. Habitat loss and fragmentation, largely driven by development projects and agricultural expansion, have played a major role in escalating conflict. In Sri Lanka, projects such as the accelerated Mahaweli Scheme have altered access to essential resources like food and water, disrupting elephant home ranges and migration routes. The spread of paddy cultivation has further intensified encounters between humans and elephants, as elephants are attracted to farmlands due to the abundance and accessibility of food.

According to Chiyo et al. (2011), crop-raiding elephants tend to grow faster and achieve greater reproductive success than non-raiding individuals, particularly during musth—a period of heightened aggression and sexual activity—giving them a competitive edge. Elephants' voracious browsing and grazing habits, combined with negative community attitudes toward them outside protected areas, exacerbate conflict. These interactions have resulted in a range of ecological and social challenges, including food insecurity, economic loss, emotional distress, restricted mobility, and fatalities among both humans and elephants.

To effectively mitigate HEC, it is essential to promote coexistence strategies that allow humans and elephants to thrive without harming one another. Prevention methods

include fencing, trenches, alarm systems, and other deterrents designed to scare elephants away or alert farmers to their presence. Traditional approaches have also been used for generations; for example, chanting mantras to deter elephants. However, due to their intelligence and adaptability, elephants quickly become accustomed to such methods, reducing their long-term effectiveness. Some farmers have created simple warning systems using hanging glass bottles that rattle when elephants pass through. These can be upgraded into tripwire alarm systems that trigger loud noises when breached a method proven effective in other regions. Other sound-based deterrents, such as thundercrackers and sirens, have also been distributed by wildlife authorities to help farmers ward off elephants. But long-term use of thundercrackers can deafen elephants; therefore, usage should be monitored.

Night guarding remains one of the oldest methods of protection, with farmers often constructing tree houses or watchtowers to monitor fields. Communal guarding has proven more effective than individual efforts, providing greater vigilance and safety.

Electric fencing is among the most widely implemented methods of reducing HEC in Sri Lanka. While effective in certain

contexts, fencing alone cannot solve the problem. Its success depends heavily on community engagement, proper planning, and regular maintenance. Communal fences that encircle multiple plots or entire villages are often more sustainable due to shared costs and responsibilities. Integrating electric fences with broader landscape management strategies, such as habitat restoration and corridor planning, enhances their effectiveness. Advanced versions, such as smart electric fences equipped with alarm and detection systems, are being explored as innovative improvements.

Trenches, or “Ali agal,” are also dug in front of fences to increase protection, though they can be hazardous to elephant calves. Solar-powered electric fences offer a sustainable alternative and have proven highly effective in some countries.

Another preventive measure is the establishment and maintenance of elephant corridors, particularly those connecting



We don't come to cause trouble. We come because we're running out of space and food.

protected areas. These corridors facilitate safe elephant movement while reducing encounters with humans. Buffer zones—unplanted areas between farmlands and elephant habitats—further help minimize conflict.

Understanding elephants’ natural behavior also plays a role in prevention. For instance, elephants are drawn to salt deposits in the soil. Artificial salt licks have been created in some regions to divert elephants away from human settlements.

Nature-based solutions have recently gained attention for their sustainability and long-term effectiveness. Biofencing, which involves planting thorny or unpalatable vegetation such as palmyrah or cacti in zigzag patterns, provides both an ecological and cost-effective barrier. Citrus plants like lime and orange have also proven to deter elephants while generating supplementary income for farmers. Other plants such as neem, cashew, and sesame are similarly avoided by elephants. The use of *Opuntia exaltata* cactus as a biofence has shown success in other countries, though its feasibility for Sri Lankan conditions requires further study.

Chili-based deterrents are another widely studied method. Mixtures of ground chili, grease, and tobacco have been used to coat ropes or cloth barriers that elephants avoid. Though effective, this technique can be costly and labor-intensive. Variations include chili bombs, chili bricks, and chili dung cakes, each designed to repel elephants using strong odors and irritation.

Beehive fences are another innovative, nature-based approach. Elephants are instinctively afraid of the buzzing sound of bees and avoid areas where hives are

present. Beehive fences thus serve as a natural deterrent while providing an additional income stream from honey production. The concept has shown great promise elsewhere and could be adapted for use in Sri Lanka with appropriate native bee species such as *Apis cerana*, which may even be more effective than other commonly used species.

Mitigation strategies can range from simple community-based practices to broader policy-driven solutions. Local education and awareness programs can correct misconceptions about elephants and emphasize their ecological importance. Training initiatives, knowledge-sharing networks, and insurance schemes to compensate for crop losses are all part of a comprehensive coexistence framework.

Changes in land use and increasing elephant populations continue to intensify conflict, underscoring the need for holistic and adaptive management. Translocation of problematic elephants to protected areas has been practiced but carries challenges, including high costs and the risk of elephants returning to their original territories.

Modern technological interventions offer new avenues for reducing HEC. Elephant detection systems using infrared beams, microwave radar sensors, and geophones can identify approaching elephants and send real-time alerts. Long-range communication technologies enhance connectivity between detection and alarm subsystems, especially in rural areas with weak mobile coverage. Smart fences integrated with detection systems can issue separate alerts for elephant movements and fence breaches, while non-lethal deterrents such as flashing lights provide additional protection. Advanced data

analysis using neural networks can even distinguish elephant footfalls from other sounds, improving the accuracy and reliability of these systems.

Through the integration of traditional practices, community participation, modern technology, and sustainable land management, Sri Lanka can move toward a future where humans and elephants coexist more harmoniously.



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Apoorva Randeni
S/19/139

SILENT FORESTS

The Decline of Sri Lanka's Endemic Birds

Sri Lanka's forests have long been alive with music: the haunting calls of the Ceylon whistling thrush echoing through misty montane valleys, the cheerful chatter of hanging parrots among the canopy, and the rhythmic drumming of woodpeckers on old trees. Yet today, these songs are fading. The forests are growing silent, a sign that many of the island's unique birds are in trouble.

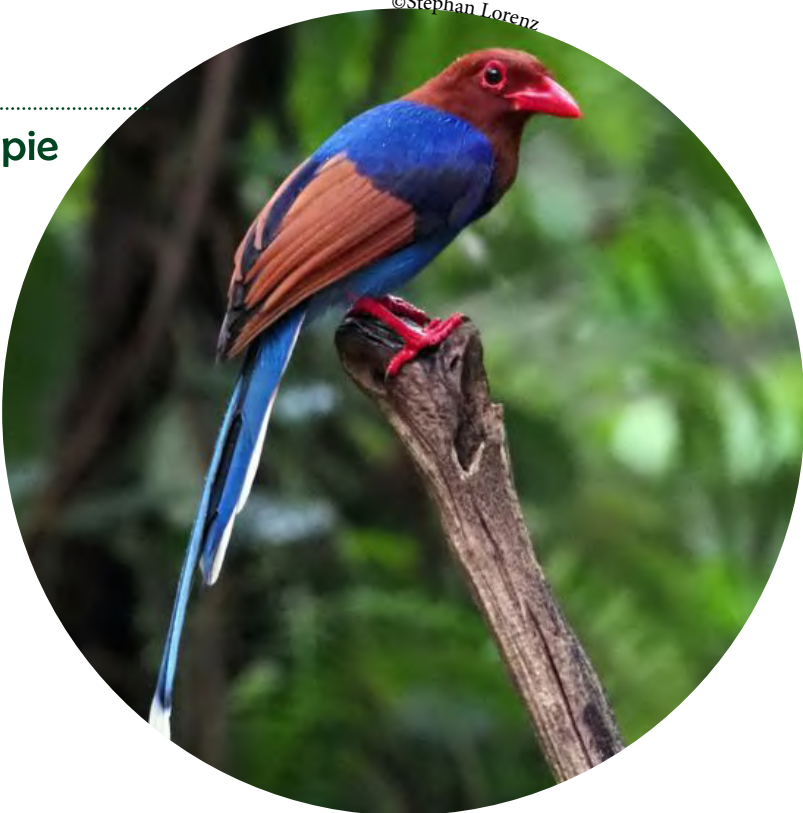
A Small Island with Great Diversity

Despite its size, Sri Lanka is one of the world's biodiversity hotspots, boasting over 34 endemic bird species found nowhere else on Earth. The island's long isolation and varied habitats from rainforests to dry scrublands which allow species such as the Sri Lanka blue magpie (*Urocissa ornata*), Sri Lanka junglefowl (*Gallus lafayettii*), and Yellow-eared bulbul (*Pycnonotus penicillatus*) to evolve independently. These birds are not just scientific treasures; they are symbols of the island's natural heritage.

Ceylon (Sri Lanka) Whistling-thrush
(*Myophonus blighi*)



Sri Lanka Blue Magpie
(*Urocissa ornata*)



Yellow-eared Bulbul
(*Pycnonotus penicillatus*)



Sri Lanka Junglefowl
(*Gallus lafayettii*)



The Vanishing Habitats

The greatest threat to these birds is habitat loss. Sri Lanka’s original forest cover, once more than 80% of the land, has been reduced to less than 30%. Lowland rainforests like Sinharaja and Kanneliya which are the stronholds of many endemic species are now surrounded by human settlements, tea plantations, and roads. When these forests shrink and fragment, bird populations become isolated, making them vulnerable to extinction.

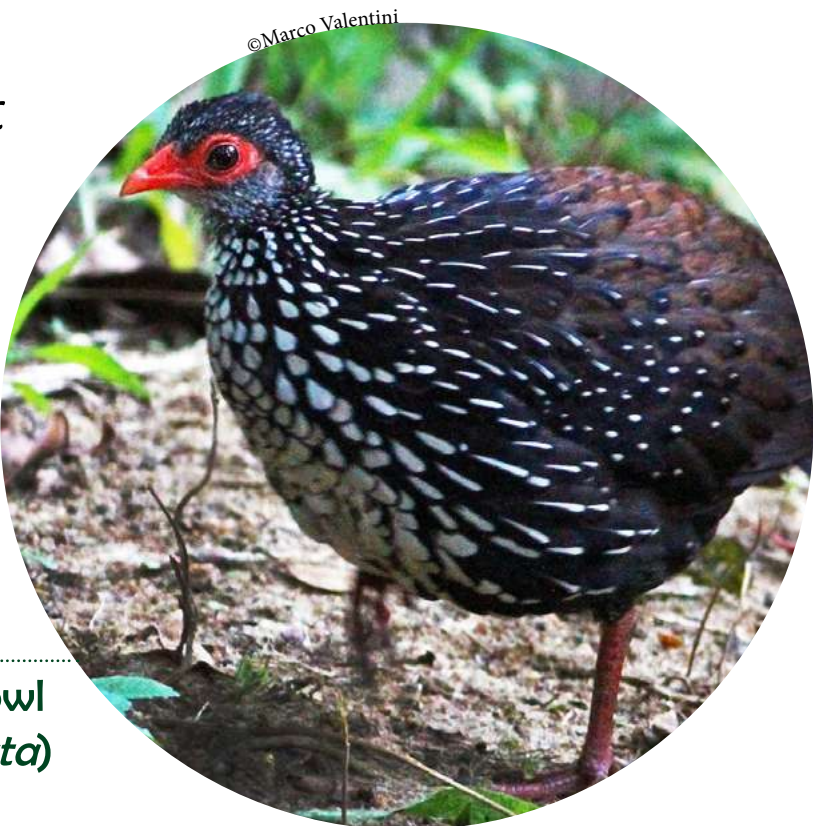
For example, the Ceylon whistling thrush (*Myophonus blighi*), which lives only in shaded streams of the central highlands, is rarely seen today. It depends on dense forest undergrowth, but expanding tourism, hydroelectric projects, and illegal logging have destroyed much of its habitat. Similarly, the Sri Lanka spurfowl, a shy ground-dwelling bird, now survives only in small pockets of undisturbed jungle.

Silent Victims of Human Change

Deforestation is not the only danger. Climate change is altering rainfall patterns and temperature, pushing many species out of their comfort zones. Invasive plants and predators such as rats and cats threaten eggs and chicks. Even noise pollution from vehicles and chainsaws can disturb the delicate breeding behavior of forest birds. Illegal bird trade has also become a silent killer. Some endemic species, prized for their bright plumage or sweet songs, are trapped and sold despite strict wildlife laws. The loss of even a few breeding pairs from small populations can be devastating.

Guardians of the Forest

These birds are more than just beautiful they play vital roles in forest ecosystems. Fruit-eating species like the Sri Lanka hanging parrot help spread seeds, while insectivorous birds control pest populations. When they disappear, the entire forest community suffers.



Sri Lanka Spurfowl
(*Galloperdix bicalcarata*)

Hope for the Future

Despite the challenges, there is still hope. Protected areas, such as the Sinharaja Forest Reserve (a UNESCO World Heritage Site), protect some of the last refuges for endemic birds. In the buffer zones of the Sinharaja and Knuckles ranges, local communities are increasingly integrated into the protection of the land. Through participatory forest management, villagers are granted the right to sustainably harvest non-timber products, such as kithul treacle or medicinal herbs, in exchange for monitoring illegal logging and poaching. Furthermore, the rise of specialized ecotourism has turned the presence of a rare bird from a curiosity into a livelihood. When a local youth can earn a living as a birding guide, the survival of the Whistling Thrush becomes a matter of economic necessity for the village. Local researchers and citizen scientists are working to monitor bird populations and raise awareness through initiatives. Ecotourism, if managed responsibly, can also create incentives for communities to protect these habitats.

Each time a Sri Lankan blue magpie flashes through the forest canopy or a whistling thrush calls at dawn, it reminds us of what is still left to save. The silence creeping across our forests is a warning but it is not too late to bring back the songs.



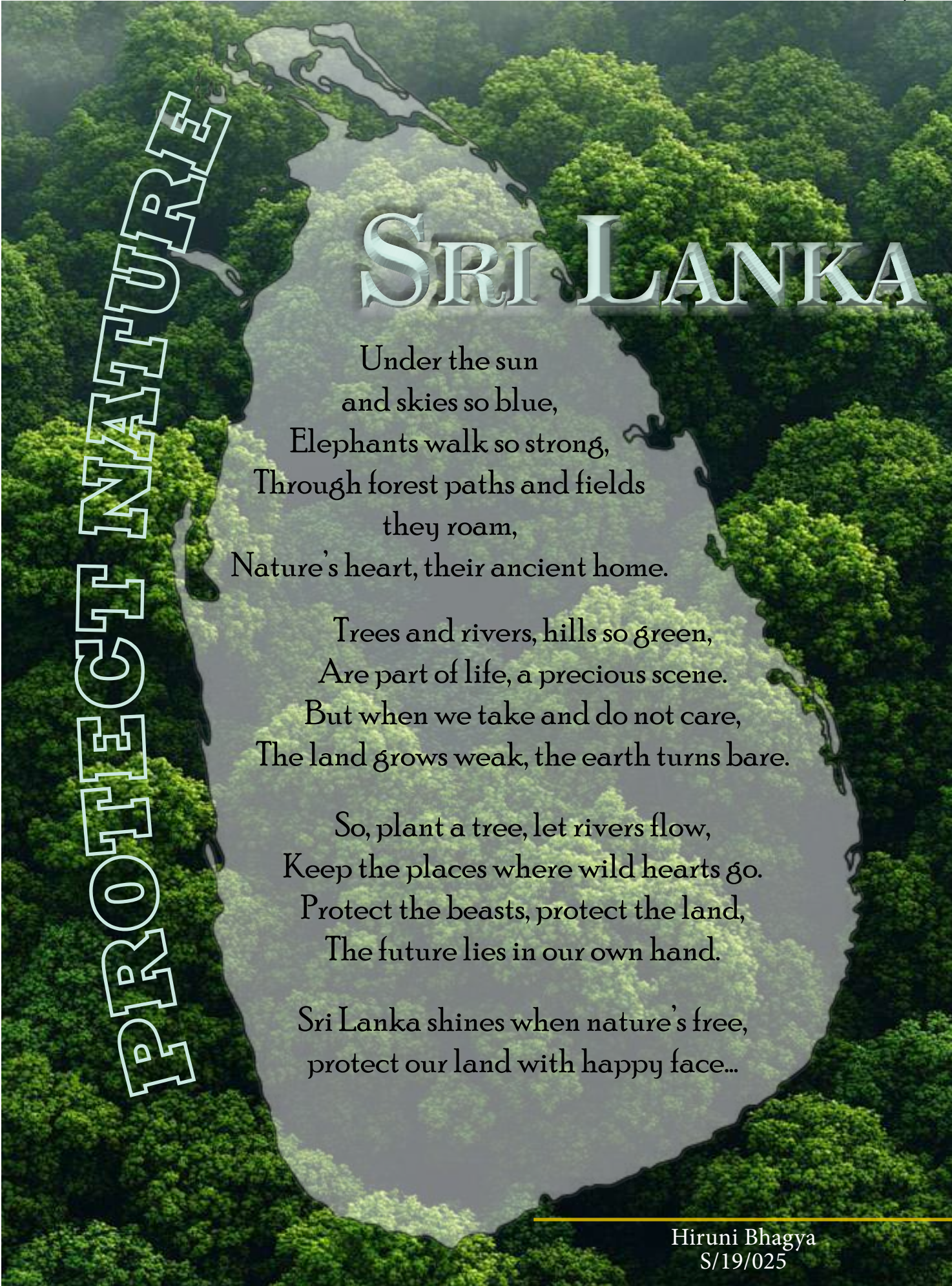
Sri Lanka Hanging-parrot
(*Loriculus beryllinus*)

Hashini Dilmini
S/19/038

TEARS OF POLLUTION



Ayanajith Kumarasinghe
S/19/206



Under the sun
and skies so blue,
Elephants walk so strong,
Through forest paths and fields
they roam,
Nature's heart, their ancient home.

Trees and rivers, hills so green,
Are part of life, a precious scene.
But when we take and do not care,
The land grows weak, the earth turns bare.

So, plant a tree, let rivers flow,
Keep the places where wild hearts go.
Protect the beasts, protect the land,
The future lies in our own hand.

Sri Lanka shines when nature's free,
protect our land with happy face...

Hiruni Bhagya
S/19/025

Trampled Paths & Tired Souls

Sri Lanka is home to an incredible diversity of wildlife, from iconic leopards in Yala to majestic elephants in Udawalawe. For decades, these animals have attracted tourists from around the world, thereby supporting the wildlife tourism industry. However, what lies behind these exciting safaris and wildlife photographs is a great irony. The very visitors who come to enjoy the beauty of nature could be its greatest threat. “Can tourism truly support conservation, or is it threatening the nature and wildlife it claims to protect?” is a question that lingers in the minds of many conservation biologists.

Tourism and Conservation

Tourism and conservation are like two sides of the same coin. Both rely on the natural and cultural resources of a country, yet one can either drive or destroy the other,

depending on how it is managed. The concept of Ecotourism is often presented as a balanced strategy for managing natural resources. Unlike conventional tourism, ecotourism is intended to minimise environmental impact, conserve biodiversity, and support local communities. It is one of the fastest-growing forms of tourism and, in principle, offers a sustainable alternative to mass tourism. However, in practice, true ecotourism is often not properly implemented. Many activities labelled as ecotourism continue to follow mass tourism models, prioritising visitor numbers and profit over conservation. As a result, although such initiatives may generate employment and income, they can still distort local economies and negatively impact wildlife and ecosystems, undermining the core principles of ecotourism.

Tourism at Yala National Park

Yala National Park spans over 151,000 hectares and shelters many animals such as elephants, leopards, sloth bears, and over 130 bird species. Research by Buultjens in 2005 revealed that unregulated tourism had created numerous issues within the park. Overcrowding of safari jeeps, unprofessional drivers speeding to reach



THE HIDDEN COSTS OF WILDLIFE TOURISM IN SRI LANKA

©2026 Tangalle Sri Lanka

leopard sightings, often off-road, had resulted in vegetation damage. Pollution from litter, vehicle emissions, and burning waste in open pits had further degraded the environment. Poor infrastructure and lack of trained staff had worsened the situation.

What is even more concerning is that these problems persist even after many years, showing little improvement, or in some cases worsening. A 2024 study by Ushantha et al. based on in-depth interviews states that visitors often describe their experiences as stressful and disappointing, with some labelling Sri Lanka as the “Africa of Asia.” Hundreds of jeeps releasing diesel fumes, drivers chasing leopards, and unsafe driving by untrained drivers have harmed the park’s reputation. Many guides lack proper knowledge and language skills, leaving tourists dissatisfied.

Another key issue is the excessive focus on leopard sightings, which can create unrealistic expectations among tourists if they are unable to spot one. Since Yala is promoted as a place for leopard sightings, visitors often expect to put that “leopard shot” on Facebook, and if they miss the chance, they leave disappointed, without actually seeing the natural beauty and other valuable wildlife in the park.

Elephants under pressure at Udawalawe

Research conducted at Udawalawe National Park has shown that even simple human presence can disturb animals and change their behaviour. Observations show that elephants exposed to the noise of vehicles, loud talking and clapping of tourists, display elevated levels of stress, fear and aggression. In addition, tourists trying to feed elephants can interrupt their natural feeding habits and make them defensive. These findings reveal the sad truth that wildlife tourism can harm animals even without direct hunting or capture.

Reset of Nature during the pandemic

Although the COVID-19 pandemic severely impacted the tourism industry of Sri Lanka, it kind of served as a reset period for nature. During the months when tourism was halted, cleaner air, healthier vegetation, and elephants returning to their natural foraging behaviours were observed. Leopards were seen resting in open spaces where once crowded with safari jeeps. The ecosystem was healing!

“What you do makes a difference, and you have to decide what kind of difference you want to make”

- Jane Goodall (British primatologist and conservationist)

Do local communities actually benefit?

Local communities living near national parks are often overlooked in wildlife tourism. Many residents face restrictions on resource use, while their crops are frequently damaged by wild animals. Sometimes, they get no compensation. Jobs in the tourism industry are seasonal and poorly paid, resulting in a lack of motivation for conservation. All these lead to local communities becoming victims of wildlife tourism, rather than gaining a benefit.

and reduce the number of safari jeeps to a manageable level. Drivers should be trained and licensed, while guides are given education in wildlife and conservation. Encouraging community participation and fair revenue distribution can ensure that local people take active roles in protecting wildlife.

As a final note, Sri Lanka still has time to prove that conservation and tourism can coexist. Not as rivals, but as true allies which support the development of each other. And the visitors also have an individual responsibility to abide by the rules, maintain proper distance and silent behaviour and not to interrupt the natural behaviours of animals. They must learn to be silent guests who leave no traces behind, allowing the wildlife to thrive for generations.

Solutions

The situation of wildlife tourism stands at a pivotal point in Sri Lanka. However, it need not remain this way. Solutions do exist. Park managers can regulate visitors

Sashini Dikmadugoda
S/19/037



THE UNSEEN STRUGGLE

Sri Lanka's Hog Deer

In a country where the trumpeting of elephants and the stealth of leopards capture our imagination, a silent struggle is playing out in marshes, rice fields and cinnamon estates of Sri Lanka's southwest. Few know the name hog deer and understand that this modest-sized deer may be one of the most endangered large mammals on the island. It's high time we shine a light on this quiet survivor.

A species off the radar

Hog Deer (*Axis porcinus*), the rarest of Sri Lanka's four deer species (Vishvanath, Nanayakara, & Herath, 2014), is listed as Critically Endangered (CR) in the 2012 National Red List of Sri Lanka. Locally, it's known as "Wil Muwa". It's mid-sized and

robustly built deer with prominent furred pedicles, that carry three-tined antlers. The hooves are splayed, as an adaptation to life in the marshy habitats. Measurements of Sri Lanka appear to show that Hog Deer in the island are smaller on average than specimens from mainland Asia.

The hog deer is the definition of low profile. Unlike its more visible cousins, the spotted deer, the sambar, the barking deer, it favours marshy scrub forests adjoining wetlands, rarely making headlines. Its low-slung, hog-like gait makes it even harder to spot in the wild. Hog deer is primarily nocturnal and crepuscular as well.

In fact, recent research in the Galle district found 306 adults and 22 fawns across 175 locations (Madhushanka & Ranawana, 2025). over a year-long survey. This is a modest increase from earlier decades but the very fact that such numbers matter tells you how perilous its situation is. And yet, how many Sri Lankans could name it on sight? I'd bet most of us haven't heard the name "hog deer". That in itself is a problem: out of sight, out of mind.

You might ask, "Okay, what's so special about a modest deer anyway?" Plenty.

Ecologically, species like the hog deer occupy a niche in wetland-edge and marshland ecosystems. They feed on new shoots, traverse rice paddies and cinnamon plantations and become part of the understory dynamics. When such species decline, subtle but real changes in vegetation, predator-prey relationships and habitat health can accumulate.

Threats on multiple fronts

The hog deer faces a suite of pressures that are at once subtle and severe:

Habitat fragmentation and human wildlife conflict - with their preferred habitats vanishing, the animal has adapted to human-modified

landscapes, finding refuge in cinnamon plantations, rice fields and vegetable orchards. As the deer sometimes feed in rice fields, vegetable plots and cinnamon estates, farmers may view them as pests. The pressure to remove or displace them builds.

Predation by non-traditional predators - Feral dogs and large water monitors (which thrive on garbage dumps) are attacking fawns and even adults. Injuries caused by monitors are often difficult to save because the wounds quickly turn septic.

Road accidents - This is one of the major contributing factor for their decline. Adults are frequently victims of vehicle collisions.

Poor visibility and awareness - Because the species is secretive, nocturnal



The first hog deer fawn born in the captive breeding facility run by the Wildlife Conservation Society of Galle (WCSG) in Hondurwa ©WCSG



Severely injured fawn at Hiyare Wildlife Rescue
©WCSG

An adult male hog deer injured due to a road accident being treated at the wildlife rescue center at Hiyare in southern Sri Lanka
©WCSG



and low-slung (it runs with its head down “like a hog” through under-brush), many may walk past it without noticing.

Why the status is urgent?

This is the most threatened deer species in Sri Lanka. Its range today is restricted to fragmented patches, largely in the south-western coastal belt. Losing it wouldn’t just be losing “another deer”. It would signal a weakening of the ecosystem’s resilience, a narrowing of genetic diversity and the further marginalization of less-charismatic species whose story we rarely tell.

What can be done (and is being done)?

There are hopeful glimmers: A captive-breeding programme was launched in 2013 by the Wildlife Conservation Society of Galle (WCSG) with help from the Geoffrey Bawa Trust. So far, 76 individuals have been released back into the wild. This is the first captive breeding programme in Sri Lanka for endangered animals (Madhushanka & Ranawana, 2025).

More detailed surveys are providing coverage of where the deer still exist.

Conservationists emphasize community engagement, habitat protection (especially wetlands), feral dog-control and further DNA/taxonomy work to clarify its status

The bigger message

Even though flagship species help rally awareness and protection for entire ecosystems, smaller and lesser-known animals sometimes remain in the shadows. When the spotlight falls mostly on the icons, species like the hog deer can quietly fade from our collective concern. Yet nature does not measure worth by size or spectacle. The hog deer reminds us that every species has a story, a niche and a reason to exist and by extension, a reason for us to care. Losing it wouldn’t just mean the disappearance of one deer. It would erase a unique chapter of Sri Lanka’s wild heritage.

So, here’s a simple challenge: the next time you hear someone mention “wildlife

conservation in Sri Lanka”, ask whether the hog deer is part of that conversation.

If they shrug, invite them in. Share that name. Let the species have a voice. Because conservation isn’t only about the elephant in the room- it’s also about the quiet creature in the reeds. The hog deer may not trump or roar, but its survival matters all the same.

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Tharani Wickramasinghe
S/22/138

Living on the Edge

In the forests and farmlands of Sri Lanka, a silent struggle unfolds every day, one that pits human survival against the survival of one of Asia’s most iconic species, the Sri Lankan elephant. This ongoing clash, known as Human-Elephant Conflict (HEC), has become one of the country’s most urgent environmental and socio-economic challenges.

A Growing Crisis

As both human and elephant populations expand, they are forced to share increasingly limited land. Forests are cleared for agriculture, irrigation, and development, shrinking elephant habitats and pushing them closer to human settlements. Today, nearly 69% of elephant ranges overlap with human activity, especially in Sri Lanka’s dry zone.

The consequences are severe. On average, around 125 people and 370 elephants die each year due to this conflict. Over the past three decades, human deaths have risen by about 42%, while elephant mortality has surged even further. Sri Lanka now records the highest annual elephant deaths in the world and ranks second in human fatalities from such conflicts.

Why Do Elephants Enter Human Spaces?

For elephants, farmland is an irresistible “buffet.” Crops like rice, banana, and sugarcane provide high-energy food, especially during dry seasons when natural resources are scarce. As a result, elephants frequently raid farms, damage homes, and even enter villages in search of food. Interestingly, most dangerous encounters are caused by solitary male elephants. In response, some farmers resort to extreme measures such as explosives, electrocution, or shooting methods that often worsen the crisis and contribute to rising elephant deaths.

The Roots of Conflict

The persistence of HEC is deeply linked to rapid land-use changes. Expanding agriculture, urbanization, and large infrastructure projects fragment natural habitats, creating a patchwork landscape where elephants must navigate through human-dominated areas.

Electric fencing has been the government’s primary solution, with thousands of kilometers installed across the country. However, poor maintenance and improper placement often reduce effectiveness. At the same time, new challenges, such as elephants feeding on garbage dumps are increasing their dependence on human environments.



HUMAN-ELEPHANT CONFLICT
IN SRI LANKA

Traditional Wisdom Meets Modern Challenges

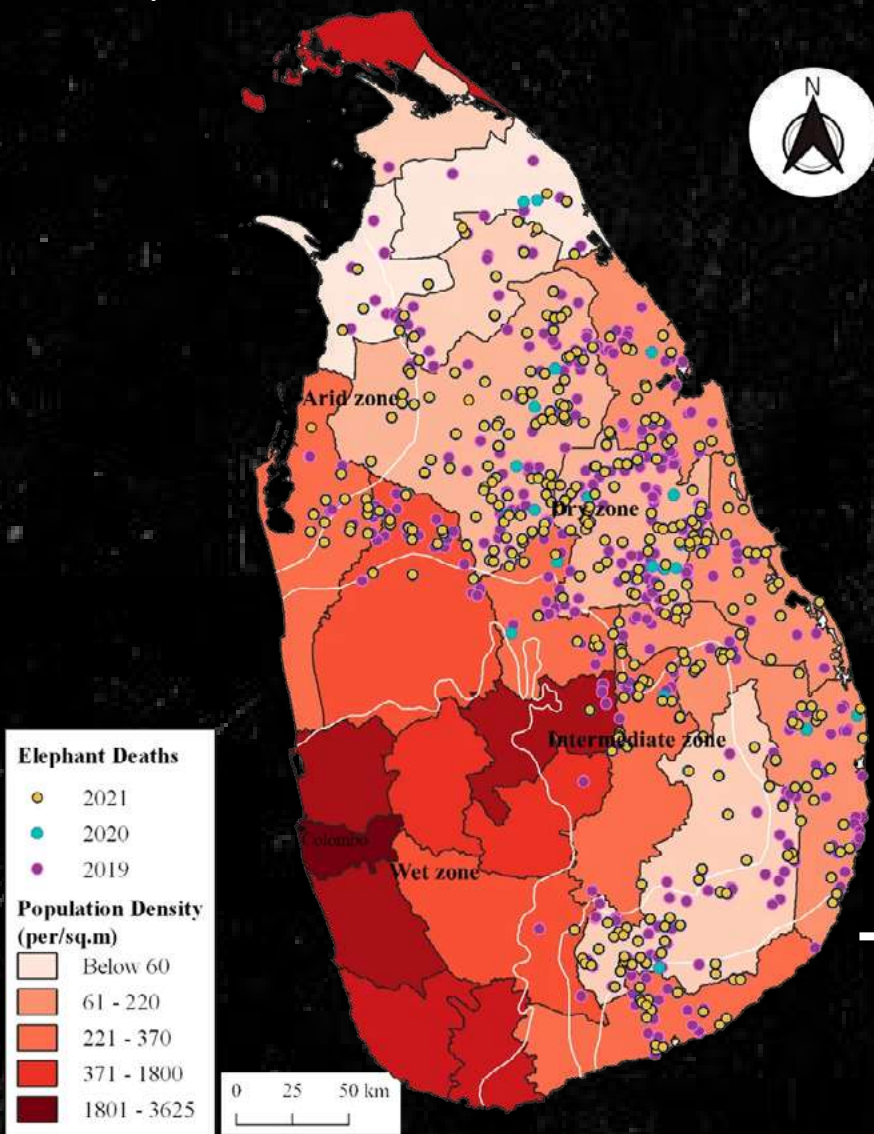
For generations, rural communities have developed their own ways to keep elephants at bay:

- Physical barriers like trenches and fences
- Noise deterrents such as drums and firecrackers
- Fire and light to scare elephants at night
- Crop strategies, including planting citrus as natural barriers
- Beehive fences, using elephants' fear of bees as a deterrent

While these methods are often affordable and culturally rooted, they are rarely long-term solutions. Elephants are highly intelligent and quickly adapt, reducing the effectiveness of many traditional techniques.

Toward Smarter Solutions

Experts now emphasize the need for a more integrated approach. Combining traditional knowledge with modern science could offer sustainable solutions. Technologies such as satellite tracking and GIS mapping can help identify high-risk zones and predict elephant movements.



Sri Lanka population density in 2019 and distribution of elephant deaths between 2019 and 2021 (Central Bank of Sri Lanka, 2019, DWC)

Other practical strategies include:

- Creating well-planned elephant corridors
- Improving waste management to prevent attraction
- Supporting community-based guarding systems
- Introducing fast compensation or insurance schemes
- Enhancing public safety and awareness

Rather than separating humans and elephants completely, the goal is to enable safe coexistence.

A Shared Future

Despite the challenges, Sri Lanka remains home to about 10% of Asia's elephants, making conservation efforts globally significant. However, habitat loss and conflict continue to threaten their survival.

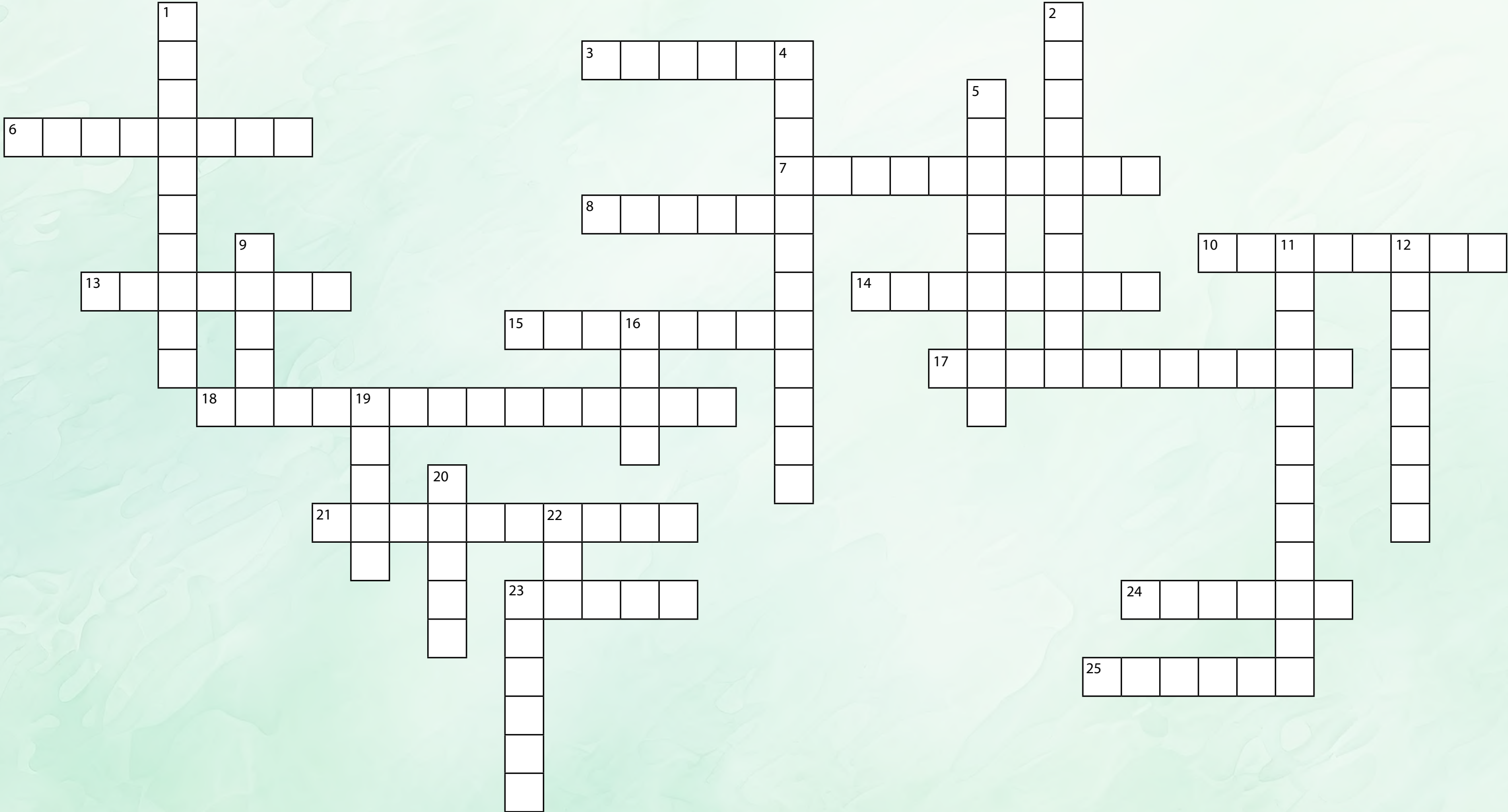
The human - elephant conflict is not just a wildlife issue, it is a complex problem involving ecology, economics, and human safety. Lasting solutions will require cooperation among scientists, policymakers, and local communities.

Ultimately, the future of both humans and elephants depends on finding balance, because in Sri Lanka, neither can afford to lose this fight.



Akila Madhusanka
S/20/102

The Bio-Logic Puzzle



Across Clues

- 3. A type of bird known for its intricate nest building, whose brain structures are analyzed for spatial memory
- 6. The complex sugar stored in animal livers and muscles, a crucial energy source for both wildlife and human athletes
- 7. The scientific study of insects, many of which are vectors for human diseases like malaria
- 8. The protective outer layer of many insects and crustaceans, inspiring light weight, durable biomedical materials
- 10. The medical field focused on diseases common to both humans and animals, such as zoonotic infections
- 13. A type of ape whose social structures are studied to understand complex primate behavior and even human disease transmission
- 14. The study of animal behavior in their natural habitats, informing conservation and understanding human psychology
- 15. The long, slender tail-like appendage of some bacteria, used for movement, and a target for new antibiotics
- 18. The scientific name for the “naked mole rat,” an animal resistant to cancer and known for its extreme longevity
- 19. The microscopic infectious agent, often studied in animal models, that causes the common cold
- 21. The biological term for the “warm-blooded” nature of mammals, crucial for maintaining optimal enzyme function
- 22. The specialized “electric organ” found in certain fish, inspiring research into bio-batteries
- 23. The gene-editing technology, often tested in animal models, derived from bacterial immune systems
- 24. A common term for a young, developing animal, often used in developmental biology research
- 25. The name for the earliest stage of embryonic development, studied in animals to understand cell differentiation

Down Clues

- 1. The protein found in red blood cells that transports oxygen, a key target in studies of high-altitude animal adaptations
- 2. The collective term for beneficial microorganisms living in an animal’s gut, impacting digestion and immunity
- 4. The process by which amphibians regenerate lost limbs, a key area of study for human tissue repair
- 5. The natural process of programmed cell death, vital for embryonic development and preventing cancer
- 9. A common laboratory rodent, whose genetic makeup is easily manipulated for disease modeling
- 11. The process by which certain fish adapt to varying salinity, relevant to kidney research
- 12. The primary component of spider silk, a protein being engineered for strong, biocompatible medical materials
- 16. A type of fish that can survive out of water, providing insights into lung evolution and adaptation
- 17. The process of an animal entering a state of metabolic inactivity during winter, studied for its implications in human organ preservation
- 20. A marsupial with a unique pouch, whose immune system is studied for clues against superbugs
- 23. A group of genetically identical organisms, such as Dolly the sheep, providing insights into reproductive biology

Pubudu Premasinghe
S/19/SP/192

Unsung Heroes of the Ocean

The Seagrass Ecosystem

When we imagine life beneath the ocean waves, coral reefs and mangrove forests often come to mind. Yet hidden in the shallow waters of Sri Lanka's coasts lies another vital treasure: seagrass meadows. Unlike seaweed, seagrasses are flowering plants with roots and leaves that anchor themselves to the seabed. Though they may not dazzle with bright colors, they play a silent but indispensable role in sustaining marine life, coastal livelihoods, and the fight against climate change.

Sri Lanka is home to 154 species of seagrass, most abundantly found mainly in the Gulf of Mannar, Palk Bay, Puttalam Lagoon, Trincomalee, and Jaffna. These meadows are true biodiversity hotspots. A single hectare can host tens of thousands of fish and millions of tiny invertebrates, providing food and shelter for creatures ranging from prawns and sea cucumbers to seahorses and stalked jellyfish. Endangered green turtles and dugongs, often called "sea cows" rely heavily on seagrass for survival, making these meadows critical for conserving some of the ocean's most vulnerable animals.

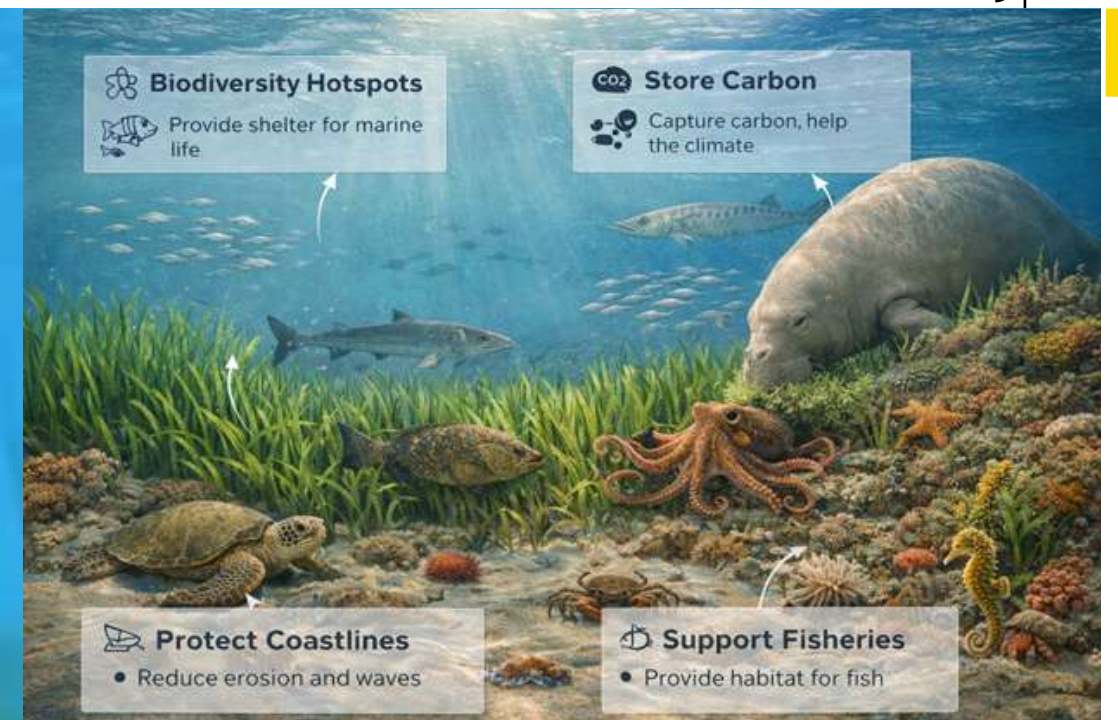
Beyond biodiversity, seagrass meadows are natural carbon vaults. They cover only a fraction of the ocean floor, yet store up to 18% of the ocean's carbon in coastal sediments, capturing it far more efficiently than tropical rainforests. This "blue carbon" function helps slow global warming and buffer ocean acidification. Their dense roots stabilize sediments, keeping coastal waters clear, while their blades absorb wave energy, reducing erosion and protecting

shorelines. For a country like Sri Lanka, increasingly exposed to climate-driven coastal damage, seagrass is a natural defense system.

Despite their importance, seagrass ecosystems are among the least understood and most threatened. Globally, they are disappearing at a rate of ~7% per year - ; roughly a football field lost every 30 minutes. In Sri Lanka, destructive fishing practices like bottom trawling uproot entire meadows, while land reclamation, aquaculture, and port development wipe out habitats. Agricultural runoff, pesticides, and plastic pollution cloud the waters they depend on. Climate change adds further stress, as warming seas and stronger storms disrupt these fragile ecosystems. Even anchors and boat propellers can severely scar shallow seagrass meadows.

The loss of seagrass meadows has cascading effects. As habitats vanish, fish populations decline, threatening food security and coastal livelihoods. Dugongs, already rare in Sri Lanka, face extinction without healthy meadows. Perhaps most concerning, destroyed seagrass beds release stored carbon back into the atmosphere, turning vital carbon sinks into harmful carbon sources.

Recognizing these risks, Sri Lanka has begun taking steps toward conservation. The Dugong and Seagrass Conservation Project has raised awareness in coastal communities about the link between sustainable fishing practices and dugong survival. Protected areas now include seagrass habitats, though enforcement remains a challenge. Researchers from NARA, universities, and NGOs are



mapping seagrass beds and piloting restoration projects, such as transplanting seagrass plugs into degraded areas. In Kalpitiya Lagoon, local communities have collaborated with scientists to restore meadows, earning both livelihoods and ecological benefits.

Still, much remains to be achieved. Effective conservation requires viewing seagrasses, mangroves, and coral reefs as parts of one connected network. Protecting one while allowing the others to decline weakens the resilience of the whole. To safeguard these ecosystems, stronger regulations are needed to control destructive fishing practices, unsustainable coastal development, and pollution. At the same time, initiatives such as citizen science and eco-tourism can empower local communities and students to participate in protecting these underwater meadows, transforming awareness into meaningful action.

Seagrass meadows may not capture the public imagination like coral reefs, but their contributions are profound. They nurture fisheries, secure coastlines, fight climate change, and sustain endangered wildlife. For Sri Lanka, protecting these ecosystems means protecting its marine heritage and the communities that depend on it.

Silent and steadfast, seagrass meadows are indeed the unsung heroes of the ocean. Recognizing and conserving them is not only an environmental priority but also a promise to safeguard the future of our seas and ourselves.

Dilmi Weerasinghe
S/19/171

THE DOMINION OF JELLYFISH



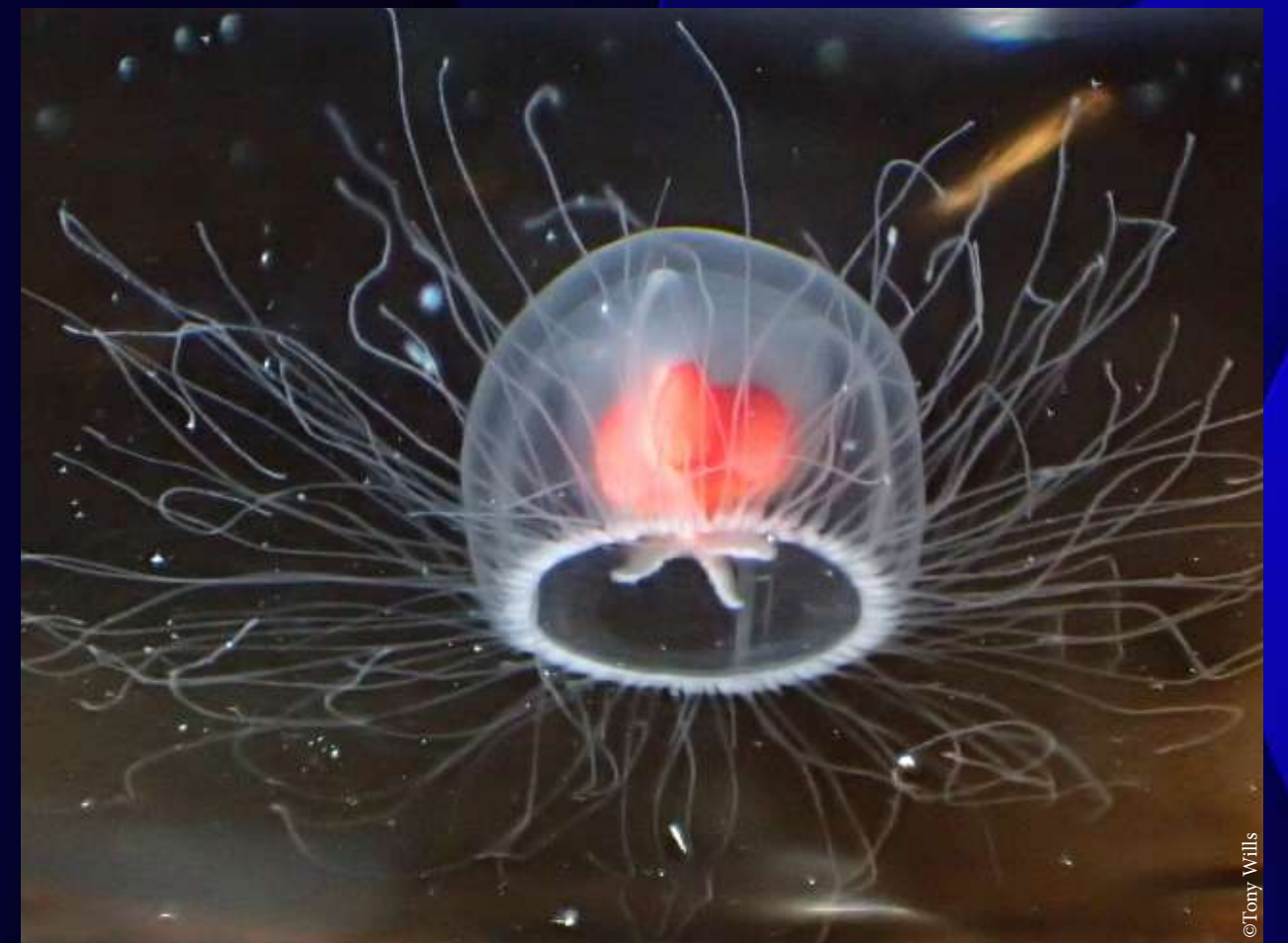
A jellyfish is, essentially, a bag of water, where 95% of its body is just water. It possesses no brain, no heart, no blood, and no bones. Yet, these ancient gelatinous creatures of Phylum Cnidaria have drifted through the oceans for over 500 million years. Their simple design is the secret to their profound success. It has allowed them to outlast countless more complex species, survive traumatic injuries, and, often described as 'biologically immortal' due to its ability to revert to an earlier life stage.

How do they coordinate movement, hunt, or sense their surroundings? They do so with nature's first draft of a nervous system, a decentralized nerve net where conduction is unpolarized, meaning impulses can travel in any direction. Thus, the system is not as simple as we believe it to be. Scientists have identified two distinct nerve nets for separate tasks. A Motor Nerve Net (MMN) generates fast, rhythmic contractions for swimming. In contrast, the slower Diffuse Nerve Net (DNN) manages all other behaviors such as feeding, protective spasm responses, and the localized movement of tentacles.

Coordinating this entire system are sensory bundles called rhopalia, which function as integrative centers with two types of structures known as Statoliths, which are similar to the otoliths in the human ear, giving a sense of up and down, and ocelli, which are light-sensitive pigment spots. One group of jellyfish, however, has taken this design to a level that questions our beliefs even further.

An organism without a brain that can not only see, but also learn, is the box jellyfish (*Tripedalia cystophora*). Far from being a passive drifter, this active hunter possesses an astonishing 24 eyes. These are grouped into their four rhopalia, six in each, and some are complex double lens eyes, structurally similar to those of fish or squid. The specialty is that the retina is behind the focal point of the lens, engineered to see a blurry image. This is considered a brilliant adaptation. The blurriness allows them to navigate the large, stationary mangrove roots of their habitat without being distracted by tiny, irrelevant plankton.

More shocking still is their learning capacity. A groundbreaking 2023 study confirmed that box jellyfish are capable of associative learning.



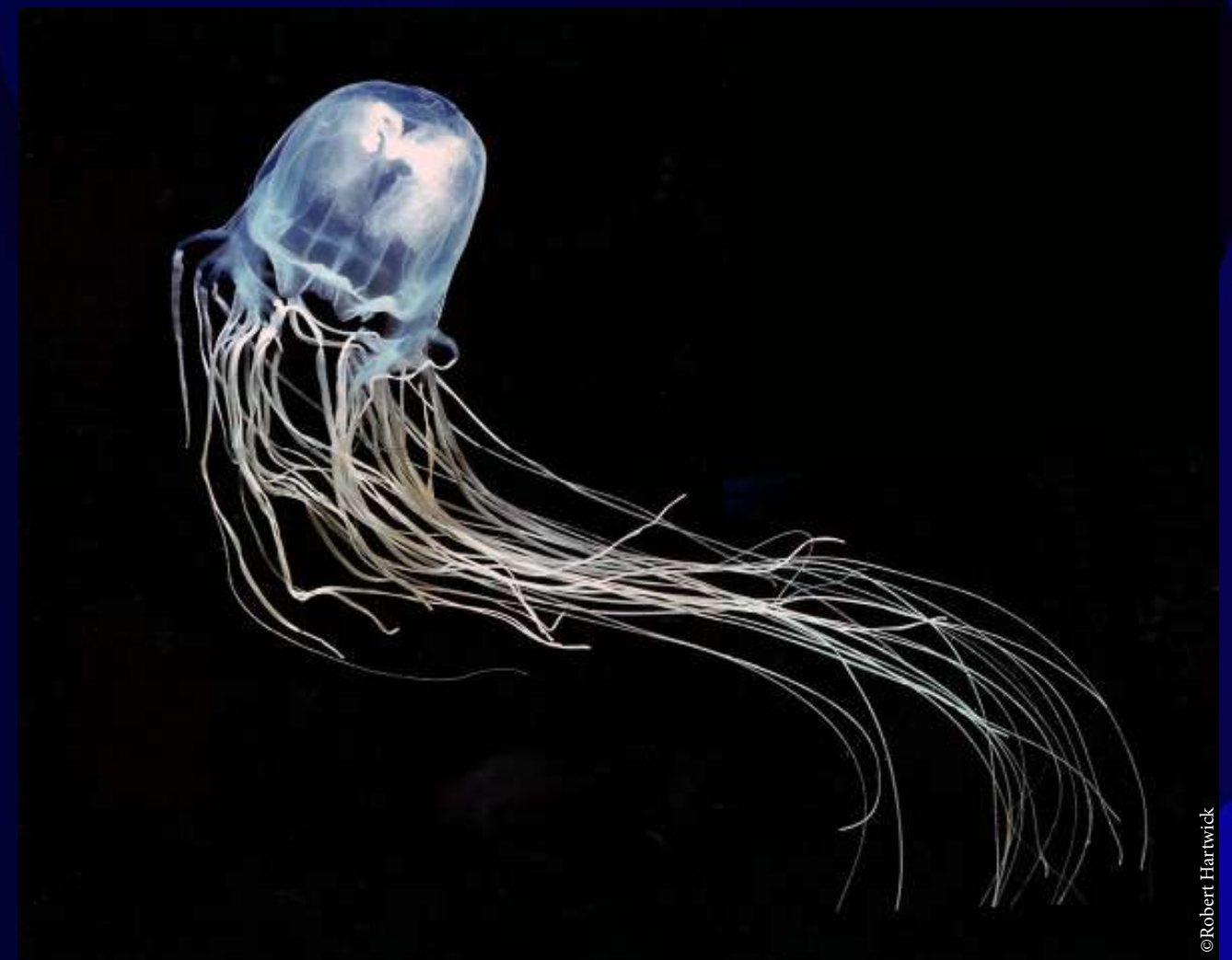
They learned to connect a visual cue (a distant root) with a negative experience (bumping into it), and then they changed their behavior to avoid the collision. The learning, researchers believe, happens in the rhopalia themselves, which act as smart sensors. This discovery proves that a complex, centralized brain may not be a prerequisite for learning at all.

If learning without a brain is strange, consider the jellyfish that achieves biological immortality. The tiny species *Turritopsis dohrnii*, smaller than a fingernail, can escape from death. When stressed, injured, or of old age, the adult medusa collapses inward, absorbs its tentacles, and reverts entirely to its earliest life stage, a stationary polyp. This is not regeneration, it is a process known as transdifferentiation, where fully mature, specialized cells revert into new stem cells and then re-specialize entirely into different cell types. From this 'born again' polyp, a new colony buds, releasing genetically identical medusae. It is a cycle that can, theoretically, be repeated forever.

The jellyfish world is also one of extremes. At one end is the titan jellyfish, the Lion's Mane jellyfish (*Cyanea capillata*). This is the largest known jellyfish on Earth. Its bell can be gigantic, but its true claim to fame is its long tentacles. In 1870, a specimen washed ashore in Massachusetts with tentacles measuring up to 120 feet (36.6 meters). If this



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record is accurate, it would be longer than a 100-foot blue whale. But the truly remarkable fact is that a blue whale lives 80-90 years, while the Lion's Mane jellyfish achieves this explosive growth in just 12 months in the cold waters of the Arctic (Brewer, 1989).

Chironex fleckeri is widely regarded as the most venomous animal in the world. Its sting is not just painful, it can kill a healthy adult human in under five minutes. Its venom punches holes in the victim's cells. This causes a massive, sudden leakage of potassium into the bloodstream, causing a condition known as hyperkalemia, leading to cardiovascular collapse and death. In simple terms, it instantly stops the victim's heart.

The most bizarre jellyfish story, however, has nothing to do with the ocean. It concerns outer space. In 1991, NASA launched 2,478 moon jellyfish polyps into orbit on the Space Shuttle Columbia. The experiment was to test how microgravity affects development. Jellyfish were the perfect analog for human balance, as they use calcium crystals (statocysts) to sense up and down. The space born jellyfish developed normally in orbit.

But upon returning to Earth, they were completely disoriented. They showed disoriented swimming behaviour and irregular pulsing and movement upon return to Earth. The experiment demonstrated that gravity is not just a passive force, but it is an essential developmental cue that life requires to build a functioning nervous system.

This brings us to the final, and most urgent, fact. While deep sea exploration continues to find bizarre new species like the Atolla jelly that uses a bioluminescent alarm to attract a bigger predator to save itself, a more devastating effect is taking place in the open waters around the world. Jellyfish populations are exploding in massive blooms because of the consequences of human actions.

We have created the perfect world for them. Climate change has warmed the oceans, favoring their reproduction. Overfishing has removed their main predators and competitors. Pollution creates low oxygen dead zones, where fish cannot survive, but jellyfish, with their low metabolism, can. And our ocean wide spread of docks and oil rigs provides a massive new habitat for their polyp stage.

These blooms are no longer a mere curiosity. They clog fishing nets, wipe out billion dollar fish farms, and devastate tourism. The most bizarre impact



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of all is that jellyfish are shutting down the nuclear power plants. Swarms are sucked into coastal cooling water intakes, clogging them completely and forcing emergency shutdowns from Sweden to Japan. This brainless, heartless, immortal survivor is perfectly adapted for the world we have created, and it is beginning to dominate the oceans over fish.

Gagani Senanayake
S/20/160

SONG of the SEA

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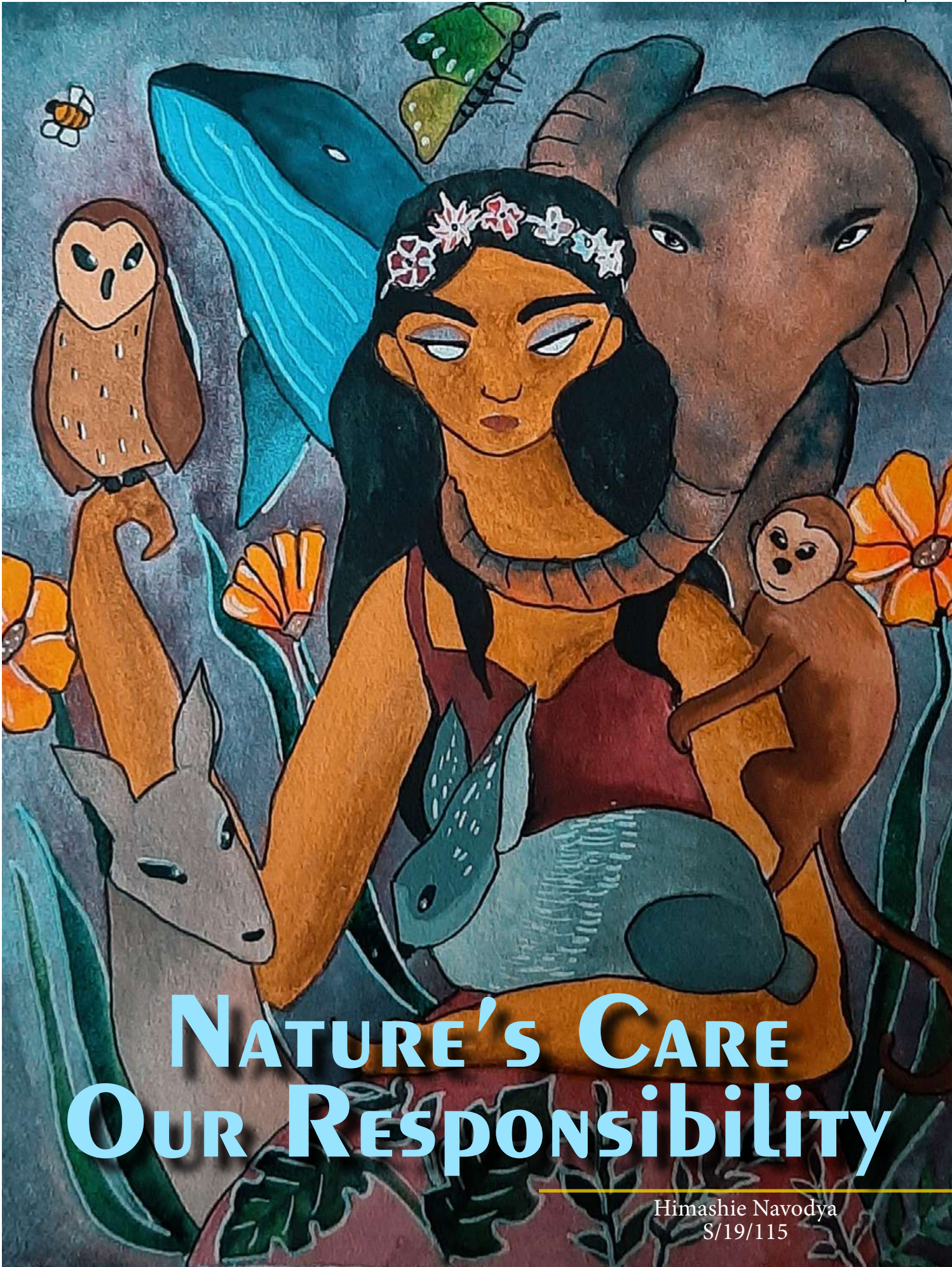
I hear the waves come to the shore,
they crash and hum forevermore,
a gentle beat, a steady sound,
that rolls and whispers all around.

The seagulls sing across the sky,
their voices drift as they fly by,
the water swirls, the soft winds blow,
the ocean sparkles, calm and slow.

Each wave that comes brings stories near,
of shells and ships and songs to hear,
of golden sands and skies so wide,
and stars that shine upon the tide.

The breeze plays tunes both low and sweet,
it dances round my bare, wet feet,
the sea's soft music calls to me
a song of peace and mystery.

Nethmi Bhagya
S/19/026



NATURE'S CARE Our Responsibility

Himashie Navodya
S/19/115

THE HIDDEN WORLD

of Sri Lanka's Endemic Shrub Frogs

Sri Lanka is a global hotspot for amphibian diversity, and the genus *Pseudophilautus* dominates its anuran fauna, with around 59–72 extant species recognized from the island's montane and lowland rainforests. These shrub frogs are primarily adapted to the island's aseasonal wet zone, which includes extensive lowland rainforests and three major mountain massifs in the southwestern quarter. This genus represents over 60% of the island's amphibian fauna. Most species are restricted to these wet, forested regions, with many confined to isolated fragments of rainforest and tropical montane cloud forest, occupying micro-habitats such as leaf litter, shrubs, rock crevices, and even the forest canopy.

The genus *Pseudophilautus* represents a remarkable radiation of shrub frogs, with a few species in southern India. Molecular phylogenetic analyses indicate that the diversification of *Pseudophilautus* began following a migration from India to Sri Lanka during the Eocene-Oligocene boundary, facilitated by a land-bridge and climatic cooling. This lineage experienced a gradual and constant rate of diversification from the Oligocene through the Miocene and Pliocene, with a slight increase during the Pleistocene, rather than an early burst typical of adaptive radiations. Direct development, a reproductive mode where frogs

bypass the free-living tadpole stage, is a key innovation in *Pseudophilautus*, enabling colonization of diverse moist habitats and promoting speciation. Ecomorphological studies reveal that *Pseudophilautus* species have repeatedly evolved distinct ecological forms such as tree-shrub, rock-boulder, leaf-litter, habitat generalists, and canopy specialists across different regions and altitudes, often in response to climatic fluctuations and monsoon cycles. The common ancestor was likely a medium-sized, wet-adapted, tree-shrub specialist, with extreme size classes evolving more recently. Phylogeographic and

species delimitation analyses show that allopatric speciation, driven by geographic isolation among Sri Lanka's Mountain ranges, is the dominant mode of diversification, with some evidence for parapatric speciation



<< Kelaart's Starry Shrub Frog (*Pseudophilautus stellatus*)
©Kumudu Wijesooriya !

where gene flow persists between diverging populations. The hills of Sri Lanka have acted as both species pumps and refuges, generating and maintaining high levels of endemism and diversity over 31 million years. Molecular data also reveal the presence of several cryptic and potentially undescribed species, highlighting ongoing diversification and the need for continued taxonomic revision. Recent discoveries, such as the rediscovery of *Pseudophilautus stellatus* and new species descriptions, underscore the dynamic evolutionary history and conservation importance of this group. The evolutionary trajectory of *Pseudophilautus* exemplifies how geography, climate, and reproductive innovation interact to drive lineage diversification in tropical montane ecosystems.

Within Sri Lanka, *Pseudophilautus* species display remarkable ecological and morphological diversity. These ecomorphs have arisen multiple times in different lineages and at various altitudes, often in response to climatic fluctuations and monsoon cycles. Many species are highly localized, often confined to single forest reserves or mountain ranges. For example, *Pseudophilautus schneideri* inhabits shrubs in open areas of the low to mid-elevations of the island's southwestern wet zone, while *P. hankenii* is found in the understorey of montane forests at the highest peaks of the Knuckles region. The Peak Wilderness (Sripada World Heritage Site) in the Central Hills is a

notable hotspot, where eight new species, including *P. bambaradeniyai*, *P. dayawansai*, and *P. jagathgunawardanai* were discovered, each restricted to specific elevations and microhabitats within this protected area. Other species, such as *P. dilmah*, are known only from the Loolkandura forest in the Central Province, a habitat now threatened by deforestation and fragmentation.

Some species, like *Pseudophilautus popularis*, are more widespread and can be found in many localities within the wet zone, often near forest edges and even in home gardens, showing adaptability to disturbed environments. In contrast, *P. zorro* is an endangered species with a distribution largely restricted to the Kandy district, though recent surveys have expanded its known range to several new localities in the central province.

Pseudophilautus hallidayi is another example, found in mid-elevation areas such as Peradeniya, Namunukula, and the lower Knuckles range, where it prefers crevices of emergent boulders in shaded streams.

The southwestern lowland wet zone, including reserves like Sinharaja and the Kanneliya-Dediyagala-Nakiyadeniya (KDN) complex, harbors a high concentration of species, many of which are endemic and restricted to these evergreen forests. The evolutionary relationships among these species are shaped by the island's complex topography and history of isolation, with many sister species distributed across adjacent mountain ranges or different parts of large montane regions, highlighting the role of allopatric speciation. Molecular studies have also revealed cryptic diversity, with at least 14 potential new species identified, and have clarified the status of some taxa, such as the synonymization of *P. conniffae* with *P. limbatus*.

The genus *Pseudophilautus* plays a vital ecological role in Sri Lanka's wet and montane forests, where these shrub frogs are

among the most diverse and abundant amphibians. As direct-developing frogs, they bypass the aquatic tadpole stage, allowing them to exploit a wide range of terrestrial microhabitats. This adaptability makes them important contributors to nutrient cycling, leaf litter decomposition, and the regulation of invertebrate populations, thus supporting overall forest ecosystem health. Their presence across different elevations and habitat types also makes them valuable bioindicators, reflecting the health and stability of their environments.

Pseudophilautus species are highly sensitive to habitat changes, and many are restricted to small, isolated forest patches or single mountain ranges, making them especially vulnerable to environmental disturbances. The loss of these frogs can disrupt ecological balances, as they occupy key positions in food webs and contribute to the unique biodiversity of Sri Lanka's rainforests. The rate of extinction within the genus *Pseudophilautus* is alarmingly high. Of the 35 globally extinct amphibian species recorded prior to 2012, 21 were from Sri Lanka, and 17 of these belonged to *Pseudophilautus*. Even after the rediscovery of a few species, the genus still accounts for the majority of amphibian extinctions on the island. The primary drivers of this extinction crisis are habitat destruction, deforestation, and anthropogenic activities, which have led to the loss of over 95% of Sri Lanka's perhumid forests. Many extant species are now classified as Endangered or Critically Endangered due to their extremely limited distributions and ongoing habitat threats.

In summary, *Pseudophilautus* shrub frogs are ecologically indispensable in Sri Lanka's forests, but they face one of the highest extinction rates among amphibians globally, underscoring the urgent need for targeted conservation efforts.



<< Golden-eyed Shrub Frog (*Pseudophilautus ocularis*)

©Kumudu Wijesooriya

Thakshila Disanayaka
S/19/195



How Ocean Life Inspires Drug Discovery

The ocean is the largest living system on Earth, covering more than two-thirds of its surface and supporting countless organisms, many of which remain unknown to science. Among these organisms are species that produce powerful toxins, substances that may seem dangerous at first glance but are increasingly being recognized as valuable tools for medicine. Over millions of years, marine animals such as cone snails, jellyfish, pufferfish, sponges, and algae have evolved chemical compounds to defend themselves or capture prey. These toxins can disrupt vital functions in the nervous, muscular, and cardiovascular systems, and in humans, accidental exposure may even be fatal. Yet when carefully studied,

purified, and applied in controlled doses, these same substances have the potential to become life-saving medicines.

One of the most remarkable examples is the cone snail, whose venom contains peptides capable of targeting specific ion channels in nerve cells. A drug developed from this venom, ziconotide, is now used to treat severe chronic pain, offering a safer alternative to opioids. Similarly, marine sponges have yielded compounds that inspired anti-cancer medicines like Cytarabine and Trabectedin, both of which are used today in chemotherapy. Even toxins produced by microscopic algae, which sometimes cause harmful red tides, are being studied for their potential in treating epilepsy, cardiovascular

conditions, and neurodegenerative diseases by acting on nerve signaling pathways. What was once considered purely poisonous has thus become a source of innovation in pharmacology.

However, this immense biomedical potential is closely tied to the health of marine ecosystems. Pollution, overfishing, habitat destruction, and climate change all threaten the survival of the very organisms that could provide future cures. Once a species is lost, the unique chemical compounds it produces are lost forever, along with the opportunity to study them for medical use. Conservation and biomedical research must therefore go hand in hand, ensuring that exploration of marine life is done sustainably and

ethically.

Marine toxins illustrate the fascinating paradox of nature: what can kill can also cure. They remind us that solutions to some of the most difficult health challenges may lie hidden in the sea, waiting to be discovered through careful research. By protecting the ocean and continuing to study its remarkable biodiversity, humanity may uncover medicines that could transform modern healthcare. The ocean, often admired for its beauty and resources, is also a reservoir of hope for the future of human health, proving once again that the survival of nature and the survival of humanity are inseparable.

Samadhi Hettiarachchi
S/20/207



GUARDIANS OF PADDY FIELDS

The Role of Amphibians in Pest Control



Across Sri Lanka's lush green paddy fields, the soft croaks of frogs and toads arise with the evening mist. To many, these sounds are simply part of the rural nightscape, but to ecologists and farmers who look closer, they tell a deeper story, a story of ecological balance, protection, and nature's own pest management system. Amphibians, often overlooked or misunderstood, play an indispensable role in maintaining the ecological health of our farmlands.

Amphibians: Nature's Pest Controllers

Frogs and toads feed on a wide variety of insects including mosquito larvae, flies, moths, beetles and even crop pests such as planthoppers and leafhoppers. By keeping these populations under control, amphibians act as a natural pesticide, reducing the need for harmful chemicals and promoting healthier ecosystems.

Sustainable Allies in Agriculture

In Sri Lanka's rice-based farming systems, amphibians are silent partners in sustainability. During the monsoon season, their populations increase naturally, coinciding with the peak abundance of insect pests. This synchrony ensures that amphibians play a direct role in maintaining pest balance and protecting yield. Their presence indicates good water quality and ecological health a true sign of sustainable farming.

Threats to the 'Guardians'

Unfortunately, amphibian populations are declining across the country. Pesticide use, water pollution, habitat destruction, and climate change have all taken their toll. Many species such as endemic *Nannophrys marmorata* and *Fejervarya greenii*, are now increasingly threatened. The loss of these species could disrupt entire ecosystems and affect agricultural productivity.

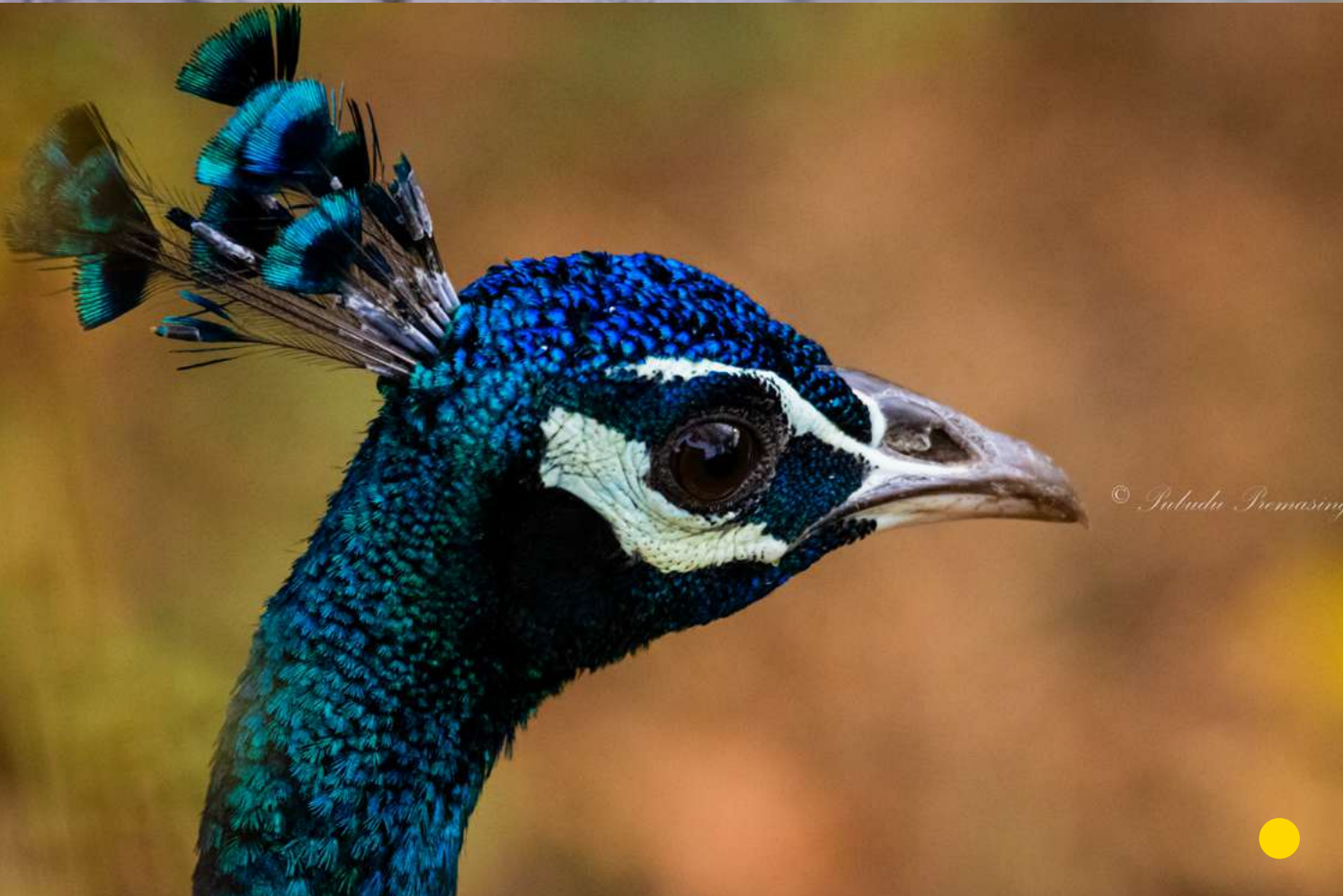
Conservation and Coexistence

Protecting amphibians requires collective effort. Farmers can reduce pesticide use, maintain natural vegetation around fields, and create buffer zones for breeding habitats. Community awareness and school-level environmental education can also inspire long-term action toward amphibian conservation.



By coexisting with these remarkable creatures, we ensure not only the protection of biodiversity but also the long-term health of Sri Lanka's paddy landscapes.

Chamodhi Jayantha
S/20/194





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Genetically Modified Crops and the Biome

Navigating Agricultural Productivity & Ecosystem Balance

Genetic modification (GM) technology has revolutionized agricultural production worldwide by enhancing crop yields, pest resistance, and environmental stress tolerance. However, its deployment presents complex environmental challenges, including potential ecosystem imbalances. GM crops have been associated with both sustainability improvements and ecological risks such as biodiversity loss, herbicide resistance, and gene flow contamination. These competing outcomes necessitate rigorous ecological risk assessment and adaptive management strategies (CBAN, 2019; Sharma et al., 2022).

Examples of GM Crops

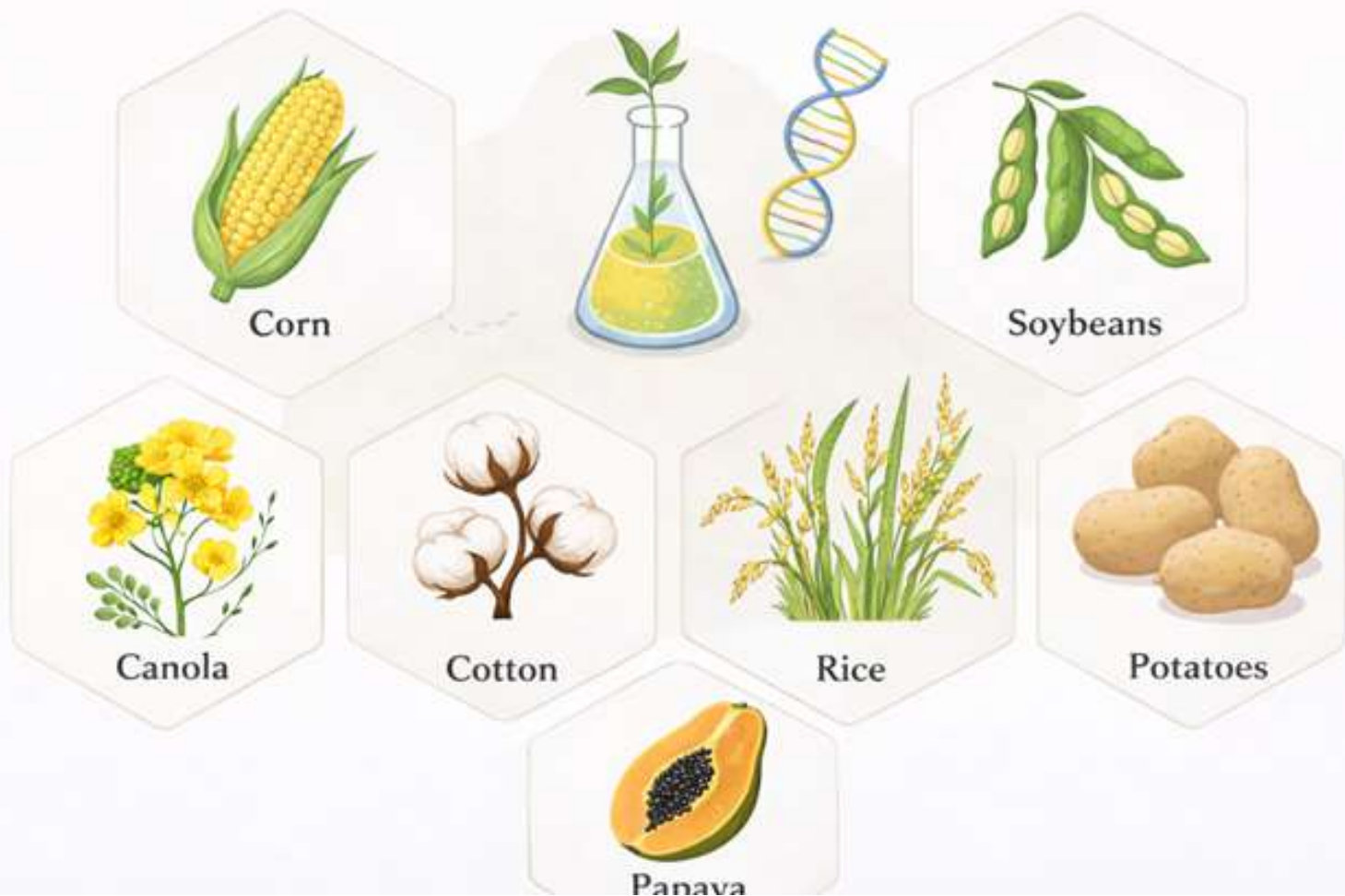


Figure 01. Examples for GM crops

Potential Benefits and Global Perspectives

Globally, genetic modification has the potential to contribute to agricultural sustainability by reducing pesticide applications, improving crop resilience to climate change, and increasing yields without the need to expand farmland. Higher productivity on existing agricultural land may help reduce pressure on forests and other natural habitats by limiting the expansion of farming areas. In addition, advances in gene editing and precision biotechnology are being explored for conservation purposes, such as developing disease-resistant native tree species and supporting the restoration of endangered plant populations (Sharma et al., 2022; Domingo, 2025).

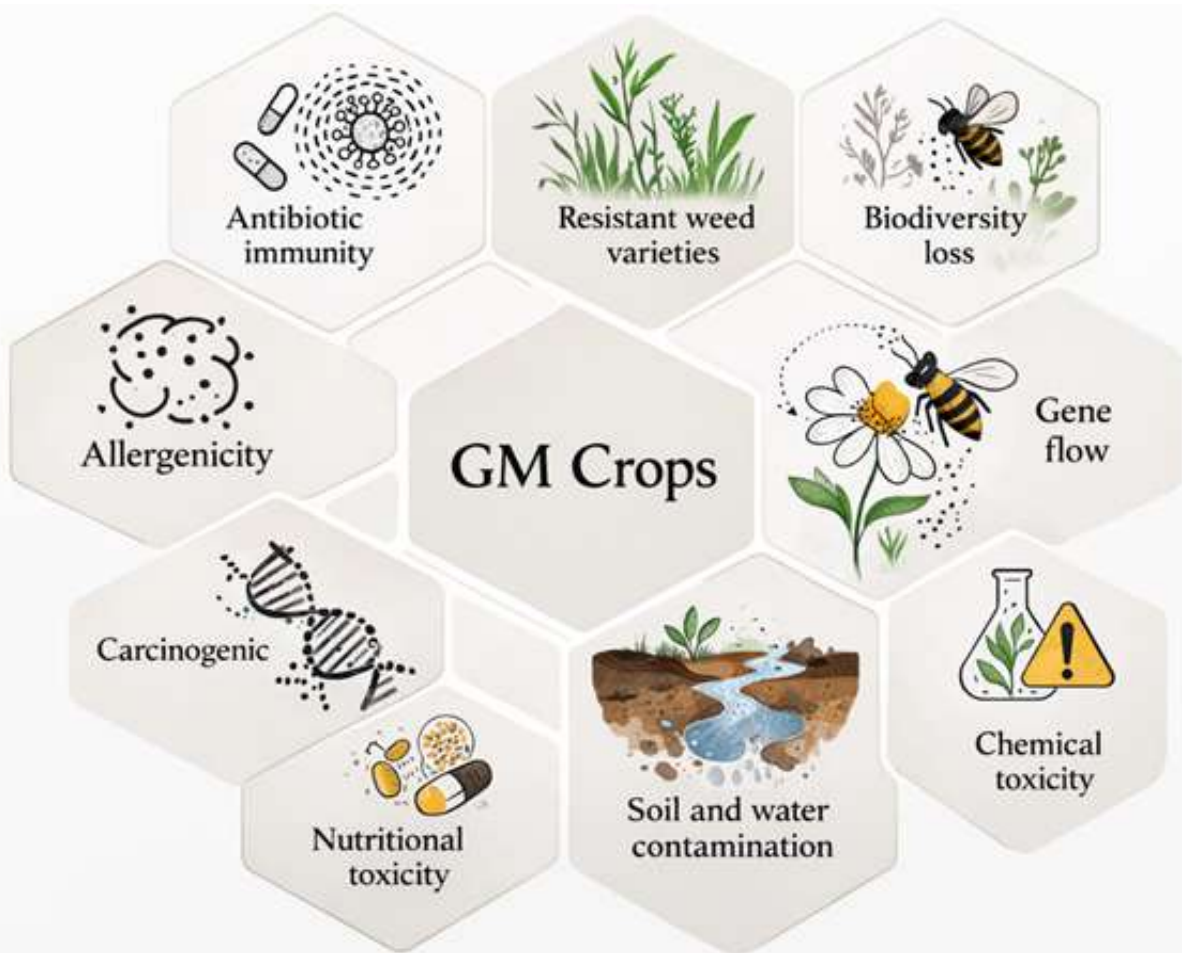


Figure 02. Potential risks and concerns associated with GM crops (Aziz et al., 2022)

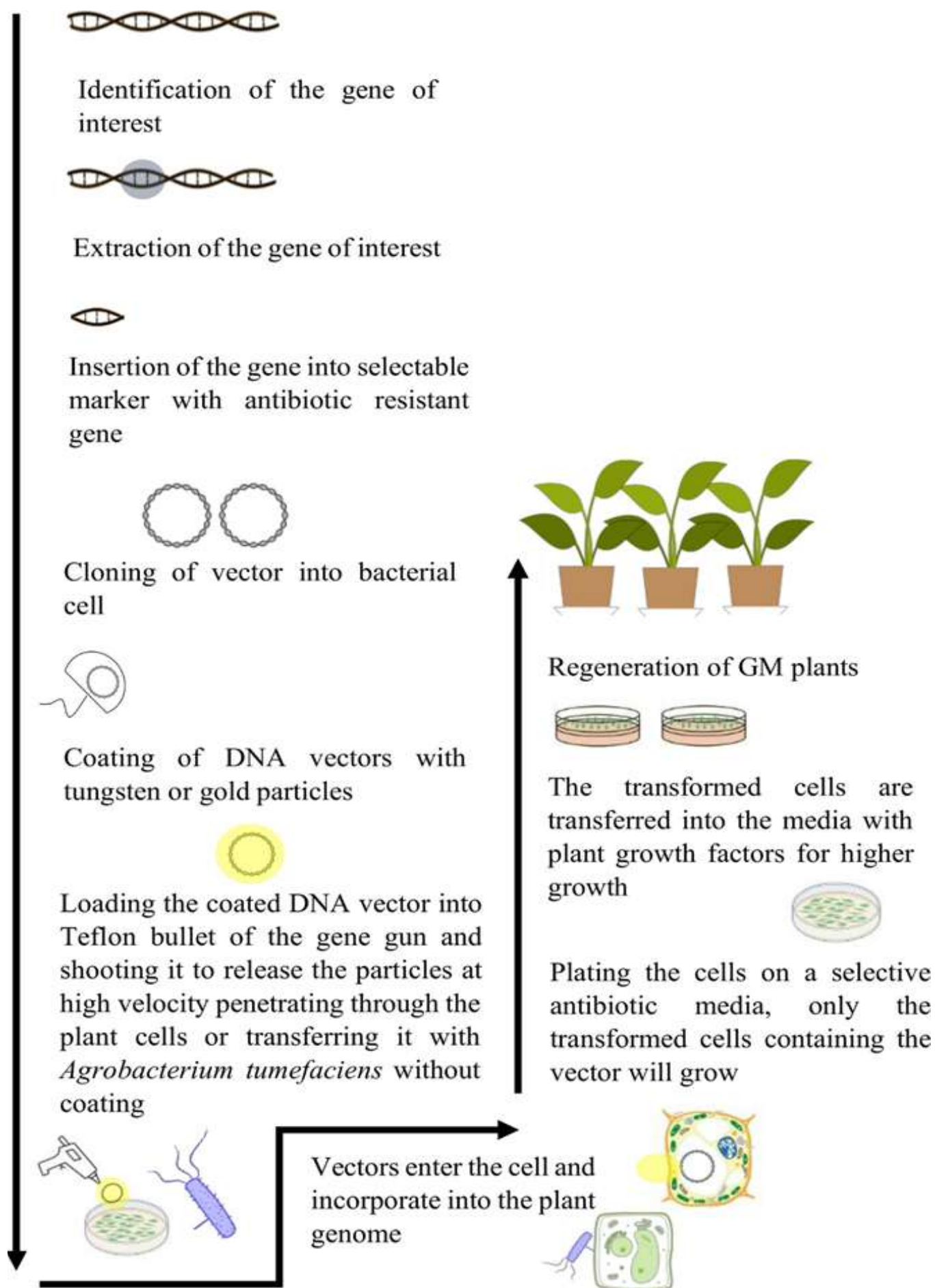


Figure 03. Illustration of genetic modification of crops (Aziz et al., 2022)

Key Concerns and Issues Related to GM Crop Production

Environmental concerns

At the same time, several environmental concerns have been discussed in relation to GM crop cultivation. Some studies suggest that the widespread adoption of herbicide-tolerant crops has been associated with increased herbicide use. For instance, glyphosate application in Canada reportedly increased substantially following the adoption of such crops, which has been linked to the emergence of herbicide-resistant weed populations in certain agricultural systems (CBAN, 2019). In a similar way, insect-resistant GM crops that express *Bacillus thuringiensis* (Bt) toxins may influence pest dynamics over time, with some evidence indicating the development of pest resistance in particular contexts (CBAN, 2019).

Another environmental consideration is the possibility of gene flow from GM crops to wild relatives or non-GM crops. Instances of unintended presence of genetically engineered traits have been documented in Canada in crops such as canola and flax. These observations highlight ongoing discussions about the challenges of containing transgenes once they are released into agricultural environments, a phenomenon sometimes described as “living pollution” due to the persistence and mobility of genetic material (CBAN, 2019).

Biodiversity and Food Web Disruption

GM cropping systems tend to reduce plant biodiversity by eliminating non-target species that serve as habitats and food sources for beneficial insects, birds, and other wildlife. This loss of biodiversity can cascade through ecosystems. A notable example is the severe decline of the North American monarch butterfly population, which has been strongly linked to the widespread use of glyphosate-resistant herbicide-tolerant GM crops that destroy milkweed, the butterfly’s critical breeding habitat (CBAN, 2019). Such disruptions underscore how GM crops can indirectly diminish ecosystem resilience.

Human Health Considerations

The potential health effects of genetically modified (GM) crops continue to be debated, with concerns focusing on issues such as allergenicity and the possible transfer of antibiotic resistance genes. For instance, the introduction of a 2S albumin gene from Brazil nut into transgenic soybean (*Glycine max*) was found to trigger allergic reactions during testing, emphasizing the need for strict safety assessments (Nordlee et al., 1996; EFSA et al., 2022). Although the likelihood of antibiotic resistance gene transfer to human gut bacteria is considered very low, it remains an important factor in biosafety evaluations (Karalis et al., 2020). Therefore, continuous research and regulatory assessment are essential to ensure the safety of GM-derived foods (Midtvedt, 2014).

GM Crops in Sri Lanka and Legal Framework

Sri Lanka currently does not commercially cultivate genetically modified crops. The government has imposed a ban on the import, manufacture, transport, storage, distribution, and sale of genetically modified foods and agricultural products since the early 2000s, reflecting precautionary policies aimed at preserving environmental integrity and public health (IATP, 2001). However, Sri Lanka amended its Food (Control of Import, Labelling and Sale of Genetically Modified Foods) Regulations in 2023, increasing the tolerance for genetically engineered content in imported foods from 0.5% to 0.9%, facilitating trade while maintaining strict oversight through the Chief Food Authority’s approval requirements (USDA, 2025).

Sri Lanka’s regulatory framework aligns with the Cartagena Protocol on Biosafety, which emphasizes risk assessments and public consultation for GMOs. The National Biosafety Framework under the National Science Foundation oversees approvals for GMO testing and research, ensuring environmental safety and compliance with international standards (6Wresearch, 2024).

Sustainable Strategies for the Development and Adoption of GM Crops

Sri Lanka’s cautious regulatory approach to genetically modified organisms emphasizes risk minimization, monitoring, and regulatory vigilance to protect its biodiversity-rich ecosystems. By restricting the cultivation of GM crops, the country aims to reduce potential ecological risks such as gene flow to wild relatives, the emergence of herbicide-resistant weeds, and possible impacts on native flora and fauna issues reported in some agricultural systems elsewhere. At the same time, the development of GMO testing technologies and the growth of the national GMO testing market reflect increasing attention to monitoring imported food products and ensuring accurate labeling (6Wresearch, 2024). These monitoring and regulatory mechanisms help prevent the unintended introduction of genetically modified materials that could affect local ecosystems. Together, precautionary policies, systematic monitoring, and regulatory oversight contribute to maintaining ecosystem balance while allowing Sri Lanka to evaluate emerging biotechnological developments in a manner consistent with long-term environmental conservation.

Although genetically modified (GM) crops are often considered promising tools for sustainable food production, their development and use require careful risk assessment to evaluate both potential benefits and possible adverse impacts on agricultural systems and the environment. When applied responsibly, genetic modification has enabled the development of efficient production systems that can provide significant advantages to farmers and

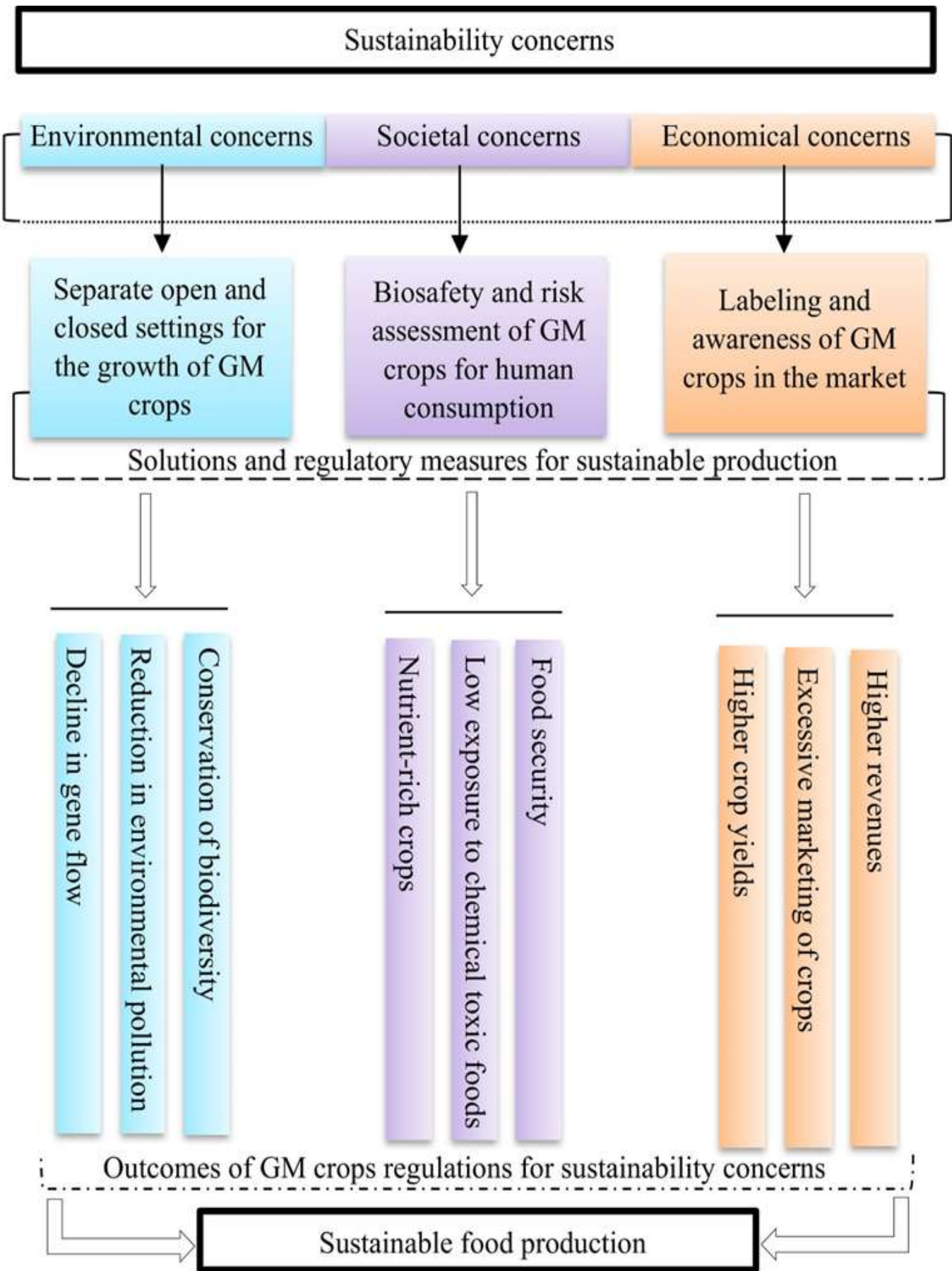


Figure 04. Schematic representation of strategies to address GM crop concerns. Effective regulatory frameworks, biosafety measures, and risk assessments can support the safe development and sustainable use of GM crops (Aziz et al., 2022)

society while supporting the key principles of sustainable agriculture and environmental protection, improved human health, and economic development. At the same time, recognizing concerns associated with GM crops has encouraged the development of advanced molecular techniques that may address some of these issues. One such approach is genome editing, particularly the CRISPR/Cas9 system, which allows precise modification of crop traits without introducing foreign genes. The integration of modern plant breeding with genome editing technologies has the potential to increase agricultural productivity per unit of land while maintaining sustainability. Consequently, these innovations may contribute to achieving the Sustainable Development Goals, especially those related to eradicating hunger, improving food security, and enhancing human health (Aziz et al., 2022).

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S/19/030

DID YOU KNOW



Worker honey bees have a built-in career path based on their age? This process, called **temporal polyethism**, means they start life with safer jobs inside the hive, like cleaning cells and nursing larvae. As they get older, they graduate to hive maintenance (like wax building and guarding) before finally taking on the most dangerous role: foraging for nectar and pollen outside the hive.



Kavintha de Soysa
S/19/225

ZOMBIE ANTS

How fungus hijacks ant behavior for its own survival

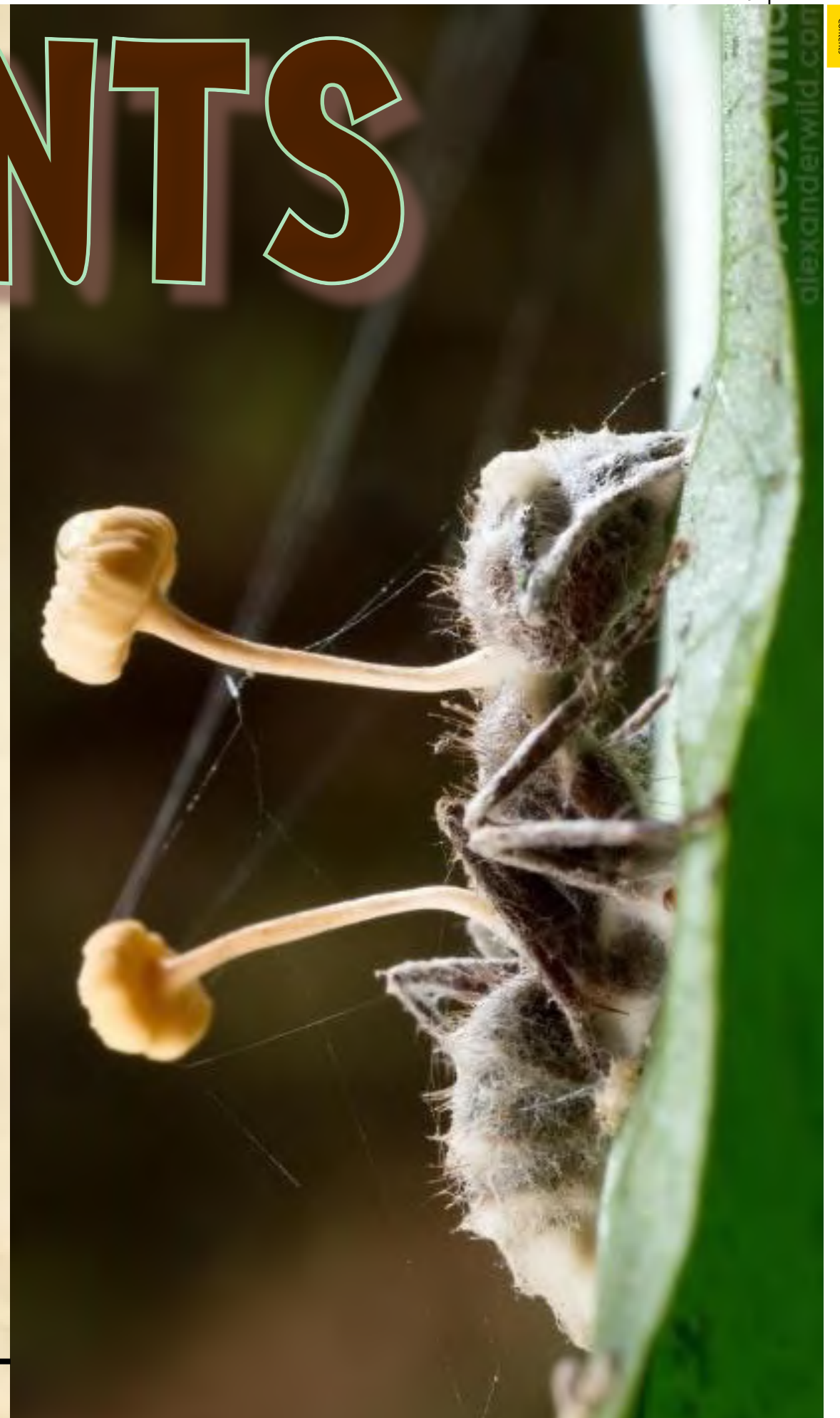
In nature, horror is not confined to haunted forests or monster tales; it thrives in the microscopic and the unseen. Some of the most chilling creatures on Earth are not predators with fangs, but parasites that hijack minds. These so-called “zombie parasites” turn their hosts into puppets, bending behavior to serve their own strange agendas. From fungi that compel ants to climb to their doom, to worms that drive insects to drown themselves, to wasps that turn cockroaches into obedient incubators, the mind control in the wild is as fascinating as it is terrifying.

The *Ophiocordyceps unilateralis* fungus has just one goal; self-propagation and dispersal. Researchers think that the fungus found in the tropical forests infects a foraging ant through spores that attach and penetrate the exoskeleton and slowly takes over its behavior. As the infection advances, the enthralled ant is compelled to leave its nest for a more humid

micro climate that is favorable to the fungus’s growth.

The ant is compelled to descend to a vantage point about 10 inches off the ground, sink its jaws into a leaf vein on the north side of a plant and wait for death. At the first glance we think that the fungal species affects the brain of the ants but they do not seem to invade the brain. Using a type of fluorescent microscopy, researchers from Pennsylvania State University watched fungal colonization in ants from the rear end of the abdomen to the head, and found no trace of fungal cells in the brain. They coupled that information with computer algorithms to chart the movement of fungi as they formed a sort of tubular scaffolding within and around ants’ muscle bundles. This suggests the fungus casts its mind control through bioactive compounds that interfere with the ants’ nervous system and control hosts directly at the muscles.

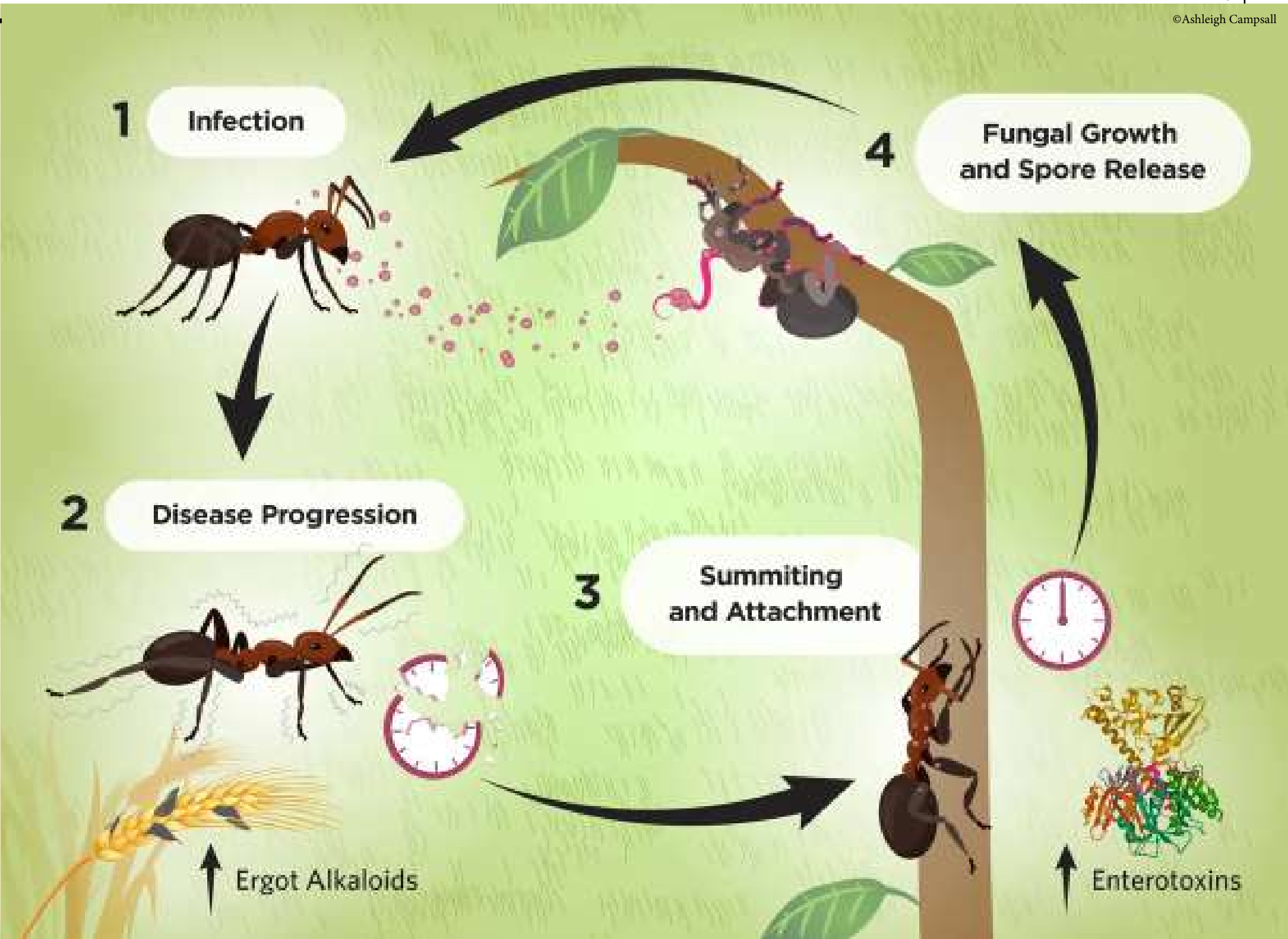
Growth of a fungus on a dead ant



How a parasitic fungus turns ants into zombies

There is an incubation period where infected ants appear perfectly normal and go about their business undetected by the rest of the colony. That is unusual because social insects like ants usually have something called social immunity where sick members get kicked out of the group to prevent the rest from getting sick too. Scientists think the ants do not really have a mechanism to get rid of *Ophiocordyceps*. While the infection is 100% lethal, the goal is not to convert all the ants into the walking dead. For eco systems to be balanced, fungi have to keep host populations in check. In fact, only a few ants in a colony are infected at any given time.

The story of *Ophiocordyceps unilateralis* and its zombie ants is a remarkable example of how complex and sometimes unsettling survival strategies can be in nature. By manipulating the behavior of its host, this fungus ensures its own reproduction. The study of such organisms reminds us of the incredible adaptability of life and offers insights into ecology, evolution and even possible medical applications. Ultimately, the zombie ant fungus stands a striking symbol of how survival in the natural world often relies on strategies far stranger and more intricate than fiction.

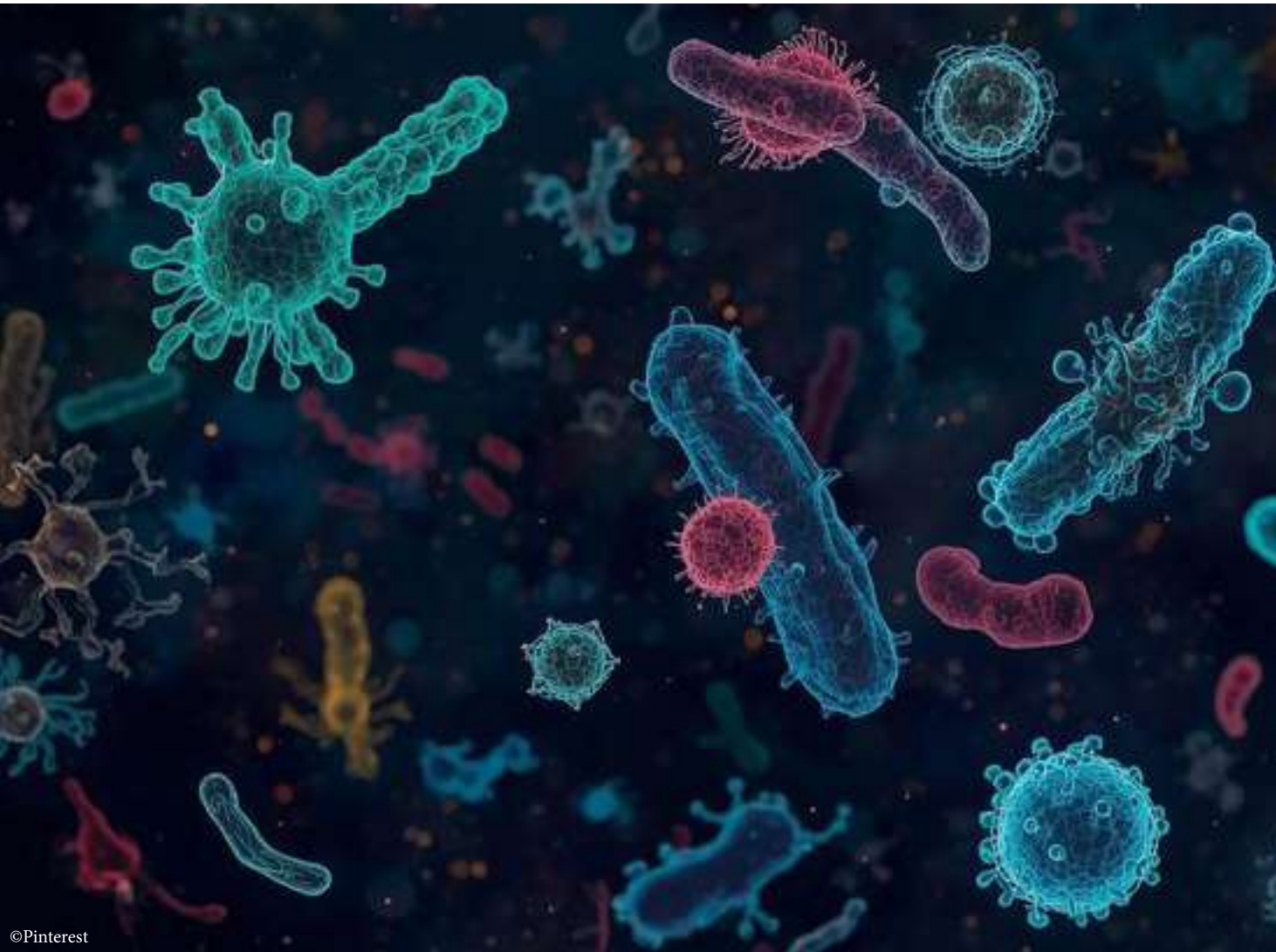


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S/20/049

The Role of Biotechnology in Cleaning Up Pollution



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Environmental pollution has become one of the biggest global concerns today, caused mainly by industrialization, urbanization, and population growth. The air, water, and soil are increasingly contaminated by waste products, chemicals, and toxic substances. Traditional methods of pollution control, such as chemical treatment, incineration, or landfilling, are often expensive and can produce secondary pollution. Therefore, biotechnology provides a more sustainable and eco-friendly alternative for cleaning up pollutants. It uses living organisms such as bacteria, fungi, algae, and plants to degrade or remove contaminants from the environment, a process known as bioremediation.

Biotechnology applies natural biological systems and processes to address major environmental problems such as waste management, pollution control, and recycling. Many microorganisms contain several special enzymes that help them use harmful compounds as food sources, converting toxic compounds into less harmful or non-toxic substances. For example, some bacteria can degrade oil and pesticides, while certain fungi can break down industrial chemicals. By understanding and improving these natural processes, scientists can design effective biological systems to clean polluted areas safely and efficiently.

One of the major techniques used in environmental biotechnology is bioremediation, which involves using microbes to break down or transform pollutants. Bioremediation can take place directly at the contaminated site (in situ) or after the polluted soil or water is removed and

treated elsewhere (ex situ). The efficiency of bioremediation depends on factors like temperature, pH, and nutrient levels. Microbial bioremediation is especially important in cleaning organic pollutants such as hydrocarbons, pesticides, and solvents. For instance, Species of *Pseudomonas* are known for degrading hydrocarbons in petroleum-contaminated environments, while fungi such as *Trichoderma* contribute to pesticide degradation through enzymatic breakdown. Plants also play a major role in pollution control through a process called phytoremediation, where plants absorb, store, or degrade pollutants from soil and water. Aquatic plants can absorb toxic substances from water. Phytoremediation is simple, visually pleasing, and cost-effective, though it can be slow. Phytoremediation is suitable mostly for areas with moderate contamination levels. Common examples include hyperaccumulator plants such as *Brassica juncea* (Mustard greens) and *Pteris vittata* (Chinese brake fern), which are capable of absorbing heavy metals like cadmium and arsenic.

Most recent advances in genetic engineering have further improved the potential of biotechnology in pollution control. Scientists can now modify microorganisms and plants to make them more efficient at breaking down pollutants or surviving in harsh environments. For example, genetically engineered *Pseudomonas* strains can degrade oil faster, and genetically modified plants can absorb metals more effectively. Biotechnology has many real-world applications in pollution cleanup. It is used to clean up oil spills, where special

microbial communities are introduced to degrade petroleum products naturally. In industrial wastewater treatment, bacteria and fungi help remove harmful substances like dyes, phenols, and heavy metals. In solid waste management, composting with microorganisms converts organic waste into useful compost or biofertilizer. Even air pollution can be controlled using biofilters that contain microbes capable of removing gases such as hydrogen sulfide and ammonia. In the mining industry, a process called bioleaching uses bacteria to extract metals from ores in an environmentally friendly way. Biotechnology-based pollution control has several advantages. Biotechnology-based pollution control is environmentally safe, cost-effective, and suitable for large-scale applications. It is cost-effective and can be applied on a large scale for use. It also promotes sustainability by maintaining soil fertility and supporting natural ecosystems. However, there are still some challenges.

Bioremediation can be slow, and its success depends on environmental conditions such as temperature and pH. Some pollutants are too complex or toxic to be completely degraded. The use of genetically modified organisms also raises safety and ethical concerns that must be carefully managed. The intentional or accidental release of genetically engineered microorganisms (GEMs) or plants into the natural environment carries significant risks. Engineered organisms might behave unexpectedly in complex ecosystems. GMOs, such as fast-growing fish or

pest-resistant crops, could out-compete native species, disrupt natural food chains, and reduce overall biodiversity. Another big concern is, if not properly controlled, the byproducts of some biological processes could result in new pollutants or toxic substances.

Despite these limitations, the future of biotechnology in environmental protection looks very promising. Ongoing research in genetic engineering, synthetic biology, and nanotechnology continues to improve the efficiency of bioremediation. Scientists are also exploring combinations of biotechnology and renewable energy, such as microbial fuel cells that can generate electricity while cleaning wastewater. With growing global awareness of environmental protection, biotechnology offers a sustainable and innovative path to restore polluted ecosystems and protect the planet for future generations. Future advancements will include highly sensitive, real-time biosensors for the precise detection and monitoring of various environmental pollutants in air, soil, and water, enabling prompt action and assessment of ecosystem health. Beyond pollution control, environmental biotechnology also contributes to ecosystem restoration through genetic tools used in conservation biology. Genetic tools will be increasingly employed for the ex-situ conservation of endangered species and the management of invasive species through targeted gene drives, helping to restore and maintain ecological balance.

Sashini Madarasinghe
S/19/107



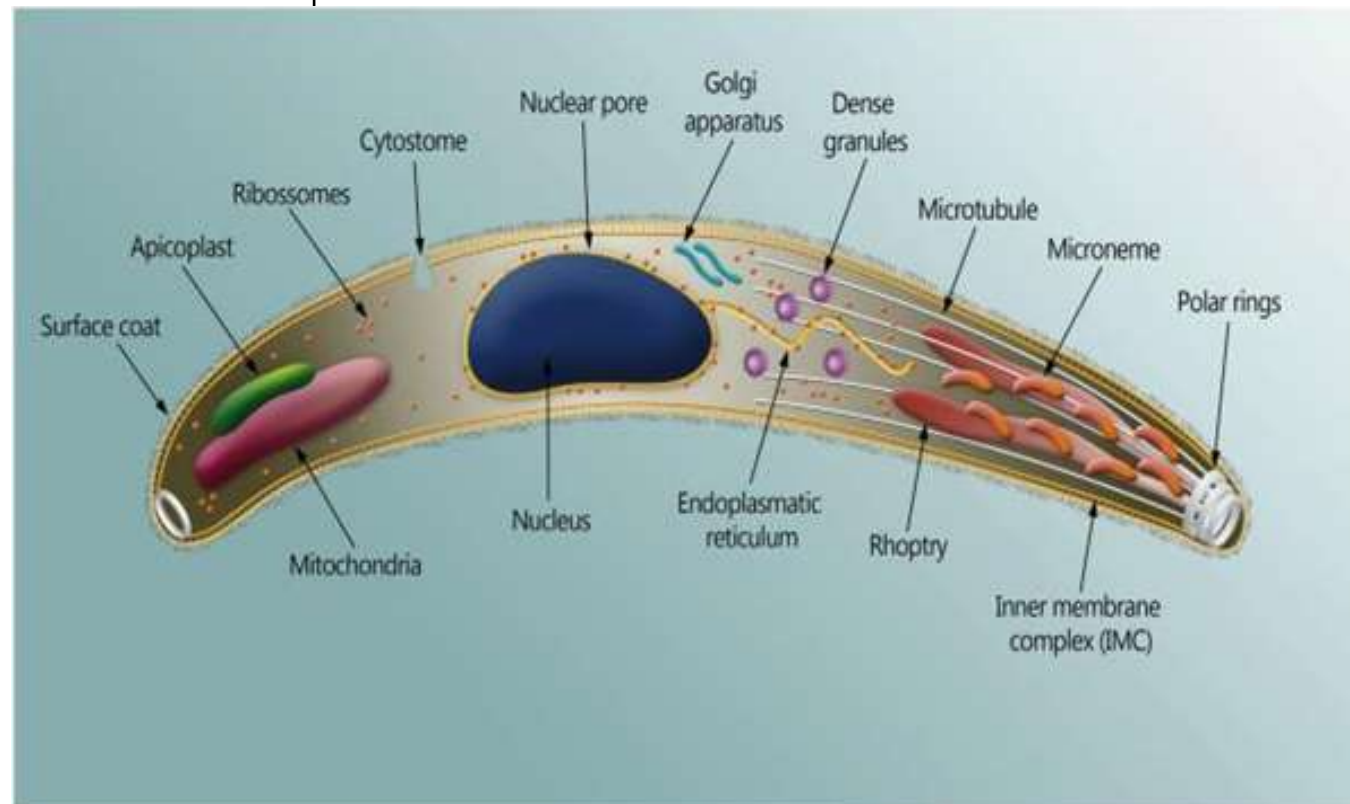


Figure 1. Evolution of the apicoplast through secondary endosymbiosis and loss of photosynthetic ability in apicomplexans

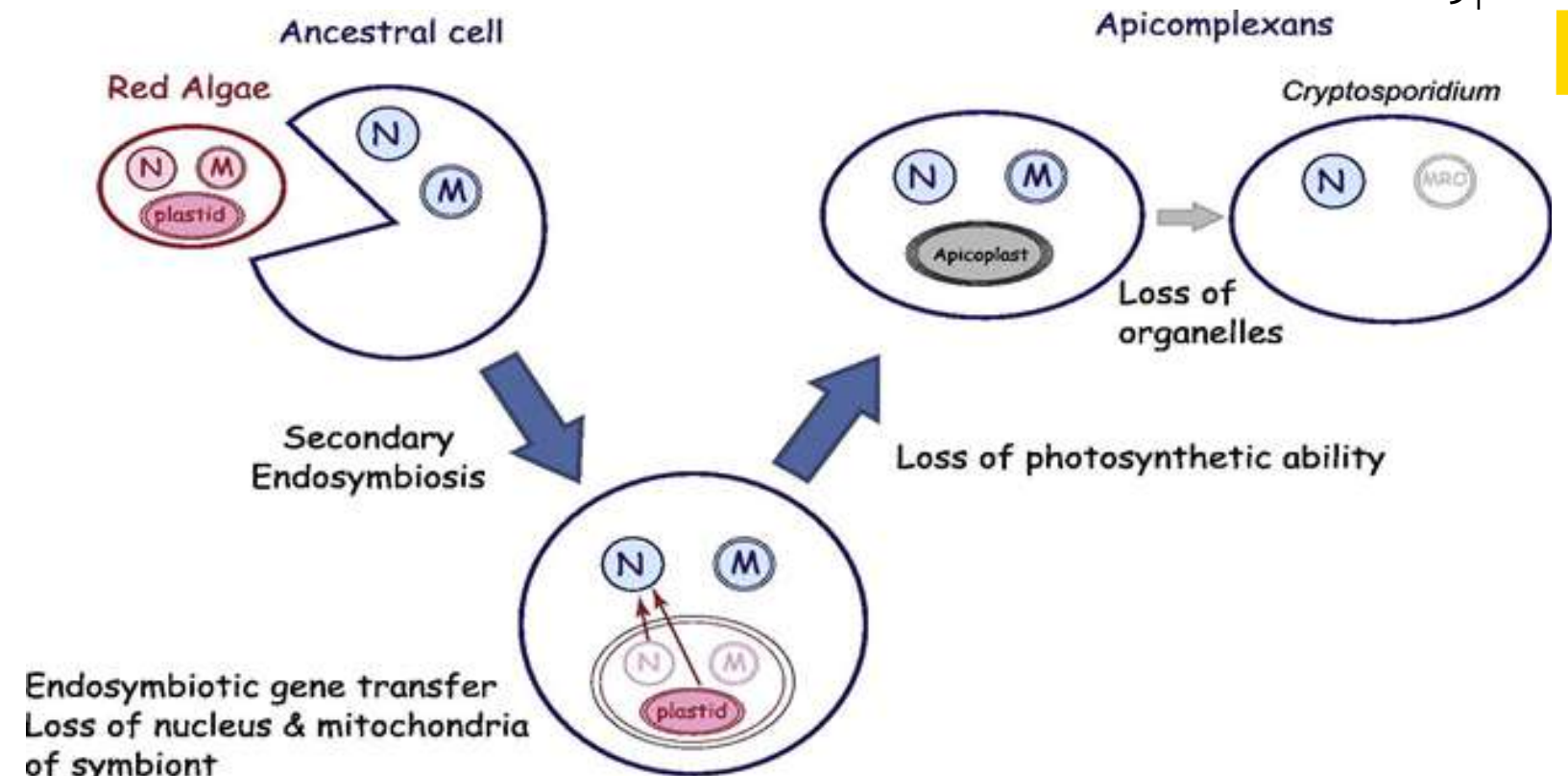


Figure 2. Cellular structure of an apicomplexan parasite highlighting the apicoplast and associated organelles

How a Photosynthetic Organism Became the DEADLIEST Pathogen Humankind has ever seen...

The Hidden Legacy of a Lost Chloroplast

The story of *Plasmodium*, the parasite responsible for malaria, begins not in the blood of humans but in the light of ancient seas. Millions of years ago, a photosynthetic alga underwent a remarkable evolutionary transformation that would ultimately lead to one of humankind's most devastating diseases. Within this parasite lies a remnant of its green ancestry, a small, mysterious organelle called the apicoplast. This relic of a once photosynthetic past offers both a window into evolution and a target for modern therapeutics.

What is the Apicoplast?

The apicoplast is a non-photosynthetic

plastid found in *Plasmodium* and other apicomplexan parasites such as *Toxoplasma gondii*. Unlike the mitochondrion, which generates cellular energy, the apicoplast is a biochemical factory. It synthesizes fatty acids, isoprenoids, and certain amino acids, compounds that are essential for parasite survival. Despite having lost its photosynthetic capabilities, the apicoplast remains indispensable, acting as a metabolic hub within the parasite's complex cellular network.

From Alga to Parasite

The apicoplast's origin lies in a fascinating series of endosymbiotic events. Roughly a billion years ago, an ancestral eukaryote engulfed a cyanobacterium,

giving rise to the first photosynthetic algae. Later, another predatory protist consumed one of these algae, keeping it as an internal symbiont. Over time, most of the algal components were lost, but the plastid, the chloroplast, remained.

In apicomplexans, this organelle became the apicoplast, stripped of its photosynthetic machinery but retaining key biosynthetic functions. This transition from an autotrophic ancestor to an obligate intracellular parasite is a striking example of how evolution repurpose biological systems to meet new ecological demands.

Functions of the Apicoplast Today

In *Plasmodium*, the apicoplast no longer captures light, yet its metabolic roles are crucial. It produces fatty acids for membrane formation, isoprenoid precursors for signalling, and participates in heme synthesis. Interestingly, the organelle contains its own small circular genome, reminiscent of bacterial DNA, which provides further evidence of its endosymbiotic origin.

Drugs that inhibit apicoplast metabolism, such as certain antibiotics, have been shown to kill malaria parasites, underscoring the organelle's potential as a therapeutic target. This dependency reveals that even after millions of years of adaptation, *Plasmodium* still relies on a relic of its ancient photosynthetic past.

A Relic that Changed the World

The apicoplast is more than an evolutionary curiosity. It symbolizes how life can reinvent itself through loss and

adaptation. What was once an organ of light has become a cornerstone of darkness in human history, fuelling a disease that continues to shape populations and economies.

Understanding the apicoplast does not just deepen our grasp of evolution; it may hold the key to eradicating malaria altogether. The transformation of an alga into a parasite encapsulates the paradox of nature, showing that within the mechanisms of creation lie the seeds of destruction.



Figure 3. The malaria parasite is transmitted by mosquitoes, making it one of the most widespread and deadly pathogens in human history

Kalana Magnus
S/20/213

ZOOPHARMACOGNOSY

How animal behaviour is guiding biomedical science

The study of animal behaviour has historically centered on quantifiable interactions related to survival and reproductive fitness, such as foraging strategies, predator-prey dynamics, and mating rituals. However, an important sub-field, zoopharmacognosy, investigates a distinct and evolutionarily significant category of behaviour: the self-medication of animals. This discipline examines the hypothesis that animals deliberately select and utilize specific plants, soils, and other natural substances to treat or prevent ailments. This article will explore the mechanisms of zoopharmacognosy and show that these observed behaviours function as critical indicators for modern biomedical research, guiding pharmacologists toward novel therapeutic compounds.

Distinguishing true self-medication from incidental foraging is a primary methodological challenge. Researchers employ a specific set of criteria to validate an observation, including evidence that the substance is consumed primarily by ill individuals, offers minimal nutritional value, is rich in biologically active secondary compounds, and that its ingestion correlates with an improvement in the animal's health status.

When these criteria are satisfied, the implications for biomedical science can be profound. The strongest examples come from

research on classical primates. Chimpanzees (*Pan troglodytes*) with parasite illnesses have been seen to engage in 'leaf-swallowing' behaviour in Tanzania. The rough, hairy leaves of the *Aspilia* plant were carefully chosen and swallowed whole. The undigested leaves had physically cleaned the intestinal canal,



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expelling whole parasites, according to a subsequent study of faecal matter. This demonstrated a mechanical, rather than chemical, form of medication.

In a separate but related case, sick chimpanzees were observed chewing the bitter pith of *Vernonia amygdalina*. This behaviour was notably absent in healthy individuals. Subsequent biomedical analysis of the plant's pith identified potent anthelmintic compounds, validating the behaviour pharmacologically sound. In these instances, the animal's behaviour was the essential prerequisite for the scientific discovery.

Zoopharmacology has significant and practical implications for the future of human medicine, making it more than just an ecological curiosity. It offers a sophisticated, behaviour-based shortcut for pharmacological discovery.

- **A High-efficiency bioprospecting filter:** The process of screening organisms for therapeutic compounds, known as 'random' bioprospecting, is extremely inefficient due to the vast number of species present in any given ecosystem. Animal behaviour functions as an evolutionary screening mechanism. It points researchers directly toward the specific organisms that possess potent biological activity, saving immense time and resources. Instead of testing thousands of random plants, researchers can begin with the one plant a primate uses to treat a specific infection.
- **Discovery of novel pharmacophores:** This targeted approach provides a direct pathway to discovering novel chemical structures, or pharmacophores. By observing what animals use to treat wounds or infections, Many modern drugs, including several anticancer and antimicrobial agents, originate from plant secondary metabolites. This is a crucial strategy for finding the next generation of therapeutics, such as new antibiotic scaffolds capable of defeating multi-drug resistant bacteria.
- **Access to Evolution's 'Clinical Trials':** In many social animals, medicinal behaviours are culturally transmitted and learned from one generation to the next. This creates a living database of medical knowledge that has been 'field-tested' and refined over millennia. By documenting this, researchers can tap into pharmacological solutions that have survived the rigorous test of natural selection, far longer than any human clinical trial.

Evidence of zoopharmacognosy is not limited to primates. Several non-primate species also display similar medicinal behaviours. For example, monarch butterflies infected with parasites preferentially lay their eggs on toxic milkweed plants. The chemical compounds in milkweed reduce parasite growth in the developing larvae, thereby improving offspring survival. Likewise, certain species of parrots regularly consume clay from riverbanks, a behaviour known as geophagy. The clay helps neutralize toxic secondary compounds present in the seeds and fruits they eat. These examples demonstrate that self-medication behaviours are widespread across animal taxa and further support the idea that animal behaviour can reveal biologically active substances valuable for biomedical research.

In conclusion, Animal behaviour has the capacity to directly influence pharmacology and go beyond conventional ecology. A carefully recorded 'anomalous' behaviour could represent the first crucial data point in a chain of discovery leading to a new class of drug. The study of zoopharmacognosy, therefore, illustrates a powerful and essential new pathway for biomedical innovation. Systematic documentation of these behaviours transforms ecological observations into a structured framework for pharmacological discovery. We are learning to read an unwritten library of pharmacological solutions.

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S/19/214

Silent Messengers

In ecological systems, every organism interacts continuously with its environment, and many respond predictably to changes in its quality. Such organisms, known as “bioindicators”, provide measurable biological responses that reflect the condition of ecosystems. Their responses, whether physiological, behavioral, or demographic, can serve as natural diagnostic tools, offering insights into the presence of pollutants, habitat disturbances, or climatic variations.

Bioindicator animals occur across almost every habitat type. Amphibians, for example, are highly sensitive to chemical contaminants and hydrological changes due to their permeable skin and complex life cycles. Declining frog populations often signal aquatic ecosystem deterioration long before chemical assays detect contamination. In freshwater systems, macroinvertebrates such as mayflies (Ephemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) are used worldwide to assess water quality; their absence or dominance patterns serve as quantitative indicators of oxygen availability and organic pollution. Within the soil ecosystem, microarthropods—particularly Collembola and Acari; reflect the biological activity and structural stability of soil. Shifts in their species richness, abundance, and community composition reveal subtle alterations in soil moisture, organic matter content, and contamination levels.

These animal groups communicate environmental change through their biology, forming a silent but precise language. However, this communication often goes

unnoticed by the public and even by policymakers. The task of the zoologist is to interpret this language and to translate patterns in population dynamics or morphological variation into ecological meaning. This requires rigorous field observation, taxonomic accuracy, and integration with physicochemical data to ensure that the biological signal is properly understood.

To “reply” to these silent messages means more than acknowledging their existence. It involves scientific and conservation responses: restoring degraded habitats, regulating pollutants, preserving indicator taxa, and incorporating biological monitoring into environmental policy frameworks. When amphibians decline, mitigation may involve reducing agrochemical runoff and rehabilitating breeding wetlands. When soil fauna diversity collapses, sustainable land-use practices and organic matter restoration become the appropriate reply. Each response transforms the observation of change into meaningful ecological action.

In essence, bioindicator animals are not passive subjects of study but active communicators of ecosystem health. Their presence, diversity, and behavior encode complex environmental information that, once decoded, allows zoologists to predict, prevent, and mitigate ecological deterioration. Recognizing and responding to their silent messages ensures that environmental assessment remains rooted not only in data but in the living systems it seeks to protect.

Biological Language of Environmental Change



Springtails:

These ground-dwelling fauna, due to their high abundance, diversity, and activity, serve as excellent bioindicators. Exposure to acids, heavy metals, nitrogen compounds, and pesticides reduces both their numbers and species richness.

Fungi:

These organisms are primarily used to assess soil radioactivity. Fungi can accumulate radionuclides in their tissues, which may then transfer through food chains to rodents or humans. Therefore, tissue analyses are conducted to evaluate the extent of radioactive accumulation.



Amphibians:

These animals are highly sensitive to drought and environmental pollutants. Their permeable skin allows acids, fertilizers, insecticides, and other contaminants to be readily absorbed and accumulated, making them among the first species to decline when ecosystem conditions change.

Bees:

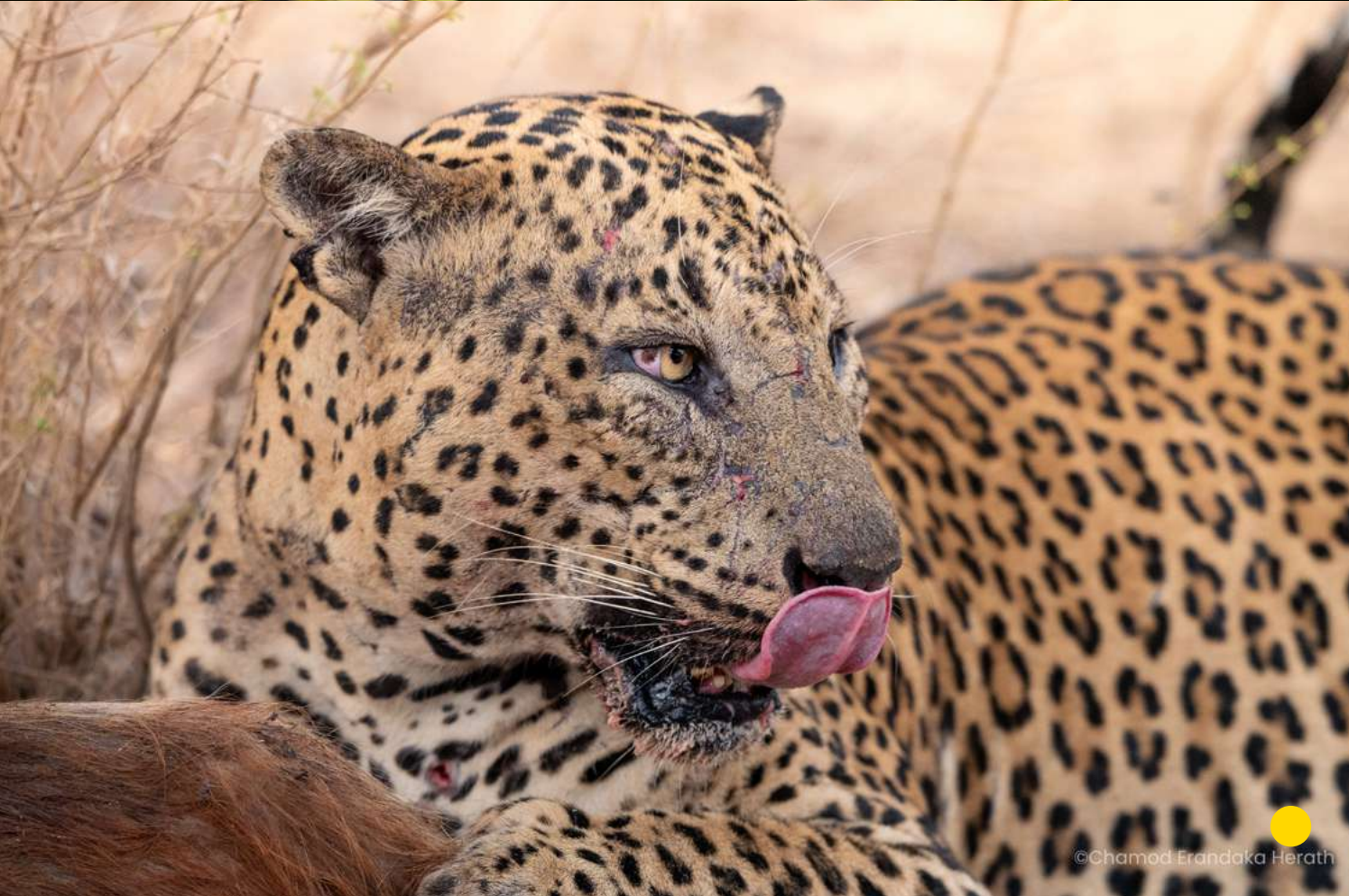
Bees are keystone species in many ecosystems. They respond sensitively to climate change and habitat fragmentation. Hence, bees are used to monitor environmental contamination, including heavy metals, radioactivity, industrial pollutants, pesticides, and herbicides.



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S/19/116



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1.0 Introduction

Space exploration is the scientific study and investigation of outer space through the use of astronomy, spacecraft, satellites, and human missions beyond Earth’s atmosphere. Space travel is vital for advancing scientific knowledge, technological innovation, and the long-term survival of humanity. It allows scientists to explore the origin of the solar system and possible theories about origin of our own universe, study planetary environments, and understand cosmic phenomena that cannot be observed from Earth’s surface due to atmospheric limitations. It also involves observing celestial bodies such

as planets, stars, moons, and galaxies, as well as sending robotic probes and astronauts to explore and understand the universe [1].

Space exploration spans a variety of subject areas including planetary science, astrophysics, engineering and materials science, biological/medical research, Earth-and-space physics, and resource & systems design for off Earth operations. Even though engineering and physics plays major role in space exploration, the contribution of biological applications in ensuring humanity’s ability to survive, adapt, and thrive beyond Earth is crucial. As we move toward long-term missions to the Moon, Mars, and possibly

deeper into the cosmos, understanding the biological challenges of space travel becomes essential. From the molecular level of DNA to the ecosystem-level design of life support systems, biology in space exploration bridges the gap between survival and discovery.

This article aims to discuss about Astrobiology which is one of the key aspects of space exploration and the role of biology in it.

2.0 What is Astrobiology?

Astrobiology is the branch of science

that studies life in the universe: its origin, evolution, distribution, and future. It brings together several scientific disciplines, including biology, chemistry, physics, geology, and astronomy, to answer one of humanity’s most profound questions: Are we alone in the universe? Astrobiologists explore how life began on Earth, what conditions make a planet habitable, and whether similar conditions exist elsewhere in our solar system or beyond. The central goal of astrobiology is to find evidence of past or present life beyond Earth, if it ever

The Biological Foundations of Astrobiology

Exploring the Universe Through the Lens of Biology



existed. The key goals include understanding origin of life on Earth and how it might arise elsewhere in the universe, studying planets and moons like Mars, Europa and Enceladus for signs of water or frozen water and microbial activity to find a form of life, investigating organisms on Earth that survive in extreme heat, cold, or radiation to learn how life could exist

on other planets and finally finding the sustainable ways for humans and other organisms could live and reproduce in space or on other worlds [2].

3.0 Role of Biology in Astrobiology

Biology is considered as the core foundation of astrobiology, because the main goal of the Astrbiology is to understand life how it begins, survives,

and evolves in different environments from normal habitable environment in our Earth to extreme environments of other planets. Biological principles help scientists identify what conditions are necessary for life and how organisms might adapt to extreme environments beyond Earth.

3.1 Study of extremophiles

For example, studying extremophiles; type of microorganisms that live in Earth’s harshest conditions: such as deep ocean vents, deserts, or polar ice provides insights into how life could exist on Mars or icy moons like Europa. Biological principles help scientists study how extremophiles’ cell membranes, proteins, and enzymes remain stable under extreme conditions. For example, thermophilic bacteria have special proteins that don’t denature at high temperatures, which biologists analyze using molecular biology techniques. Moreover, by comparing extremophile DNA with that of normal organisms, researchers can identify genes responsible for adaptation to extreme environments and able to trace evolutionary pathways, and predict how life might survive on other planets. Biological studies also reveal how extremophiles interact with their environment, process energy, and reproduce. This can provide clues about the limits of life and potential habitats for extraterrestrial organisms.

3.2 BioSentinel

Another project named as BioSentinel which is a CubeSat mission launched by NASA on 16 November 2022, aimed at

measuring how deep-space radiation affects DNA repair mechanisms in yeast. Direct biological experiment in space: observing how living cells respond in deep-space conditions with radiation and microgravity help immensely to understand and solve challenges related to space travel. Through biological principles, scientists can monitor how yeast DNA becomes damaged and repaired under radiation levels far higher than those in low-Earth orbit. This information helps biologists and astrobiologists learn how cells maintain genetic stability in space and what biological risks humans might face during



Figure 1: NASA’s Jet Propulsion Laboratory^[4]

long missions to the Moon or Mars [3].

3.3 Jet Propulsion Laboratory

Moreover, biology plays a major role in understanding the conditions that make life possible, and how biological/chemical signals might appear in extraterrestrial samples. In NASA’s Jet Propulsion Laboratory (JPL), the planetary protection laboratories, where scientists ensure that

spacecraft are sterilized to prevent biological contamination of other worlds. Biologists analyze and monitor microbial populations on spacecraft surfaces to maintain cleanliness standards required for interplanetary missions. Furthermore, JPL’s biotechnology research explores how biological systems can be used in future space exploration. For example, developing bio-based sensors, life-support systems, and regenerative resources for long-duration missions.

4.0 Conclusion

Astrobiology not only guides where and

organisms provide crucial knowledge for future human exploration. By combining biological knowledge with space science, astrobiology transforms the quest for life beyond Earth into a systematic and evidence-driven scientific approach, bridging the gap between terrestrial life and the possibilities that lie within the cosmos. In essence, biology transforms astrobiology from a theoretical pursuit into an evidence-based science that connects life on Earth with the possibility of life elsewhere in the universe and act as the lens to explore the wonders of our universe.

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S/19/535

The Role of Indigenous Knowledge



in Sustainable Development

Introduction

Indigenous communities consider humans as a part of nature rather than separate from it. This creates a balance and respect for all living things in the world. The traditional or indigenous knowledge is founded on several generations of empirical observation, experiments and adaptation. This knowledge plays a vital role in their cultural and daily life, and encompasses a wide range of fields, including agriculture, healthcare, conservation and education. It is typically transmitted orally and via cultural rituals, reflecting a strong connection to nature and to adapt to new environments.

The value of Indigenous Knowledge

Indigenous knowledge is highly important because it enhances our understanding of ecosystems promotes sustainable resource management. These are methods, that have been developed over many years, and often more environmentally friendly than modern scientific methods. Indicatively, traditional farming practices such as polyculture whereby crops of various types are cultivated together have been demonstrated to be stronger and sustainable compared to the application of monoculture systems.

The indigenous communities have developed sophisticated methods of environmental management and there is increasing recognition that these approaches can contribute to more sustainable development. They possess extensive knowledge of environment around them, experiment with new ideas and adapt to the environmental changes. This continuous learning and adaptation are actually critical for developing sustainable practices that could form part of larger development plans.

Case Studies in Indigenous Knowledge

A notable example of the effective indigenous knowledge is the traditional polyculture system of farming in Sri Lanka. This system that has been in place for more than 2,500 years offers a wide range of food, a stable economic flow and effective management of labor and resources. It minimizes risks and pest outbreaks while maximizing productivity with low levels of technological input. Such systems portray the value of integrating indigenous practices into contemporary agricultural policies, particularly in nations where a large number of small-scale farmers exist.

In many regions of the world, including Australia or Asia, indigenous communities continue to rely on their traditional knowledge to sustain themselves on a daily basis and manage their resources. This knowledge contributes to biodiversity conservation, as well as, to food security and local economic independence. Indigenous practices, including artisan fisheries, sustainable hunting, and gathering play a vital role in maintaining ecological balance and sustaining the existence of these communities.

Challenges and Threats to Indigenous Knowledge

Despite its value, indigenous knowledge is being threatened by many factors such as globalization, modern development practices, and environmental changes. The traditional knowledge systems are usually eroded by the introduction of foreign technologies and development models. Also, the knowledge systems have been threatened by the socio-political changes and wars that have interfered with the traditional lifestyles of most indigenous communities.

Climate change alters traditional climatic patterns and typical seasons relied on for farming, fishing, and animal migration, creating indigenous practices difficult to sustain. Deforestation, habitat destruction, and excessive exploitation of the natural resources reduce the diversity of the species on which the indigenous knowledge relies. Invasive species disrupt native ecosystems, including altering the typical food web, and undermining local knowledge. Resource-based practices become unsafe or impossible due to mining activities and, agricultural / chemical runoff which contaminate soil and water.

Development projects or deforestation commonly causes indigenous communities to be displaced, resulting in a loss of access to traditional lands, which the indigenous people highly value as sources of their knowledge. Western education, media influence, and consumer habits knowledge systems, leading younger generations to neglect indigenous practices.

Since this knowledge is primarily transmitted orally, there is also a risk of exploitation, where commercial organizations may use indigenous knowledge of natural products without proper consent or benefit-sharing, discouraging communities from sharing their knowledge.

Indigenous knowledge is not only lost within indigenous communities; its loss also has global consequences for sustainability. When indigenous knowledge disappears, it not only affects the communities that created it, but also weakens global efforts toward sustainable development. Therefore, it is crucial to document, preserve, and integrate this knowledge so that researchers, policymakers, and development practitioners can utilize it effectively.

The Role of Indigenous Knowledge in Biodiversity Conservation

Indigenous knowledge is crucial for the conservation of numerous living organisms. Over a long period of time indigenous people have been managing and protecting their environments to ensure the presence of a wide variety of living organisms, using techniques that are well adapted to local conditions. These approaches include the management of plants and animals by using traditional farming, hunting, and fishing practices. The Convention on Biological Diversity

recognizes that it is particularly significant to incorporate traditional knowledge in strategies for biodiversity conservation.

In countries like Asia and Australia, indigenous knowledge among the traditional population is being integrated into modern conservation efforts. This traditional knowledge is being used to protect and manage the biodiversity in the form of projects such as digital libraries, biodiversity registers and on-site management plans. Through these projects, there is an appreciation of the importance of protecting indigenous knowledge not only as a cultural value, but also for its practical values in conservation and sustainable management of resources.

Policy Implications and Recommendations

To ensure that indigenous knowledge is effectively utilized in the sustainable development, the policymakers should consider integrating the knowledge both at the national and global development strategies. Active governance and co-management are essential, including the incorporation of indigenous voices in environmental decision-making bodies from the local to the international level. This change entails abandoning the view of indigenous knowledge as something outdated and fixed to a new approach that allows appreciation as dynamic and important. The policies should revolve around protecting and improving the indigenous knowledge systems, ensuring that it is respected and incorporated in the development projects.

Educational initiatives and research projects must focus on documenting and studying indigenous knowledge, thereby enhancing its preservation and dissemination. Collaboration between indigenous communities, scientists, and policymakers can help them exchange knowledge and develop new and sustainable solutions to global issues. In addition, community-based monitoring schemes can help the indigenous community to utilize their ecological/natural observations in the management of resources and adaptation to climate changes.

Conclusion

The inclusion of Indigenous knowledge in sustainable development is essential to the real ecological and social balance. By recognizing and integrating this knowledge, we can develop more effective and sustainable solutions to the current issues. Beyond recognition, it is also necessary to actively preserve, protect, and promote this knowledge for future generations.

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Ezhilvathana Rajendran
S/19/196

Monsoons lullaby

*The sky unbraids her silver hair
Soft thunder hums through heavy air
She hums upon the rooftops
A lullaby for thirsty souls*

*The rivers forget their dusty dreams
Swollen banks, once thirsty in summer
Each drop a note, a whispered grace
To cleanse the scars of thirst*

*Leaves sway within her song
Children laugh where puddles gleam
The world, once cracked, harsh and dry
Now listens to her sweet, whispering cry*

*She sings through months, through nights and days
Leaving behind a world made new
Then bows and slowly fades away
Until the next time.*

Chamodi Sandaruwani
S/21/141

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Reflections of the Carps

*Beneath the lilies' tender shade,
Two carps in mirrored silence wade.
Their fins disturb the silver glass,
Where time and thought together pass.*

*Each movement slow, yet full of grace,
They weave soft circles, face to face.
No struggle marks their tranquil play,
Just rhythm in the light's ballet.*

*From depths unknown to surface bright,
They drift through shadows into light.*

*So nature whispers, calm and clear
True strength lies not in speed, but steer.*

*O watcher, pause — the pond will show,
In every heart, such peace may flow*

Pyara Athukorala
S/19/017

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Table of Contents



The kingfisher inspired the streamlined design of Japan's bullet train

Avian Adaptations & Their Applications in Engineering Design

For thousands of years, people have watched birds with wonder. Their ability to fly, build nests, and navigate the skies has always amazed us. However, birds are not only visually striking organisms; their structures and behaviors are shaped by evolutionary adaptation. By studying how birds live and behave, humans have developed many modern technologies that enhance our lives. From airplanes to trains, and from building design to robotics, birds have inspired ideas that have changed the world.

The dream of flight began with observing birds. Long before airplanes existed, people sought to

understand how birds could stay in the air. The Wright brothers, who built the first successful airplane in 1903, carefully studied bird wing movement. They observed that birds adjust wing camber and angle of attack to control lift and roll, which inspired early aerodynamic control mechanisms. The brothers adapted this observation into a system they called "wing warping," which contributed to their airplane's stability and flight capability. Even today, airplanes incorporate ideas derived from birds. For example, the small upward-turned tips on airplane wings, known as winglets, were designed after observing how eagles

Comparison between the flight of a Bald Eagle and a Boeing C-17 aircraft



©Tina Stafford | Richard Calver

and hawks spread their feathers while gliding. These winglets help planes save fuel and fly more smoothly.

An impressive example comes from Japan, where engineers faced an issue with the high-speed Shinkansen bullet trains. When the trains emerged from the tunnels, they produced a loud “boom” noise that disturbed nearby residents. One engineer, also a bird watcher, observed how the kingfisher dove into the water without creating a splash. He realized that the bird’s long, pointed beak streamlined its entry through air and water. Inspired by this, the engineering team redesigned the front of the train to resemble the kingfisher’s beak, resulting in a faster, quieter, and more energy-efficient train. This simple idea from a bird solved a significant engineering challenge.

Birds have also influenced the design of quieter and more efficient machines. For example, owls possess specialized feather structures that enable near-silent flight during nocturnal hunting. Their wings have leading-edge serrations that break up incoming airflow, reducing turbulence and associated noise. The feathers also have trailing-edge fringes that smooth the airflow behind the wing and further decrease aerodynamic noise. In addition, the velvety dorsal surface of owl feathers absorbs aerodynamic noise produced during flight. These structural adaptations have been studied and applied in engineering to reduce noise in technologies such as aircraft wings, cooling fans, and wind turbines.

Another bird that has inspired technology is the hummingbird. It can hover in one spot by flapping its wings at an astonishing rate of about 50 times per second. Scientists have studied this unique movement to create small flying robots, known as drones, capable of hovering, rapid turns, and manoeuvring in tight spaces. These “hummingbird drones” can be utilized in search

and rescue missions, photography, or wildlife studies without causing disturbance.

Birds are not only adept at flying; they are also exceptional builders. Each bird species distinctly constructs its nest, using materials such as sticks, leaves, feathers, and even spider webs. Some nests are durable enough to last for years, while others are soft and lightweight. Architects and engineers study bird nests to develop structures that are both strong and flexible. For example, weaver birds construct hanging nests by tightly interweaving plant fibers, which helps maintain material tension within the structure. This woven arrangement allows effective load distribution across the nest walls and attachment point on the branch. As the nest hangs and moves with the wind, its woven fibers allow structural flexibility under dynamic stress, enabling the nest to sway without breaking. This construction strategy has inspired the design of lightweight yet robust bridges and shelters. Nature’s designs often achieve maximum strength with minimal material, which is a goal modern builders strive for as well.

Even bird feathers have inspired technological advancements. Feathers are light, strong, and perfectly shaped for flight, providing insulation and waterproofing. Engineers have emulated the structure of feathers to develop superior materials for airplanes and space suits. Some feathers, like those of the peacock, showcase bright colors without using paint or dye because their coloration arises from minute structures that bend and reflect light. Scientists have used this principle to create vibrant materials that resist fading and to improve screens for phones and tablets.

Moreover, birds have contributed to the development of navigation and communication systems. Many migratory birds can travel thousands of kilometers and still return to the same breeding or feeding locations. This ability

is partly based on magnetoreception, a sensory mechanism that allows birds to detect the Earth’s magnetic field for orientation and navigation. Research suggests that cryptochrome proteins in the retina are involved in this process, enabling birds to perceive magnetic field information during flight. Scientists propose that this occurs through a radical pair mechanism, in which magnetic fields influence chemical reactions within these light-sensitive proteins. Understanding these biological systems has inspired the development of navigation technologies that can operate without GPS by using magnetic field detection. In addition, studies of birds’ songs and calls have helped researchers develop improved methods for sound pattern recognition in computers and robotic systems.

In recent years, engineers have applied insights from bird behaviour to create advanced flying robots and airplanes. Flapping-wing robots, known as ornithopters, are designed to mimic the wing movement of real birds. These robots can fly more smoothly and consume less energy than traditional drones with rotating propellers. They can also change direction easily, like birds navigating through the air. Scientists use some of these robots to study actual bird behavior, while others assist in search operations or environmental monitoring. The albatross, one of the largest flying birds, has the incredible ability to glide across oceans with minimal flapping. It employs a flight technique called “dynamic soaring,” which takes advantage of wind currents to cover vast distances. Airplane designers continue to study this technique to improve flight efficiency in human-made aircraft. Birds have significantly influenced fashion, sports, and daily life. The concept of “streamlining,” which enhances the speed of cars and bicycles as they travel through the air, also originated from studying the bodies and wings of birds.

Perhaps the most important lesson that birds teach us is about maintaining balance with nature. Birds do not waste energy. Their designs are efficient, elegant, and perfectly suited to their needs. When we mimic their designs, we are reminded that effective technology does not always equate to increased complexity; it can also mean working in harmony with the environment. Many technologies inspired by birds not only benefit humans but also help to reduce noise, save energy, and protect nature.

As scientists continue to explore the avian world, discoveries keep emerging. For example, studying how pigeons stabilize their heads while flying has led to improvements in camera stabilization for drones. Observing how swans move through water has inspired better boat designs. Even the way tiny sparrows take off from the ground can inform the creation of more efficient jumping robots. Every aspect of a bird’s life holds valuable lessons.

Ultimately, birds remind us that nature is the greatest engineer. The designs shaped by evolution over millions of years are far superior to many of our inventions. By observing birds, humans have learned how to fly, glide, and navigate gracefully through both air and water. From airplanes to robots, and from buildings to computers, birds continue to guide us toward smarter, cleaner, and more sustainable ways of living and creating.

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Chalani Munasinghe
S/19/111

THE STORY OF “NELUMA”

The Big Male Leopard of Nelum Vila,
Wilpattu, Sri Lanka

Sri Lankan leopard (*Panthera pardus kotiya*) is recognized as the apex terrestrial predator of Sri Lanka. The Wilpattu National Park is one of the best places to spot these majestic creatures. Leopards are regularly recorded in Wilpattu, though exact population estimates remain uncertain. Among this population, a notable male leopard, nicknamed ‘Neluma,’ is recognized as one of the most famous and dominant large leopards in Wilpattu, identified as WM05 (Wilpattu Male 05). The above image was taken during a safari in Wilpattu on 8 June 2024. One of the unique features to identify this male leopard is its forehead spot pattern.

Neluma, also known as Andhare, is a distinctive leopard of Wilpattu, noted for his habituated to safari vehicles. He is also the sire of several cubs with the Kuruttupandi female (Manikrala Uraniya female 1, WF10) and Cleo (Kumbuk Villa female 2, also known as Cleopatra, WF09). Before the first photograph was taken, the approximate 8 years old Neluma was lying on the forest floor, 15 feet away from the road. The leopard was well-camouflaged among the tree trunks, and that alarm call of a spotted deer helped us locate him. After about 10 minutes he rose and began moving slowly through the forest. The tracker drove the vehicle to a nearby forest glade, and by the time we arrived, Neluma was sitting at the edge of the forest.

He then began walking through the forest glade, basking in the morning sunlight. It was evident that he showed no interest in hunting at all, as a scared wild hare quickly hopped past him, and he paid no attention. Then he crossed the road and stopped for a while to lick and clean his limbs. Then he slowly disappeared into the forest near the road. Fortunately, we were able to locate him again about 20 minutes later, wandering through another forest glade.



Neluma wondering through a forest glade (08/06/24)



Neluma crossing the road near Nelum villa (08/06/24)

Yehara Disanayake
S/19/042

©Chathurika Munasinghe

BIODIVERSITY

The Web of Life



Biodiversity refers to the variety and variability of living organisms found on Earth, including the diversity within species, between species, and among ecosystems. It represents the complex network of interactions among all life forms that maintains the balance of nature and supports ecological stability. Every organism, from the smallest microbe to the largest mammal, performs a specific role within this network. The interdependence of these living forms and their environments creates what is often described as the “web of life,” a system in which the disturbance of even one component can affect the entire structure of the ecosystem.

Biodiversity provides the basis for many ecological processes that sustain life on Earth. It regulates essential services such as nutrient cycling, soil formation, pollination, decomposition, and climate regulation. Forest ecosystems act as major carbon sinks, purifying the air and influencing rainfall patterns, while wetlands and mangroves filter pollutants, prevent floods, and provide breeding grounds for aquatic life. Oceans absorb a significant portion of atmospheric carbon dioxide and produce oxygen that sustains life. These ecosystem services are not only crucial for maintaining the planet's health but are also vital for human survival, providing food, water, raw materials, and medicines that support global economies and societies.

Sri Lanka, although small in geographical size, is one of the world's most significant biodiversity hotspots. Its varied climatic zones and topography have created a wide range of ecosystems, from coastal mangroves and coral reefs to tropical rainforests and montane cloud forests. This diversity supports a varied number of species, many of which are endemic to the island. The country's rainforests, such as the Sinharaja Forest Reserve, harbor a high proportion of endemic trees, birds, and insects. The montane ecosystems of Horton Plains and Knuckles are home to numerous rare and endangered species adapted to cooler and misty environments. Along the coastal areas, coral reefs and mangrove forests play an essential role in protecting the shoreline and supporting fisheries, which in turn sustain many local communities.

However, this rich biodiversity is increasingly threatened by human-induced activities. Rapid urbanization, deforestation, agricultural expansion, and industrial pollution have severely degraded habitats and reduced natural forest cover. Wetlands are being used for development, while coral reefs are damaged by destructive fishing practices and rising sea temperatures. Habitat fragmentation creates barriers animal movement and breeding patterns, leading to population declines. Globally, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (2019) estimates that around one million species are at risk of extinction, and Sri Lanka is not immune to this crisis. Changes in temperature and rainfall caused by climate change further worsen the situation by altering natural habitats and ecosystem functioning.

The decline in biodiversity has far-reaching consequences. The loss of pollinators can reduce crop yields, affecting food security, while the destruction of mangroves increases the vulnerability of coastal regions to storms and sea-level rise. When forests disappear, the soil loses its fertility, and local climates become drier. Such disruptions directly impact human livelihoods, particularly in communities that depend on natural resources for their survival. The degradation of ecosystems also weakens their ability to recover from natural disasters, increasing environmental and economic vulnerability.

Recognizing the importance of biodiversity conservation, Sri Lanka has established various protected areas such

as Yala, Wilpattu, Udawalawa, and Horton Plains National Parks. These areas serve as critical habitats for wildlife and play a key role in maintaining ecological processes. National policies and conservation programs implemented by the Department of Wildlife Conservation and the Forest Department aim to restore habitats and protect endangered species. In addition to government initiatives, community-based conservation efforts have become increasingly important. Many local organizations and environmental groups are involved in reforestation, wetland protection, and promoting sustainable resource use. Public awareness campaigns and educational programs have encouraged people to adopt environmentally friendly lifestyles and reduce activities that contribute to biodiversity loss.

Biodiversity conservation is not only an environmental necessity but also an economic and cultural priority. Ecotourism based on Sri Lanka's natural heritage provides income and employment opportunities to rural communities while fostering appreciation for wildlife and nature. Traditional knowledge systems, such as Ayurveda, rely heavily on biodiversity for medicinal plants and natural products. Maintaining diverse ecosystems therefore sustains both cultural traditions and economic resilience. Protecting biodiversity ensures the continuity of these benefits and preserves the natural capital that supports human welfare.

As individuals and as a society, our actions have a direct impact on the preservation of biodiversity. Simple

efforts such as minimizing plastic use, conserving water, planting native trees, and supporting conservation programs can collectively create meaningful change. Education plays a vital role in shaping positive attitudes toward the environment, especially among young people who will become the next generation of conservationists. Understanding that all living beings are part of a single interconnected system helps foster respect and responsibility toward the natural world.

Biodiversity is the foundation of life, connecting species, ecosystems, and people in a delicate but resilient web. The survival of humanity depends on maintaining this web in balance. The loss of biodiversity weakens the planet's ability to sustain life, while its protection ensures ecological stability and resilience. Sri Lanka, as a nation blessed with exceptional natural wealth, holds both the privilege and the duty to safeguard it. By valuing and conserving biodiversity, we protect not only the environment but also our shared future on this living planet.

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Vidumini Kumarasinghe
S/19/095

Plastic is a synthetic polymer. Its widespread utility stems from its durability, resistance to degradation, making it an essential material for various daily applications, from molded water bottles to packaging and ease of forming different shapes. However, its rapidly increasing production began in the mid of 20th century, global plastic production has surged from 1.5 million tons in the 1950s to over 335 million tons in 2016 (Lebreton et al., 2017). Plastics are utilized in many applications across all industries, from clothing and packaging to medical equipment and electronics. Only some 9% of plastic waste globally is recycled, 12% is burned, and approximately 79% ends up in landfills, rivers, and oceans, and thus plastic pollution has become a global environmental crisis (Suzuki et al., 2022). An estimated 31.9 million metric tons of plastic trash are dumped into the natural environment annually (Bucci et al., 2020). The increase of plastic pollution is one of the most critical environmental challenges of the 21st century.

Plastic pollution is classified according to its diversity, persistence, and widespread environmental reach. Frequently utilized as mixtures comprising monomers, oligomers and additives in forming plastic are polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polyethylene terephthalate (PET), and polystyrene (PS) (Rhodes, 2018). Numerous anthropogenic activities are the source of plastic contamination, which enters aquatic, terrestrial and atmosphere via landfills, domestic sewage, wastewater treatment plants, poorly managed plastic waste, agricultural practices, and urban dust. The widespread distribution of plastic is facilitated by the “plastic cycle,” in which plastics move between terrestrial, aquatic, and atmospheric systems much like carbon or nitrogen.

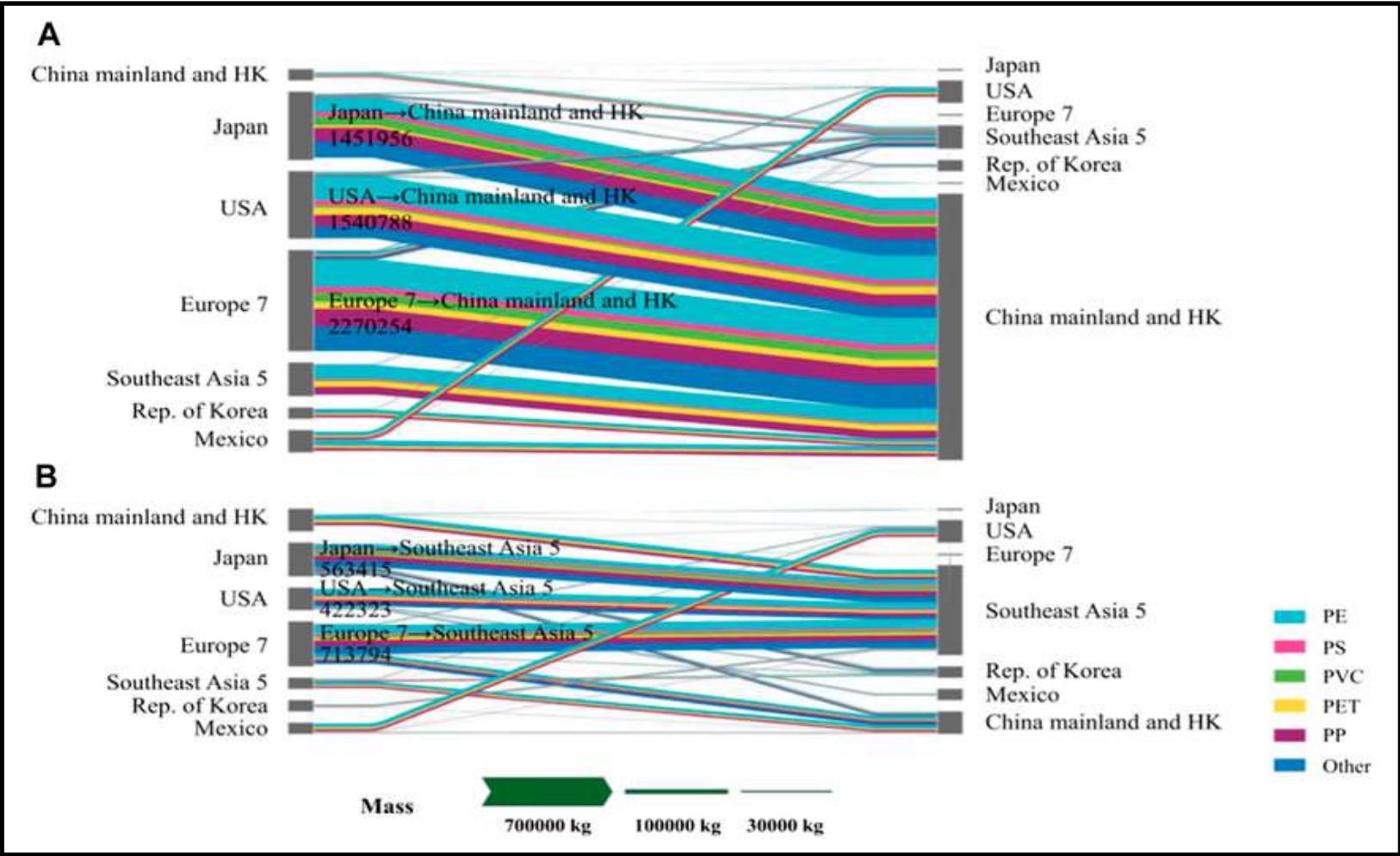
When plastic is introduced into one of these systems, plastic debris not only accumulates but also interacts with other pollutants and microorganisms, leading to combined pollution.

Plastic acts as a carrier for other environmental pollutants as adsorbing persistent organic pollutants (Pops) like polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT), heavy metals (Cd, Pb, Cu, and Zn), and even nanoparticles (Nijamdeen et al., 2020). Microorganisms and pathogens are invisible organisms that can also colonize plastic surfaces, potentially accelerate their diffusion and increase threats to living organisms (Ahmad et al., 2025). Plastics can also act as a source for releasing toxic chemicals such as bisphenol A (BPA) and phthalates into the environment, which are neurotoxic, hormone-disrupting and carcinogenic (Lithner et al., 2011).

Plastics can’t be degraded easily due to their high molecular weight and synthetic nature. They persist in natural ecosystems for hundreds of years, fragmenting into microplastics and nanoplastics through processes like photodegradation, thermal oxidation, hydrolysis, and biodegradation. These are generally very slow and rarely lead to the destruction of plastic materials in natural environments (Bajt, 2021). Microplastics are tiny plastic particles less than 5 mm in size and are omnipresent on the globe. These particles are ingested by marine and freshwater organisms, leading to the infiltration of food chains and accumulating in organisms such as mussels, fish, and seabirds (Ziani et al., 2023). Microplastics are subjecting humans to daily diets such as drinking water, salt, seafood, honey, sugar, and beer (Bajt, 2021). Humans are exposed to microplastics through ingestion (food and water), inhalation of airborne fibers from textiles and tire wear, and dermal contact. Microplastics may migrate into tissues, causing effects like oxidative stress, inflammation, endocrine disruption, and even cancer. Ingestion can also result in intestinal blockage or gastric impaction in larger animals and chronic impacts with potential accumulation along the food chain, affecting organisms from zooplankton to whales. Chemical and biological impacts are often chronic and less readily observed.

Southeast Asian countries collectively contribute between 4.8 to 12.7 million metric





Trade flows of six types of plastic waste under two scenarios. (A) Global trade flows of six types of plastic waste prior to the ban (Baseline Scenario); (B) flows subsequent to the ban (2018 Scenario). The unit of the flows is tons (Wen et al., 2021).

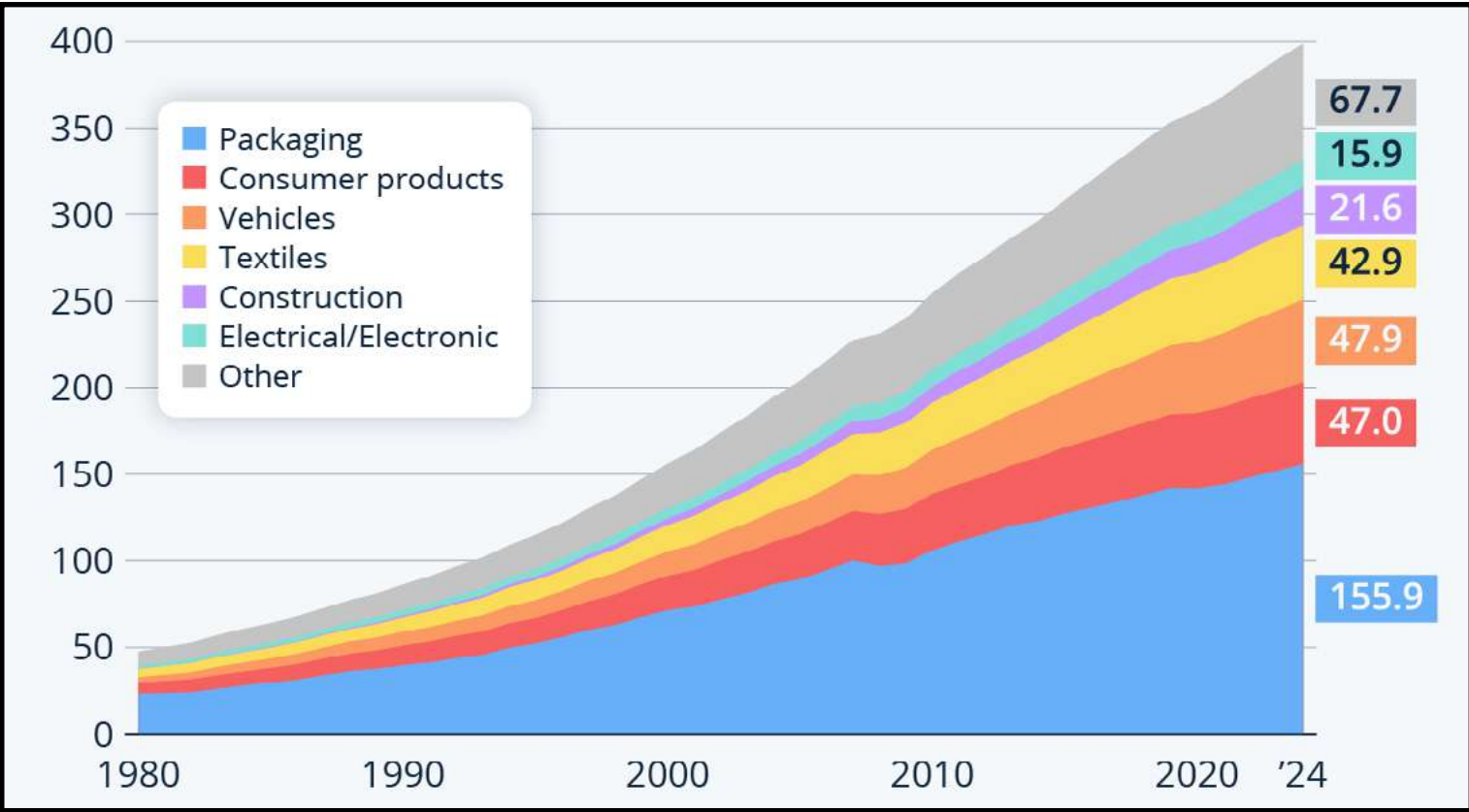
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The Global plastic waste production by application (in million tonnes) by Anna Fleck

tons of environmental waste via rivers and urban runoff. In Sri Lanka, the impact of plastic waste is highly evident along popular tourist beaches and fishing harbors, where plastic fragments and microplastics are found in vast amounts. Studies funded by the National Aquatic Resources Agency (NARA) have shown that rivers and canals are major conduits for plastic debris into the coastal waters, where they pose a direct threat to marine biodiversity and fisheries-based livelihoods. A study of the Rawana-Oya tributary in Sri Lanka found microplastics in both stream water and sediments, predominantly fibers and fragments, with higher concentrations in sediments.

Transitioning toward a circular economy, implementing extended producer responsibility (EPR), promoting biodegradable alternatives and strengthening recycling infrastructure are critical strategies for long-term mitigation. Moreover, plastics persist in the environment for long periods due to their resistance to degradation. Addressing this crisis requires improved community education, stricter policy enforcement, and enhanced waste management systems.



Jaraniya Rasenthira
S/19/067







Guardian of the Green Sri Lanka

Protecting Sinharaja, Sri Lanka's Living Treasure

Few places on Earth are as alive as Sinharaja Rainforest. Nestled in the wet zone of south-western Sri Lanka, this UNESCO World Heritage Site is not just a forest, it is a pulsating cradle of biodiversity, a natural laboratory of animal behavior, and one of the last great strongholds of Sri Lanka's wild heritage.

Sinharaja, meaning "Kingdom of the Lion," has an aura that captivates every visitor. Mist drapes its emerald canopy, cicadas pulse in rhythmic waves, and troops of purple-faced langurs leap between trees in choreographed arcs. To walk here is to enter a realm where life thrives in every fold of bark, every trickle of stream, and every shaft of sunlight filtering through the leaves.

A Hotspot of Biodiversity

Sri Lanka is recognized as one of the world's 36 biodiversity hotspots, and Sinharaja Rainforest is its shining jewel. Despite covering only 11,187 hectares, the forest shelters an extraordinary concentration of life found almost nowhere else. Over 60% of the tree species here are endemic, with botanists recording more than 190 species of trees and woody climbers, many of which are classified as rare or endangered. Towering dipterocarps, wild cinnamon, and a dazzling variety of orchids make Sinharaja a living repository of evolutionary history.

The animal life is equally remarkable, with surveys documenting over 147 bird species, including 19 out of the 20 endemic species recorded in Sri Lanka. The iconic Sri Lanka blue magpie, green-billed coucal, and red-faced malkoha are just a few examples. A highlight for ornithologists is the phenomenon of "mixed-species bird flocks," where up to 30 different bird species move together in coordinated groups, a survival strategy that reduces predation and improves foraging success.

Mammals thrive here too, with at least 45 recorded species, including the endangered purple-faced langur, the small Indian civet, and the elusive Sri Lankan leopard. Reptile diversity is no less impressive, with over 65 species, many of them endemic. Amphibians, often considered sensitive indicators of forest health, are exceptionally diverse, with over 20 species of frogs identified in Sinharaja, many found nowhere else on Earth.



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The invertebrates are just as vital to the ecosystem. Butterflies such as the Sri Lanka rose and the tree nymph flit across sunlit clearings, while countless insect species, still being discovered, drive pollination, decomposition, and the unseen machinery of the forest. Insects such as army ants march relentlessly across the forest floor, flushing out prey for waiting birds, creating dynamic interactions that ripple through the food web. Male tree frogs compete for mates by inflating their throats to produce resonant calls that echo long after rainfall, displaying remarkable endurance and intricate behavioral adaptations.

Even the plants demonstrate fascinating strategies. Certain dipterocarp trees exhibit mast fruiting, producing seeds simultaneously only once every several years. This overwhelms seed predators, ensuring that at least some seeds survive to germinate. Orchids, ferns, and lianas form intricate ecological networks that support countless pollinators and provide shelter and food for animals of all sizes. These interactions highlight the complex interdependence of life in Sinharaja, where the survival of one species is often intricately tied to the behavior or timing of another.

In total, scientists estimate that nearly 50% of Sri Lanka’s endemic wildlife is concentrated within Sinharaja. This density of unique life forms, coupled with the extraordinary behavioral adaptations of its inhabitants, makes the forest not just a national treasure but a global priority for conservation. The forest is a living laboratory where each species, from the smallest ant to the largest predator, plays a vital role in sustaining the delicate balance of this rainforest ecosystem.

Threats on the Horizon

For all its richness, Sinharaja is not invincible. Encroachment, illegal logging, poaching, and shifting cultivation have historically chipped away at its borders. Though large-scale logging has been banned since the 1970s, subtle threats remain climate change alters rainfall cycles, invasive species challenge native plants, and the pressure of tourism, if unmanaged, risks disrupting fragile habitats.

Equally concerning is the gradual loss of buffer zones around the rainforest. Villages bordering Sinharaja often depend on firewood, small-scale agriculture, and forest products for survival. When these needs clash with conservation policies, the forest silently bears the cost.

Protecting Sinharaja is not just an environmental necessity it is a cultural duty. Sri Lanka’s deep history of reverence for nature finds expression here. Ancient chronicles speak of “Vana Sampatha” the wealth of the forest seen not only as a resource but as a living heritage. Conservation strategies must be multi-layered. Strengthening community engagement is crucial. Local people must benefit from preserving the forest, whether through sustainable eco-tourism, guided tours, or participatory forest management. Education, especially among younger generations, is key to nurturing long-term stewardship. Scientific research plays an equally important role. Continuous monitoring of species populations, climate patterns, and ecological interactions allows conservationists to anticipate threats before they become irreversible. Global collaboration, too, is essential;



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Sinharaja’s value is not only national but universal.

A Call to Protect Sinharaja

Sinharaja Rainforest stands as one of the most fragile and irreplaceable ecosystems in the world. Its chorus of cicadas, the vivid flash of a blue magpie’s wing, and the scent of wild cinnamon drifting through the canopy are not luxuries, but living legacies. These natural wonders are part of what makes Sri Lanka unique on the global map of biodiversity.

Safeguarding Sinharaja cannot be left only to conservationists or policymakers. It is a shared responsibility, requiring collective effort whether by reducing ecological footprints, supporting responsible tourism, or raising awareness of the treasures hidden within its green walls.

At a time when the planet faces critical environmental challenges, protecting Sinharaja is about more than preserving a single rainforest. It is about securing the very soul of Sri Lanka’s natural heritage for generations yet to come.

Sanduni Sewmini
S/20/164



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Why We Need to Think Like ECOLOGISTS

Balancing Humans and Nature

In the 21st century, humans face unprecedented environmental challenges, including climate change, deforestation, pollution, and biodiversity loss. Despite scientific advancements, society often continues to treat nature as an inexhaustible resource, ignoring the complex relationships that sustain life. In this context, ecological thinking is no longer limited to scientists—it is a necessary mindset for everyone. Ecology is the study of interactions between organisms and their environment. Thinking like an ecologist means understanding that the world functions as an interconnected system where every action has consequences. Humans are not separate from this system; rather, we are deeply embedded within it. Everyday decisions—such as land use, food production, and resource consumption—have ripple effects across ecosystems.

For example, clearing forests for agriculture may provide short-term benefits, but it also disrupts soil fertility, water cycles, and wildlife habitats. The loss of even a single species can trigger cascading effects, altering food webs and ecosystem stability.

Ecological thinking encourages us to consider these long-term impacts instead of focusing only on immediate gains. This perspective is especially relevant in daily life. Poorly planned urban development can increase flooding by disrupting natural drainage systems. Excessive use of chemical fertilizers may improve crop yields temporarily but ultimately degrades soil and pollutes waterways. Even introducing non-native plant species can harm biodiversity by outcompeting native flora. Recognizing these connections allows individuals and communities to make more sustainable decisions.

Sri Lanka, a tropical biodiversity hotspot, highlights both the importance and urgency of ecological thinking. The country's forests, wetlands, and coastal ecosystems support a remarkable diversity of life, including many endemic species. However, increasing human activities such as urbanization, agriculture, and tourism have placed significant pressure on these ecosystems. One of the most visible issues is human-elephant conflict. As forests are cleared, elephants lose their natural

habitats and move into agricultural lands, causing damage and loss of life. Preserving wildlife corridor, natural pathways that connect fragmented habitats, can reduce these conflicts while maintaining ecological balance.

Deforestation in regions such as Knuckles, Horton Plains, and Sinharaja further illustrates the consequences of ignoring ecological principles. Forests in these areas regulate water cycles, prevent soil erosion, and support biodiversity. Their destruction not only threatens wildlife but also reduces water availability for human populations. Similarly, wetland degradation in areas like Muthurajawela and Colombo's marshes reduces natural flood control and water purification, increasing risks to both people and ecosystems. Globally, ecological imbalance is evident in many forms. Climate change, driven by greenhouse gas emissions, is altering habitats, shifting species distributions, and increasing extreme weather events. Overfishing has depleted marine populations, disrupting ocean food webs and threatening food security. Deforestation in regions like the Amazon contributes to biodiversity loss and climate instability. Pollution—particularly plastic and chemical waste—continues to damage ecosystems and human health. These issues highlight the importance of ecosystem services, the benefits humans derive from nature. Forests store carbon, wetlands filter water and reduce floods, and pollinators such as bees are essential for crop production. When ecosystems are degraded, these services are compromised, often with serious consequences for human well-being.

Biodiversity is central to ecosystem stability. Each species plays a unique role, whether as a predator, prey, pollinator, or decomposer. The loss of species can disrupt ecological balance and lead to system collapse. For instance, the removal of top predators can cause herbivore populations to increase uncontrollably, resulting in habitat degradation. Ecological thinking helps us recognize these relationships and take actions



that preserve biodiversity. Encouragingly, several conservation efforts demonstrate the value of ecological thinking. In Sri Lanka, wildlife corridors have helped reduce human-elephant conflict. Forest restoration projects in areas like HortonPlains and Knuckles have improved biodiversity and stabilized ecosystems. Wetland rehabilitation in Colombo and Negombo has enhanced flood control and water quality. Community-based conservation initiatives, which combine local knowledge with scientific approaches, have also proven effective in promoting sustainability. As zoology students and future scientists, we have a critical role to play. Our work contributes to understanding ecological relationships and developing solutions to environmental challenges. Beyond research, we can engage in awareness programs, citizen science, and community-based conservation. Promoting sustainable practices and influencing policy decisions are also essential responsibilities. Ultimately, thinking like an ecologist means recognizing that humans are part of nature, not separate from it. Protecting ecosystems is not only about conserving wildlife—it is about ensuring human survival. Sustainable development requires balancing human needs with environmental protection, guided by long-term thinking. In a rapidly changing world, ecological thinking provides a framework for making responsible decisions. By understanding interconnectedness, valuing biodiversity, and prioritizing sustainability, we can work towards a future where both humans and nature thrive together.

Shyamali Herath
S/19/031

Parasites are typically defined as organisms that require another to exist, often detriment of the host. However, they can also be defined as organisms that live in or on another organism and exploit that organism causing harm. This harm typically results from the parasite’s specific adaptations to the host environment. Considering the matter more from a food web perspective, parasites may be regarded as “predators that eat prey units of less than one.” Hence, the relationship between parasites and their hosts is described with an emphasis on food webs and ecosystem concepts. Wildlife conservation is concerned with the conservation of species and ecosystems. It can be defined as the practice of protecting wild species and their habitats to maintain healthy wildlife populations and to prevent species from going extinct. This emphasizes the need for comprehensive measures in conserving both species and their habitats to ensure their survival against environmental threats.

Parasites play a very important and often overlooked role in ecosystems. Parasites are a major force of nature, acting upon host populations, exerting influence upon community dynamics, and contributing to nutrient cycling and energy flows. Parasites maintain ecological balance by influencing host abundance and food web stability. Besides being crucial in coevolution, parasites place selective pressure on the host organisms to develop defenses and behaviors. Such evolutionary interactions mold biodiversity and the adaptive behaviors of species over time. These complex relationships illustrate how parasites dictate the existence of an individual species while also shaping the evolutionary path of entire lineages. Furthermore, parasites

serve as useful environmental bioindicators. Certain parasites such as helminths may be used as indicators of pollution in aquatic ecosystems, including monitoring heavy metals. In effect, this makes parasites tools for conservation besides ecology.

Parasites hold the key to environmental interactions but also pose great threats to human health through the transmission of zoonotic and emerging diseases. Possibly arising in wildlife, a spectrum of parasitic infections can shift into humans. Anyone who can jump the interspecies barriers has become more worrisome, including health issues of grave concern to the general population. There is an increasing threat of parasitic diseases to global public health, especially in response to rapid environmental changes, followed by human encroachment of natural habitats, thereby increasing transmission opportunities. Given this situation, these parasites must be well understood for the purpose of preventing and curbing future outbreaks.

The growing emergence of zoonotic diseases is closely associated with man-managed environmental changes, especially the loss of biodiversity and expansion of cattle agriculture. Global growth in zoonotic outbreaks is correlated with acute cattle production and natural habitat erosion. As

humans invade the areas of wildlife, the possibility of transmission of diseases increases from animals to humans. Low biodiversity interrupts ecological balance, usually leading to the domain of species that are efficient reservoirs of disease. On the other hand, rich ecosystems in various species regulate and dilute the proliferation of pathogens, reducing the risk of zoonotic transmission. These conclusions underline the important requirement of



integrated approaches that consider ecological health in efforts to avoid future epidemics. The traditional approach to the parasite has been primarily negative, as they are often considered harmful to both human health and ecosystems. Historically, the parasites have been targeted for abolition due to their cooperation with disease and disintegration of ecological balance. However, recent approaches challenge this approach, raising the central question: are parasites only a threat, or can they be an important contributor to the ecosystem? Although it is true that some parasites are highly harmful and should be managed with available resources, a growing belief suggests that parasites can play an important role in maintaining biodiversity and the health of the ecosystem. Therefore, in addressing global environmental changes, it may be necessary to integrate the parasite into conservation strategies.

Parasites face a growing risk of extinction due to various factors. Climate change disrupts their habitats and host interactions, making survival increasingly difficult. Additionally, many parasites experience “double jeopardy,” where they are vulnerable both directly from environmental changes and indirectly through their hosts’ decline. Their complex life cycles, which often depend on multiple host species and specific environmental conditions, further heighten their susceptibility to extinction. These challenges highlight the precarious future of parasitic species in a rapidly changing world.

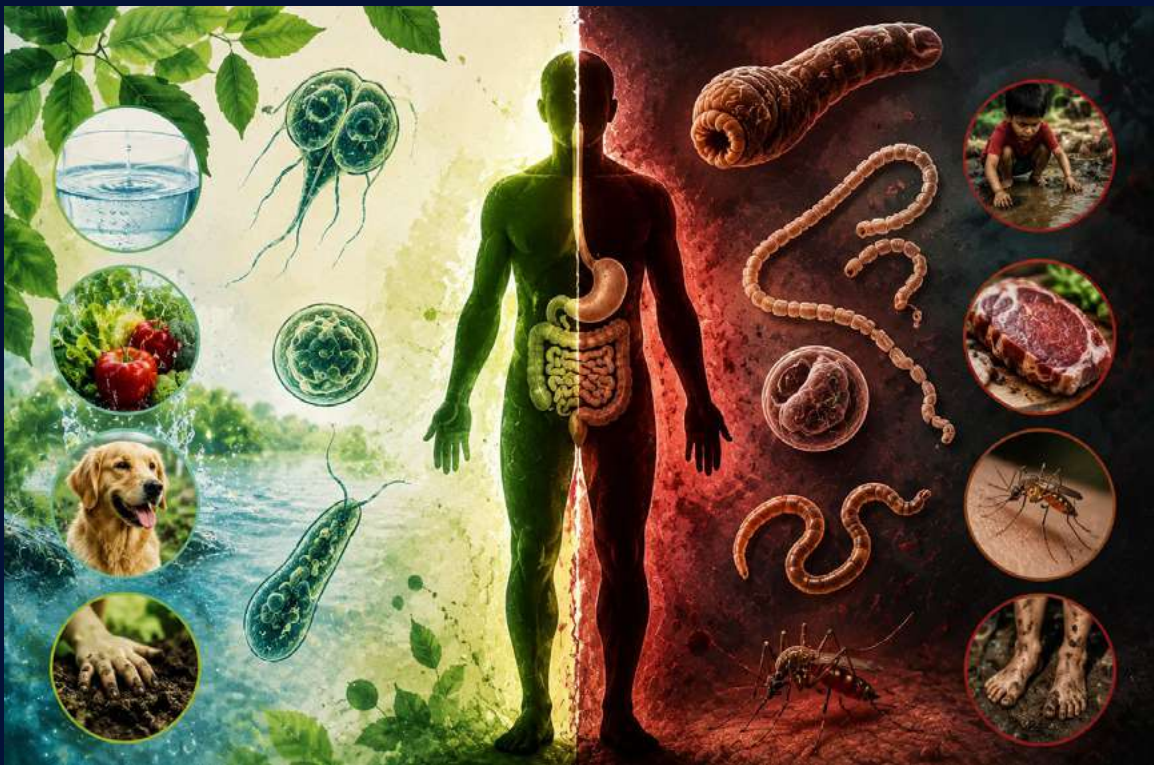
While parasites face threats, they also pose risks. Parasites pose significant dangers to host individuals and populations, specifically below environmental stressors including pollution or climate change, which can weaken host immunity and enhance parasitic success. While parasitic illnesses do not often force extinctions independently, they often act synergistically with other threats like habitat loss to accelerate population declines. Climate warming exacerbates these dangers by expanding the geographic range and activity of parasites, increasing their transmission rates. Human activities, together with wildlife translocation without parasite management, furthermore expand disease spread, as seen in instances in which invasive species introduce novel pathogens or enlarge local parasites through spillover and spillback dynamics. These interactions underscore the need to integrate parasite ecology into conservation strategies to mitigate unintended consequences.

Parasites play an essential ecological role in that ecosystems support health and stability. Their presence can serve as a bioindicator; for example, some trematodes firmly reflect environmental pollution levels, helping monitor ecosystem conditions. A rich parasitic community also indicates a healthy and diverse host population, as the parasites require multiple host species at sufficient densities. In terms of energy dynamics, parasites such as trematodes contribute adequate biomass to food webs, sometimes in aquatic ecological systems and serve as a food source for the species, crossing the insect biomass in aquatic ecosystems. In addition, the parasitic food web increases connectivity and stability, especially with complex life cycles, which create long, weak interaction loops that unbalance the unstable effect of high species richness. Even microorganisms, like viruses, help stabilize nutrients through mechanisms such as “viral shunts,” which recycle organic materials in marine systems. Therefore, the protection of the parasites is important to maintain the functioning of the ecosystem under especially multi-faunal life cycles.

So, it is clear that the role of parasites in the ecosystem is more complex than traditionally understood. Many studies agree that parasitic biodiversity and ecosystem contribution to function, yet the subject of parasitic protection is often ignored or contacted

with moral concerns. Interestingly, researchers are divided on how the parasites affect their host’ s stress and physical damage, while others suggest that the effects are minimal or short-lived. This disagreement extends to conservation strategies, where some scholars advocate to include parasites as part of ecological protection, while others prioritize risks that they pose and exclude them completely. Despite these differences, the one that stands out is an attempt to synthesize conclusions from various ecological systems and to bridge parasitic biology with conservation practice. However, the research is limited in the realm, especially about tropical ecosystems, and is often based on short-term or laboratory-based studies. This makes it difficult to fully understand the long-term ecological roles the parasites can play in the wild.

The dual role of parasites in the ecosystem suggests that they are not only pathogens but also major players in regulating the host population, driving evolutionary processes, and maintaining ecosystem stability. Current conservation strategies often ignore or actively ignore parasites, which risk the incidence of coordination and disrupt ecological balance. A more refined approach is required, one that recognizes the parasite as contributors required for potential hazards and biodiversity conservation. To pursue this region, future research should be expanded beyond specific host-parasitic systems and a wide range of geographical areas. Integrating parasites, especially non zoonotic is important to ensure overall ecosystem management in the conservation structure of host specific species. Additionally, prioritizing field based and long-term studies will provide deep insight into real world effects and parasitic benefits, and reduce the difference between theoretical knowledge and practical protection efforts. By adopting these strategies, the scientific community can promote a more balanced and informed perspective on the role of parasites in biodiversity and the health of the ecosystem.



Isuru Wijerathna
S/18/165

IMPORTANCE of integrating GENETIC KNOWLEDGE into animal BIODIVERSITY CONSERVATION

Animal biodiversity conservation is one of the frequently discussed topics in the 21st century. It can simply be stated as the strategic act of protecting endangered and threatened animals and their natural habitats. The fundamental goal is to maintain animal biodiversity at a high rate to secure both the existence of species and the balance of ecosystems. Conservation methods focus on three main components of biodiversity: organismal, ecological and genetic diversities. Organismal diversity is typically observed at the species level. Ecological diversity spans a vast spectrum from populations to biomes. Genetic diversity comprises the genetic factors that govern the variable survival and adaptation of organisms.

Conservation practices are mainly categorized into two approaches: in-situ conservation and ex-situ conservation. In-situ conservation ensures the protection of a specific species in its natural habitat (e.g., national parks, sanctuaries). It is preferred as it does not alter the inherent relationships of species with their ecosystems involved. Ex-situ conservation techniques are typically conducted for species that are critically endangered. They were protected under controlled conditions outside of their natural habitats (e.g., zoos). In-situ techniques address biodiversity loss while not changing the natural selective pressures act on species evolution. Ex-situ methods are ideal for species on the verge of extinction, and for

those that constantly face environmental pressures; both biotic (e.g., predation) and abiotic (e.g., climatic changes).

However, the above two well-defined structures have not always taken the expected turn. In-situ National parks and sanctuaries are confined to a limited area. Small captive populations of land-dwelling animals may be susceptible to inbreeding depression and genetic drift, leading to a decline in genetic variation in the long run. The Florida Panther (*Puma concolor coryi*), native to the southeastern USA, was under the protection of the state of Florida in 1958. It was observed that the population size declined to fewer than 100 within a century. Prolonged isolation-led inbreeding resulted in a high frequency of genetic defects (e.g., heart and sperm defects, undescended testicles in males) in many Panthers. Ex-situ conservation mainly focuses on raising the population size of endangered animals. These animals are



protected under careful management that may involve little or no involvement with their native predators or challenges with hunting and mating (captive breeding). It is an ideal decision in the short term, but issues can arise in the reintroduction process. The captive breeding program for the Black-footed ferret (*Mustela nigripes*) was conducted for all the remaining 18 individuals in Wyoming. By 2013, the number had grown to over 300. The

researchers expected 10 self-sustaining populations after reintroduction. According to the results, as of 2019, only 2 of 29 reintroduced sites were in the expected condition, with a total wild population size of 325. The major cause was mortality, a consequence of the reduced adaptation to avoid natural predators, the prairie dogs and the repeated outbreaks of Sylvatic plague.

Black-footed ferret (*Mustela nigripes*)

The above scenarios suggest the neglect of a significant factor that tailors the survival of species, genetics and genetic diversity. Genetic diversity can be described as the variations in genetic characteristics that are possessed by a species for its survival or adaptation. A higher rate of diversity implies higher adaptability to altering environmental conditions and pressures. This improves population health, ensuring their existence in the long run. The number of variations in a population's gene pool can be raised by several means: increasing population size, promoting gene flow between different populations (migration), and introducing advantageous changes to existing genes using genetic engineering.

Understanding the crucial role of genetics turned the fall-backs into success stories. In the 1990s, conservationists implemented a technique called genetic rescue. Eight healthy females of the Texas cougar (*Puma concolor stanleyana*), who are closely related to the Florida panther, were introduced into

the Florida panthers' habitat. The final data revealed that the hybrid kittens have about a three times higher chance of reaching adulthood, and the hybrid females have a better survival rate than that of purebreds. This eliminated the effect of harmful genes accumulated due to inbreeding, improving health and fitness in their own habitat. Likewise, scientists were able to put a stop to the continuous decline of ferrets. In 2014, it was discovered that a ferret (Willa) that died in 1988 with no descendants had thrice as many genetic variations in comparison to



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the living population. This implies a severe decline in their genetic diversity. In 2020, scientists successfully cloned a ferret from the preserved DNA of Willa, reintroducing its traits which remained resilient even after restoration. Further research hopes to provide resistance to sylvatic disease through gene editing techniques.

The integration of genetic methods into traditional conservation strategies addresses issues that may be overlooked. It assesses whether the inherent capabilities of remaining individuals are strong enough to combat extinction. Separate focus on different populations rather than whole species allows for more suitable strategies based on local adaptations. This core realization allows to design and implementation of more effective solutions for the conservation of biodiversity.

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Florida Panther (*Puma concolor coryi*)

Janani Dissanayake
S/21/041

Masters of the Night

Microchiroptera & Megachiroptera

An In-Depth Look at Nature's Aerial Acrobats



Soaring silently through the twilight, bats have captivated and unnerved humans for centuries, often shrouded in myth and misunderstanding. Yet, these creatures are not creatures of horror but of wonder, representing one of evolution's most spectacular success stories. As the only mammals to have achieved true, sustained flight, bats have inhabited a nocturnal niche with a level of sophistication that is only beginning to be fully appreciated. Their story is one of incredible adaptation, spanning unique reproductive strategies, complex social behaviours, and biological engineering that rivals our most advanced technology. By peeling back the veil of the night, we discover that bats are not just fascinating flyers; they are indispensable guardians of global ecosystems, whose survival is intricately linked to our own.

The Ecological Roles of Bat Diets

The feeding strategies of bats have directly shaped their evolution and their critical roles within ecosystems. The nectar-feeding bats, such as the long-tongued bat, are not merely drinking from flowers; they are co-evolved partners in a delicate dance of survival. Their muzzles are elongated, housing tongues that can extend astonishingly far, often tipped with brush-like structures to lap up nectar. In return, they

transfer pollen from flower to flower, making them vital pollinators for hundreds of plant species, including the agave plant used to make tequila and many iconic tropical fruits. Without these bats, entire food webs and agricultural economies would falter.

Meanwhile, the insect-eating bats form the silent army of pest control. A single bat may consume hundreds of small insects in an hour, and a maternity colony can eat tons of insects each summer. Their impact on agriculture is staggering, saving farmers billions of dollars annually by reducing crop damage and the need for pesticides. Their hunting prowess is a direct result of their echolocation, allowing them to detect and capture evasive prey like moths, which have themselves evolved counter-measures to avoid bat sonar, creating a perpetual evolutionary arms race in the night sky.

The fruit-eating bats, or frugivores, are the forest gardeners of the tropics. Species like the Jamaican fruit bat consume vast quantities of fruit and, through their droppings, disperse seeds over great distances. This seed dispersal is crucial for forest regeneration, as it helps plants colonize cleared areas and maintains genetic diversity by connecting fragmented plant populations. In essence, they are actively planting the forests of tomorrow, ensuring the health and resilience of these vital carbon sinks.

Reproductive and Social Behaviours

The life history of bats is marked by strategies that maximize the survival of their slow-maturing, typically single offspring. Delayed fertilization is a remarkable feat

of biological timing. A female bat can mate in the fall, store the male's sperm alive but dormant in her reproductive tract throughout hibernation, and only trigger fertilization in the spring when conditions are optimal for raising young. This ensures that the energetically demanding processes of pregnancy and lactation coincide with the abundance of insects or fruit.

Furthermore, bats are profoundly social creatures. Communal roosting in maternity colonies, which can number in the millions, provides thermoregulatory benefits—huddling together keeps pups warm—and protection from predators. Within these colonies, parental care is intensive and sophisticated. Pup recognition is acute, with mothers locating their own offspring among thousands in a crowded cave through a combination of spatial memory, scent, and the pup's distinctive vocalization. They nurse their pups for weeks and will carry them on night flights until the young are capable of flight themselves, a testament to their maternal investment.

Anatomical Marvels and Aerodynamic Prowess

To understand a bat is to understand its flight. The bat wing is a masterpiece of evolutionary modification, fundamentally different from a bird's wing. It is a thin, elastic membrane of skin, called the plagiopatagium, stretched over dramatically elongated finger bones—essentially a webbed hand. This design provides an immense surface area, allowing for slow, highly manoeuvrable flight and even brief, controlled hovers.

The aerodynamic adaptations are equally impressive.



Bats possess highly flexible wrists and joints, enabling them to change the shape and camber of their wings with each flap. This allows for incredible agility, from sharp turns to rapid dives. The tail membrane, or uropatagium, stretched between their legs, acts as an air foil and rudder, providing additional lift and stability during complex manoeuvres. Their bones are not hollow like a bird, but they are exceptionally slender and lightweight, reducing the energy cost of flight. This unique combination of traits makes bats the most agile mammalian flyers, capable of flying through dense forests and cluttered caves with pinpoint accuracy.

The Mounting Threats to Bat Populations

Despite their resilience and adaptability, bats are facing unprecedented threats that have led to alarming population declines. Habitat loss is a constant pressure, as deforestation and urban development destroy the caves, trees, and abandoned buildings they rely on for roosting.

More acutely, White-Nose Syndrome has emerged as a catastrophic wildlife disease in North America. Caused by a cold-loving fungus, it invades the skin of hibernating bats, irritating them and causing them to awaken too frequently during winter. This burns through their crucial fat reserves, leading to starvation and death. Since its discovery in 2006, it has killed millions of bats across North America, pushing some species to the brink of regional extinction.

The push for renewable energy has also created an unintended consequence: collision with wind turbines. The pressure changes around spinning turbine blades can cause fatal lung damage in bats, even without a direct impact. This has made wind energy facilities a significant source of bat mortality, requiring careful siting and mitigation strategies like temporarily shutting down turbines during low-wind nights in migration seasons.

Finally, centuries of persecution fuelled by cultural myths and fears of

diseases like rabies have led to deliberate eradication efforts and vandalism of roosts. While some bats can carry diseases, the incidence is low, and the risk to humans is minimal with simple precautions, far outweighed by the benefits bats provide

Bats are far more than just “flying mice”; they are intelligent, socially complex, and ecologically vital animals. They pollinate our plants, disperse our seeds, and control our insect pests, services that underpin healthy ecosystems and economies. The challenges they face are significant, but they are not insurmountable. Through continued research, habitat protection, public education to dispel myths, and supportive policies for wind energy mitigation and disease research, we can change their trajectory. By learning to appreciate the complexity of these fascinating nocturnal flyers, we can transition from a history of fear to a future of stewardship, ensuring that the night sky remains filled with these remarkable guardians of our planet.

Paramee Madawala
S/19/101

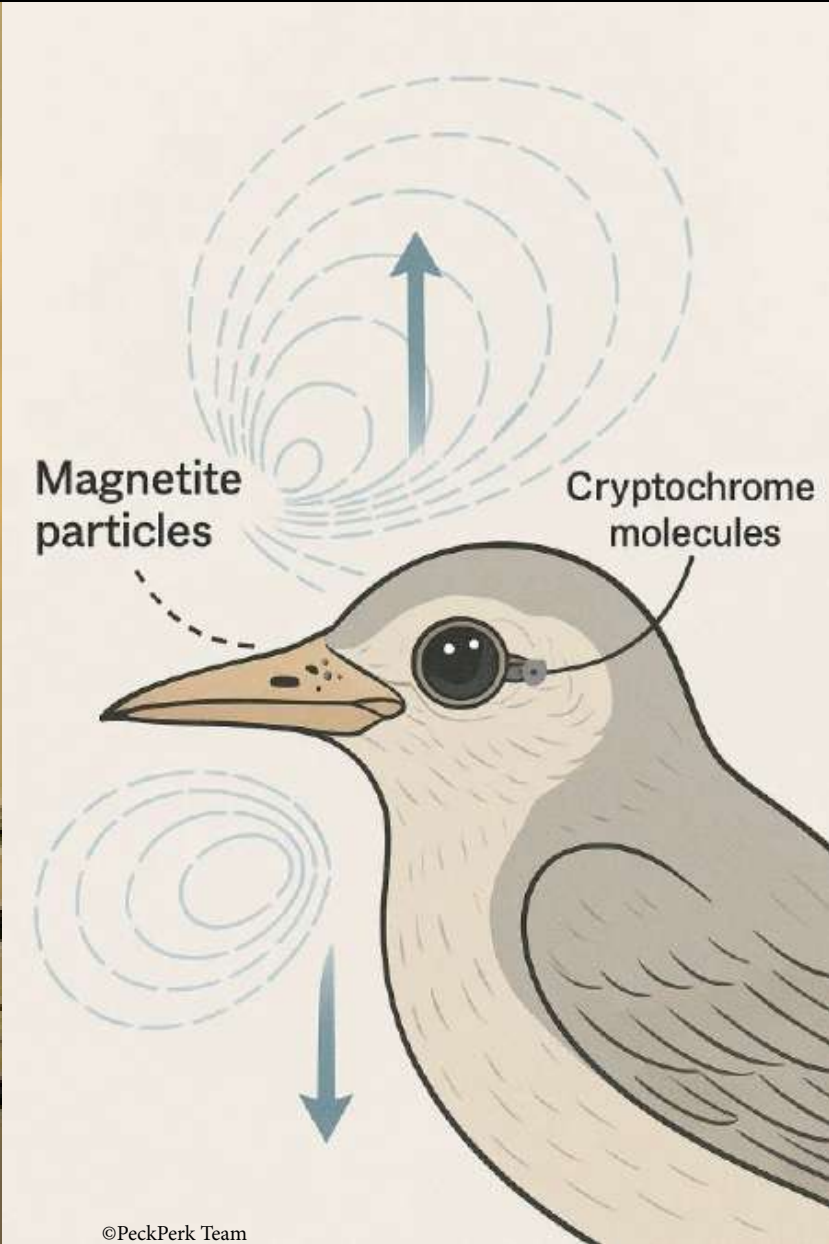
Migratory How Birds Navigate Across the Globe arvels

Introduction

Bird migration is one of the most remarkable biological phenomena, involving seasonal journeys that can span thousands of kilometers across continents and oceans. For decades, researchers have sought to understand how birds navigate with such precision. Increasing evidence demonstrates that birds rely on a suite of orientation mechanisms, most notably the ability to perceive Earth’s magnetic field, a process known as magnetoreception. This article explores the history of migration research, the biological basis of magnetoreception, complementary navigation systems, case studies of migratory species, and the challenges birds face in a changing world.

Every year, billions of birds embark on extraordinary migratory journeys, traversing mountains, deserts, and oceans to reach breeding or wintering grounds. The Arctic tern (*Sterna paradisaea*), for example, travels nearly 70,000 km annually between the Arctic and Antarctic, making it the longest known migration of any animal.

Early naturalists believed birds relied on instinct or even mythical transformations, but modern research demonstrates that migration involves multiple orientation systems. Birds



use celestial cues, olfactory signals, landmarks, and, crucially, Earth’s magnetic field. Magnetoreception provides a universal compass, enabling orientation even in featureless environments such as oceans or cloudy skies.

A Brief History of Bird Migration Research

The mystery of migration has fascinated humans for centuries. Ancient Greeks believed swallows hibernated underwater during winter, while Aristotle suggested that small birds transformed into larger species.

Concrete evidence for migration emerged in 1822, when a white stork in Germany was found with a Central African spear embedded in its body. By the 20th century, bird banding, radar, and later satellite telemetry revealed the precision and consistency of migration routes. These tools showed that migration is not random but carefully oriented across continents.

Mechanisms of Bird Navigation:

- **Celestial Cues:** Birds use the position of the sun during the day and star constellations at night. Indigo buntings, for example, learn star patterns to guide nocturnal migration.
- **Landmarks and Topography:** Rivers, coastlines, and mountain ranges provide orientation for experienced migrants. Homing pigeons rely on familiar landscapes near their nests.
- **Olfactory Cues:** Some seabirds and pigeons use ‘odor maps’ by detecting regional scent signatures carried by the wind.
- **Earth’s Magnetic Field:** Magnetoreception allows birds to detect both the inclination angle (the tilt of field lines relative to Earth’s surface) and field intensity, giving them both a compass and a map-like sense of location.

Biological Basis of Magnetoreception

The Quantum Compass in the Eyes: Birds perceive magnetic fields through cryptochrome proteins (Cry4) in the retina. When exposed to blue light, these proteins produce radical pairs whose reactions are influenced by Earth’s magnetic field. This process may create a visual overlay of magnetic lines, effectively allowing birds to ‘see’ magnetic patterns.

This system works as an inclination compass:

- Near the poles, magnetic field lines point steeply downward.
- Near the equator, they run horizontally.

Birds use this dip angle to determine whether they are flying poleward or equatorward.

Magnetic Map in the Beak: Tiny magnetite particles in the beak, linked to the trigeminal nerve, are thought to sense field strength. Since magnetic intensity varies globally, this provides geographic information, helping birds determine latitude and recognize ‘stop signs’ along their route.

Integration in the Brain: Functional imaging shows that the cluster N region of the avian brain processes geomagnetic information, particularly in nocturnal migrants. Birds likely integrate both the retinal compass and beak-based intensity sensing for robust orientation.

Integration of Multiple Navigation Systems

Magnetoreception does not work in isolation. Birds combine it with:

- **Solar compass:** sun position plus circadian rhythms.
- **Star compass:** learned constellations for nocturnal orientation.
- **Visual landmarks:** geographic features near destinations.
- **Olfactory cues:** scent-based regional mapping.

This redundancy ensures accuracy even under challenging conditions.

Experimental Evidence for Magnetic Orientation

In the 1950s, Gustav Kramer’s orientation cage experiments showed that even birds in dark rooms, unable to see the sky, oriented correctly using geomagnetism. By artificially altering magnetic north with coils, Kramer demonstrated that birds responded predictably, providing strong evidence for a genetically encoded magnetic compass.

Challenges in a Changing World

- **Magnetic Field Disturbances:** Solar storms and anomalies can cause disorientation.
- **Light Pollution:** Artificial lighting interferes with both celestial and magnetic orientation, leading to mass collisions in cities.
- **Habitat Loss:** Migrants need stopover sites for rest and feeding; deforestation and wetland loss reduce survival chances.
- **Climate Change:** Altered seasons disrupt the timing of migration relative to food availability.

Conservation Implications

To ensure the survival of migratory birds, conservation must address navigational and ecological needs:

- Protecting international flyways and stopover sites.
- Reducing light pollution in urban areas.
- Monitoring infrastructure impacts on geomagnetic sensitivity.
- Adjusting conservation areas to account for shifting migration routes.

Broader Significance for Science

Magnetoreception research not only deepens understanding of avian biology but also inspires technology, such as bio-inspired navigation systems and autonomous drones. Birds, as global connectors, highlight the interdependence of ecosystems across continents.

Conclusion

Bird migration is a biological marvel enabled by a sophisticated set of navigational mechanisms, with Earth’s magnetic field at its core. Birds combine quantum effects in the eye, magnetite-based sensing in the beak, and brain integration with celestial, visual, and olfactory cues.

As environmental challenges grow, protecting migratory species requires both scientific insight and global conservation efforts. Migration is more than a spectacle—it is a powerful demonstration of adaptation, resilience, and the deep ties between life and Earth’s geophysical systems.

Naroshani Govindarajas/20/111



"The sea, once it casts its spell, holds one in its net of wonder forever."

— Jacques-Yves Cousteau (Oceanographer)