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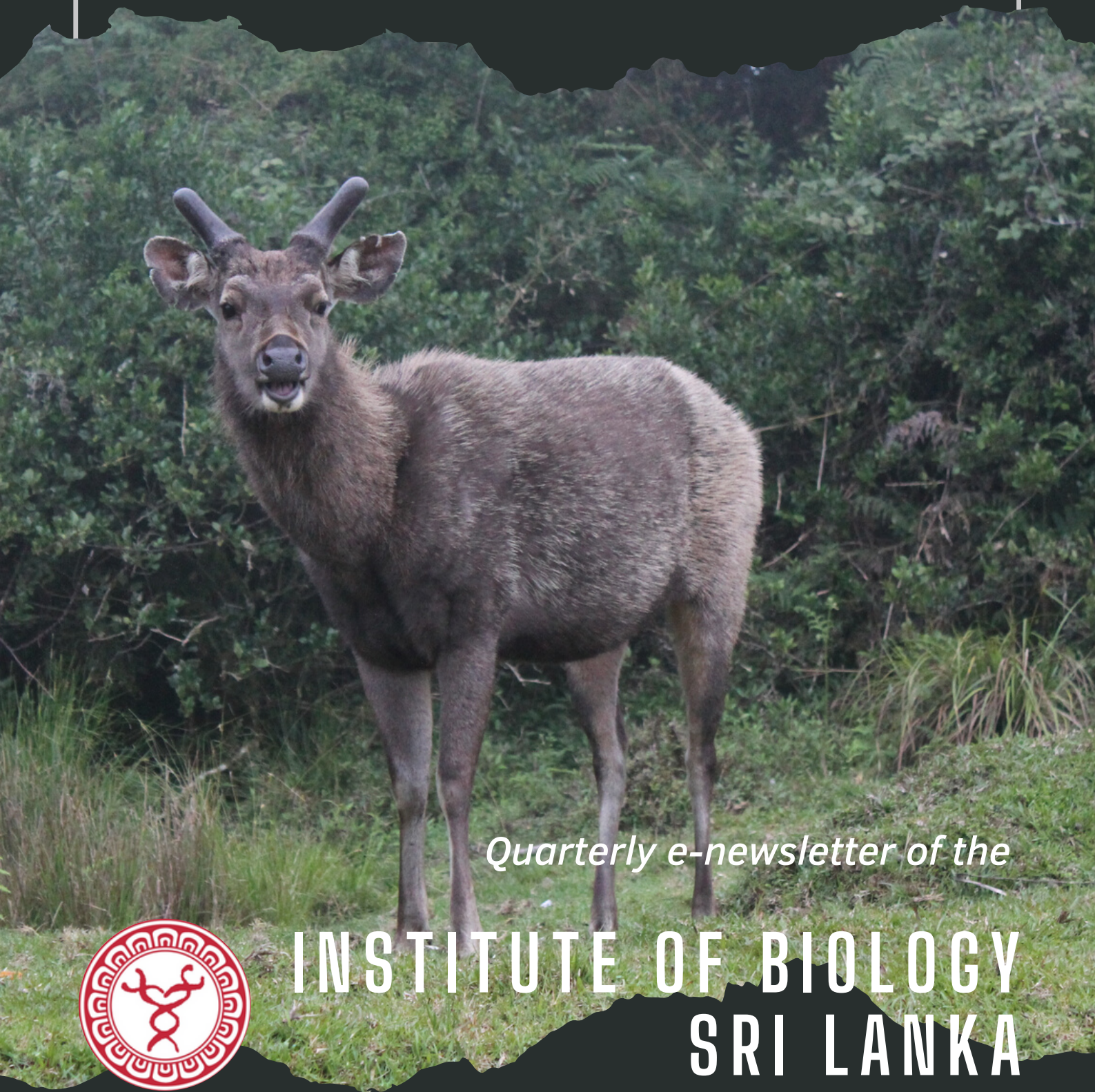
E-NEWSLETTER



Quarterly e-newsletter of the

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COVER STORY

The Sri Lankan sambar or Indian sambar (*Rusa unicolor unicolor*), also known as gōṇā in Sinhala, is a subspecies of the sambar that lives in India and Sri Lanka. It is the largest species of deer found in Sri Lanka. Males have impressive antlers and a dark brown coat, while females lack antlers and have a lighter brown coat. They are generally solitary animals and can be found in various habitats, including forests, grasslands, and wetlands. Sambar deer primarily feed on grass, leaves, fruits, and young shoots. They have excellent sense of hearing and smell, which helps them detect potential predators. Sambar deer is classified as "Least Concern" by the IUCN. However, populations within specific regions or habitats may face varying levels of threat due to factors such as habitat loss, hunting, and competition with other species.

Photograph by Dr. Saminda Fernando
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IOBSL NEWS AND EVENTS

INTERNATIONAL BIOLOGY OLYMPIAD

The IOBSL takes immense pride in fostering and nurturing our exceptionally talented youth, providing them with guidance and mentorship as they strive for excellence in the field of biology. Four students, Janithya Sanathmi Rajasekara (Maliyadeva Balika Vidyalaya, Kurunegala), Rahal Nalina Bandara Walisundara (Trinity College, Kandy), Kisara Hirun Manimelwadu (Ananda College, Colombo 10), and Senithi Vidusini De Alwis (Sanghamiththa Balika Vidyalaya) participated in the International Biology Olympiad Contest held from 3-11 July 2023 at UAE University in Al Ain, United Arab Emirates. Prof. Hiran Amarasekera (University of Sri Jayawardenapura) and Emeritus Prof. M. J. S. Wijerathne (University of Kelaniya), who are members of the IOBSL, graciously served as jury members.

The applications are now open for the Sri Lankan Biology Olympiad 2023.
For more information, please visit the IOBSL webpage.

Do not miss out on this exciting opportunity to showcase your biology knowledge and skills!

INTER-UNIVERSITY BIOLOGY QUIZ COMPETITION

The Inter-University Biology Quiz Competition was organized by the IOBSL for the 6th consecutive time, targeting undergraduates from the state and other UGC-approved universities in Sri Lanka. The competition consisted of two stages: Stage I was conducted online through the Learning Management System (LMS), and Stage II took place at the Department of Zoology and Environment Sciences, University of Colombo. Stage I was held on 18th June 2023 with the participation of 86 undergraduates. Based on their performance, 13 students were selected to proceed to Stage II of the quiz competition, which was held on 30th July 2023. Stage II encompassed MCQs and short answer questions, followed by a 3-minute talk on a chosen topic from a list of 10 provided topics. The winners will receive medals and certificates at the IOBSL Annual Sessions which will be held on the 22nd September 2023.

GOLD MEDAL
Mr. R. A. Pasindu Eranga
University of Sri Jayawardenapura

SILVER MEDAL
Ms. G. C. Amaya Perera
University of Colombo

BRONZE MEDAL
Mr. M. P. Charith Yohan
Sri Lanka Institute of Information Technology

Congratulations to the winners!

SUCCESSFUL COMPLETION OF 'STATISTICS FOR BIOLOGISTS' SHORT COURSE SERIES

We are thrilled to announce the successful conclusion of the 'Statistics for Biologists' short course series, organized by IOBSL. This comprehensive series aimed to equip participants with essential statistical skills tailored for the field of biology.

Under the guidance of our esteemed resource persons, Dr. Rushan Abeygunawardana, Dr. Dilshani Tissera, Dr. A. A. Sunethra, Dr. Gayan Dharmarathne, and Dr. Sameera Viswakula, participants gained valuable insights into applying statistical methods effectively in biological research. Their expertise and guidance greatly contributed to the success of this series.

We extend our heartfelt gratitude to all participants for their enthusiastic engagement throughout the series. The dedication shown by each participant was truly inspiring.

Stay tuned for more insightful and skill-enhancing initiatives from IOBSL in the future. For further updates and information, please visit our official webpage.

E-PHOTOGRAPHY COMPETITION

The *e*-Photography Competition 2023 has come to an end, leaving us in awe of the remarkable journey it has been. With over 250 captivating entries received, our chosen theme **"Hidden Biological Wonders"** truly sparked a wave of creativity that uncovered the mysteries of the natural world. We would like to extend our heartfelt gratitude to all participants who submitted their incredible work to this year's *e*-Photography Competition.

Stay connected with us on our social media platforms and website to receive updates on the winners. The certificates will be awarded at the Annual Sessions of the IOBSL.

IOBSL ANNUAL GENERAL MEETING AND ANNUAL SESSIONS

We are excited to announce a significant event on our calendar – the **IOBSL Annual General Meeting and Annual Sessions**. Mark your calendars for this important event:

- **Date:** 22nd September 2023
- **Venue:** Ariyana Reach Hotel, Maharagama

Keynote Speaker: Prof. B. Marambe (Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Sri Lanka)

We are honored to have Prof. B. Marambe, a distinguished figure in the field of Crop Science, as our esteemed keynote speaker. Prof. Marambe's expertise and pioneering contributions are sure to inspire and enrich our discussions.

We encourage all members to keep the 22nd September 2023 free on their calendars!

Submit your research to

Sri Lankan Journal of Biology (SLJB)

SLJB provides high quality, comprehensive and broad coverage in all areas of Biology. The journal publishes original scientific research articles that describe significant research findings. SLJB encourages the submission of original contributions in all fields of basic and applied research involved in Biological Sciences.

Read the submission guidelines

Integrative Conservation: An Effective and Efficient Tool for Biodiversity Conservation

The twin crises

Global climate change has an unparalleled impact, reshaping the macro and micro environments for all living organisms on our planet. Climate change, caused by both natural factors and human activities, has a significant impact on biodiversity, agricultural production, and food security, leading to the extinction of biological diversity. Despite conservation efforts, the International Union for Conservation of Nature (IUCN) has reported that approximately 28% of all assessed species are currently threatened with extinction. Although they are often treated separately, biodiversity loss and climate change are twin crises primarily caused by human activity. Therefore, one of the greatest challenges of our time is to safeguard global biological diversity from the negative impacts of unsustainable anthropogenic activities.

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Island biodiversity

Island biodiversity is globally and locally important due to its rich diversity, high endemism, and biogeographic significance. Moreover, island populations of flora and fauna are more vulnerable than mainland populations due to both human and natural interventions, as well as the occurrence of high levels of inbreeding. In addition to their unique ecosystem diversity, isolated islands are characterized by the presence of rare, endangered, and endemic taxa. Sri Lanka's biodiversity stands out in the region due to its rich diversity, high endemism, and its unique position in the Indian Ocean. The flora of Sri Lanka and their preferred habitats are also subjected to various threats, including deforestation, habitat changes, climate change, unsustainable development activities, and rapid socio-economic changes over the last 2-3 decades. Out of the total number of native and endemic seed plants in Sri Lanka, which is 3,087, including 863 endemics, approximately 48% have been classified as threatened species. Moreover, in the 1800s, Sri Lanka had a forest cover of 80%, but by 2010, it had been reduced to 25%. This indicates the urgent need for immediate action to safeguard this unique plant group and their habitats for conservation and sustainable management.

Conventional conservation strategies

The above facts highlight the critical need for the conservation of biological diversity in the face of changing climates and unsustainable land use patterns that result in habitat loss. Conventional conservation strategies primarily align with *ex-situ* and *in-situ* conservation methods. Furthermore, the country places great importance on safeguarding the protected area network and aims to expand it by acquiring biologically sensitive peripheral lands. Despite administrative difficulties, political pressure, and financial constraints, the responsible institutions and organizations are engaging in the challenging task of protecting the biological wealth of the country. However, even though the country's natural ecosystems and species have adequate legal protection, the biological diversity is eroding at an alarming rate. This indicates the importance of revisiting the existing conservation strategies.

Integrative conservation

Within this context, today, the Integrative Conservation (IC) approach is gaining widespread attention and discussion for its practicality and effectiveness in conserving biodiversity worldwide. IC is a multidisciplinary approach that integrates academic disciplines, socio-economic aspects, and professional and public engagement, with the aim of achieving sustainable management and conservation of biological diversity (Figure 1). This concept is not a new idea and has long been more or less practiced by traditional communities in the developing world. The IC approach was further shaped by conservation biologists, who added new dimensions and combined them with modern sciences. However, IC is now used for conserving biodiversity, particularly species and ecosystem conservation. Regardless of the type of organism and system, the conservation plan needs to integrate all related fields and stakeholders to achieve better outcomes. The conservation plan needs to align with the following aspects.

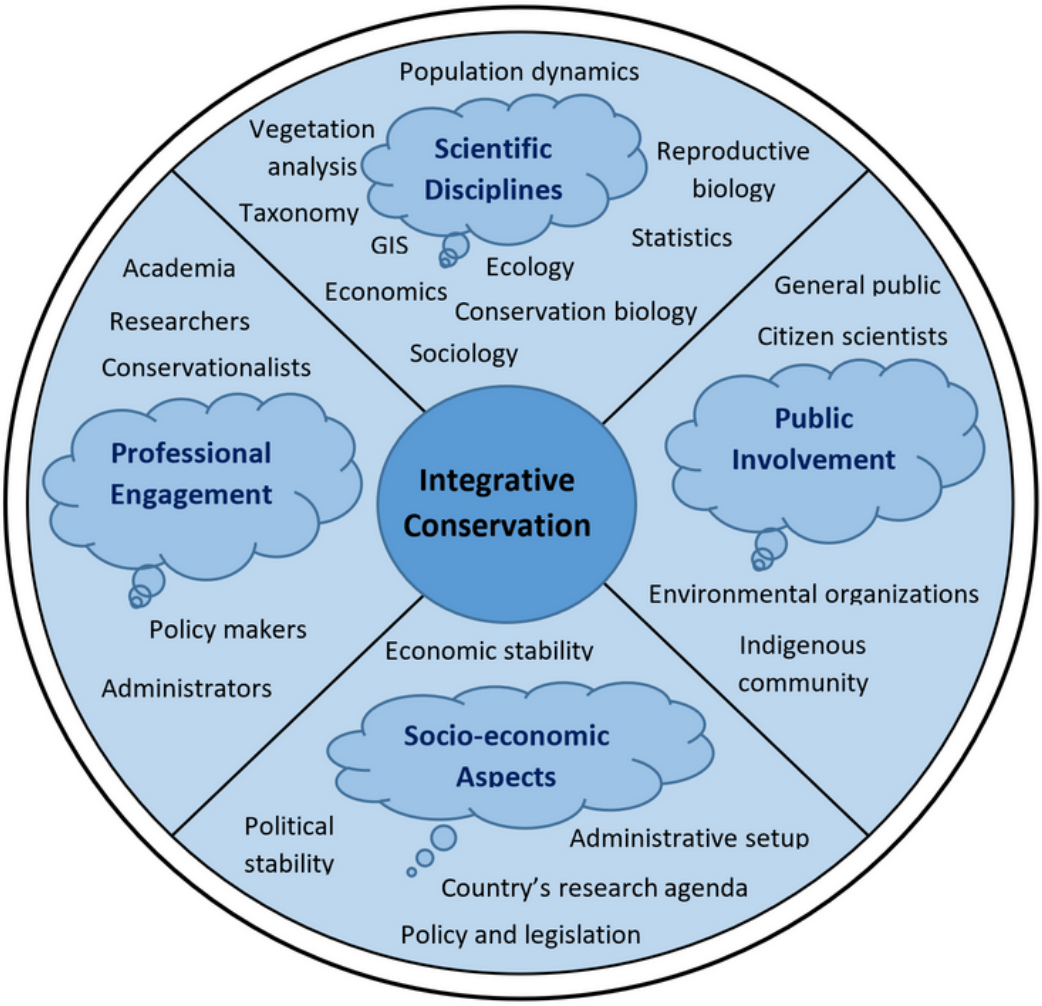

Figure 1 The multidimensional integrative conservation approach

(a) **Diagnose the needs for conservation:** The correct understanding of the need for conservation of specific taxa or ecosystems is essential in developing an effective conservation plan. For instance, the threat level and conservation status of a particular species can be determined by referring to the National Red List of a specific country or region. When it comes to the ecosystem level, a comprehensive and detailed survey is required to understand the extent and scale of conservation needs.

(b) **Integrating of relevant disciplines:** In addition to academic disciplines like ecology, reproductive biology, geo-spatial science, ethnobotany, sociology, economics, and others, it is also essential to consider and integrate other disciplines such as socio-economic aspects that are linked with administrative setup, policy and legislation, and more. All these aspects need to be considered and interconnected within the framework of IC. By incorporating a wide range of disciplines and stakeholders, a comprehensive and holistic approach to conservation can be achieved.

(c) **Professional and public engagement:** Professionals representing academic and research institutes play a key role in the IC approach. The contribution of administrative staff and policymakers in relevant government institutes is equally important. Moreover, understanding community aspirations is a critical factor because the success and effectiveness of conservation measures depend largely on public engagement. Therefore, all conservation plans should be aligned with the concepts of "benefit sharing" between nature and the community and "conservation through utilization."

(d) **Setting conservation strategies and implementing them:** Setting conservation strategies while integrating all the above disciplines with the agreement of all stakeholders is a challenging and time-consuming task. The active involvement of relevant government authorities is essential because conservation plans need to align with the country's policies and legislation. When conservation strategies are aligned with existing legal and administrative frameworks, their implementation becomes easier and faster.

(e) **Monitoring and evaluation:** Monitoring and evaluating the outcomes of a conservation or recovery plan for a specific species and ecosystem is a lengthy and ongoing process. Continuous monitoring is critical as it allows for the identification of sequential changes, measurement of progress, assessment of effectiveness, and, importantly, the identification of shortcomings and areas in need of revision. This ongoing evaluation enables necessary adjustments and revisits to ensure the plan's success
.

Practical application

Here are three realistic examples provided to further understand the application of the IC approach for safeguarding two endangered species and a vulnerable forest ecosystem in Sri Lanka.

Gini hota (*Sphaeropteris crinita*) and Dorana (*Dipterocarpus glandulosus*)

Sphaeropteris crinita (Hook.) R. M. Tryon is recognized as an endangered tree fern species under the National Red List 2020 (Figure 2a). Furthermore, it has sufficient legal coverage as it is listed in the Fauna and Flora Protection Ordinance in Sri Lanka and Annex II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The species is restricted to high altitude areas in the Nuwara Eliya district of Sri Lanka and South India. Despite having adequate legal protection, the species faces threats due to overutilization. In addition to the population found within protected forests, a significant number of individuals can be observed in human habitations, privately owned plantations, and up-country agricultural ecosystems.

(a)

(b)

(c)

(d)

Figure 2 (a), *Sphaeropteris crinite*, an endangered and endo-lankan endemic tree fern species; (b), Oil extraction from *Dipterocarpus glandulosus*; (c) - (d), The rich diversity of Beralia Mukalana proposed forest reserve.

Photo credit: (a), (c) and (d): The Author; (b): Prof. D. K. N. G. Pushpakumara, Faculty of Agriculture, University of Peradeniya, Sri Lanka

Dipterocarpus glandulosus Thwaites is an endemic tree species that exhibits a narrow distribution pattern across the southwest region of Sri Lanka (Figure 2b). The species is classified as endangered on the National Red List due to its limited area of occurrence, restricted population size, and the threats it faces. The species holds high economic value because its oil can be extracted and used in the painting of temple murals after being mixed with other organic substances. The traditional oil extraction process endangers the tree's survival. However, due to their economic potential and usefulness, these two species face an extinction risk.

Since these two species have legal coverage, conservation strategies need to align with relevant acts and policies. On the other hand, due to their high user value, community engagement plays a key role in the conservation plan. In addition to their taxonomic information, both species have not been adequately studied regarding their reproductive patterns, modes of propagation, population distribution and dynamics, distributional ecology, and ethnobotany. Therefore, incorporating scientific disciplines along with professional engagement is highly important to achieve the above objectives. Introducing these protected species into the industry poses a challenge. However, in order to provide an income avenue for the community, decisions need to be made with the support of policymakers and relevant administrative bodies.

Beraliya Mukalana proposed forest reserve

The Beraliya Mukalana proposed forest reserve (4,639 ha) is located in the southwest of Sri Lanka. The forest is a typical lowland rainforest with rich biological diversity (Figures 2c & d), surrounded by human settlements and agricultural lands. Apart from the type locality, the Sinharaja World Heritage Site, the Beraliya forest is the only known location for the endemic and critically endangered tree fern species, *Alsophila srilankensis* (Ranil) Ranil. As a fragmented and isolated forest patch, the Beraliya forest is subjected to threats such as over-visitation, encroachment, and habitat degradation. This makes it an ideal site for proposing a conservation plan aligned with the IC approach to safeguard its biological diversity. Given the high level of community engagement, certain aspects like declaring a buffer zone, introducing ecotourism, and developing community organizations for conservation need to be prioritized. Since the biodiversity of the forest has not been systematically studied, promoting research and educational activities must be integral parts of the conservation plan. Active engagement with the Forest Department and other responsible authorities in the area is necessary for the successful implementation of a conservation and management plan.

It is important to note that developing a species recovery plan or management plan for an ecosystem poses challenges due to insufficient basic information on taxonomy, ecology, distributional patterns, population dynamics, reproductive biology, and threat status of candidate species, as well as the structure, composition, and level of threats to an ecosystem. Additionally, the conservation of any biological component heavily relies on the socio-economic stability of the nation. Considering the current circumstances, the implementation of conservation research and projects presents significant challenges. Therefore, conservationists and policymakers must play a key role in developing a comprehensive conservation plan that addresses all these issues while garnering support from all stakeholders for the conservation mission.

Acknowledgement

I would like to acknowledge Professor D. K. N. G. Pushpakumara from the Faculty of Agriculture, University of Peradeniya, for his invaluable contribution in conceptualizing the idea and providing valuable information.

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Mitophagy: An Emerging Therapeutic Target

Mitochondria are the sites of cellular respiration during which glucose and oxygen are used to produce adenosine triphosphate (ATP) in a process known as oxidative phosphorylation (OXPHOS). Maintaining a healthy population of mitochondria is central to sustaining the energy requirements of the host cells. During their proper function, mitochondria dynamically exchange components through mitochondrial fusion and fission. In the fusion process, mitochondria fuse together, facilitating their biogenesis, and the fission process is a prerequisite for their degradation. Thus, cellular bioenergetic homeostasis is dependent on mitochondrial quality control mechanisms such as mitochondrial dynamics, the biogenesis of nascent mitochondria, and the efficient degradation of dysfunctional mitochondria, ensuring the effective management of mitochondrial turnover.

The OXPHOS also contributes to the ineluctable formation of superoxide free radical ($O_2^{\bullet -}$) which then converts to hydrogen peroxide (H_2O_2). These oxidative species are collectively termed reactive oxygen species (ROS). The impact of ROS depends on their abundance in cells; low concentrations function as important signalling molecules for certain processes, while high quantities exert deleterious effects on all cell processes leading to oxidative stress.

Therefore, as a defence, a low concentration of ROS is maintained in cells with the proper function of multiple cellular antioxidant systems. Reactive oxygen species generally build up when these antioxidant systems are overwhelmed and become dysfunctional. Moreover, damaged mitochondria can contribute further to ROS production, resulting in an increased generation of ROS. This insists on the need for the effective elimination of damaged mitochondria from cells.

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Cellular degradative process of autophagy

Autophagy is the major self-degradation process in cells that is triggered by nutrient deprivation or cellular stress. This process recycles superfluous cells, cell organelles, and cytosolic proteins through lysosome-mediated degradation. This is a rapid process mediated by several specific autophagy-related proteins.

There are three types of autophagy based on the specific components subjected to degradation. First, microautophagy degrades cytosolic components via direct engulfment by lysosomes. In the second, macro-autophagy or non-selective autophagy, portions of the cytoplasm and cellular organelles are sequestered by phagophores, forming a vesicle termed the autophagosome. The autophagosome next fuses with lysosomes forming autophagolysosomes, where the enclosed contents are eventually degraded by lysosomal proteases. Third, selective autophagy targets specific tissues, cells, pathogens, protein aggregates, and damaged organelles to form the autophagosome. The light chain 3 (LC3) proteins on the phagophore act as cargo receptors to distinguish poly-ubiquitin (Ub) chains on the target cargo destined for degradation. Chaperone-mediated autophagy is a subtype of selective autophagy in which heat shock proteins, such as Hsp70, transport target proteins to lysosomes.

During apoptotic cell death, mitochondria play a central role in the integration and propagation of death signals. These death signals originate from events such as DNA damage, nutrient deprivation, oxidative stress and hypoxia. Under these stress conditions, cellular respiration increases to match the ATP requirements, leading to increases in ROS levels. Excessive ROS levels induce apoptosis by increasing pro-apoptotic BCL-2 family proteins relative to anti-apoptotic BCL-2 proteins. Proteins of the pro-apoptotic BCL-2 family regulate the outer mitochondrial membrane (OMM) permeabilization by triggering the opening of mitochondrial permeability transition pores (mPTPs) and the release of cytochrome c (CYT-C) into the cytoplasm, which activates a cascade of events leading to apoptosis. However, it has been found that, at this point, instead of proceeding with the apoptotic process, regulatory mechanisms of cell survival shift towards eliminating only the damaged mitochondria via a pathway known as mitophagy.

Mitophagy: selective autophagy of damaged mitochondria

Mitophagy ensures mitochondrial integrity and efficient function by preventing the accumulation of dysfunctional mitochondria, hence, it is recognized as an essential element of cellular protection. Additionally, mitophagy occurs as a programmed event at specific developmental stages in certain cell types. For instance, it is an essential step of development during retinal ganglion cell differentiation and the maturation of cardiomyocytes and erythroid cells. During these events, cells switch to an alternative ATP source such as glycolysis. In mammalian cells, there are three major classes of mitophagy: type 1 is basal mitophagy, type 2 is PINK1/Parkin-mediated mitophagy, and type 3 is mitochondrial vesicle-based mitophagy (Figure 1).

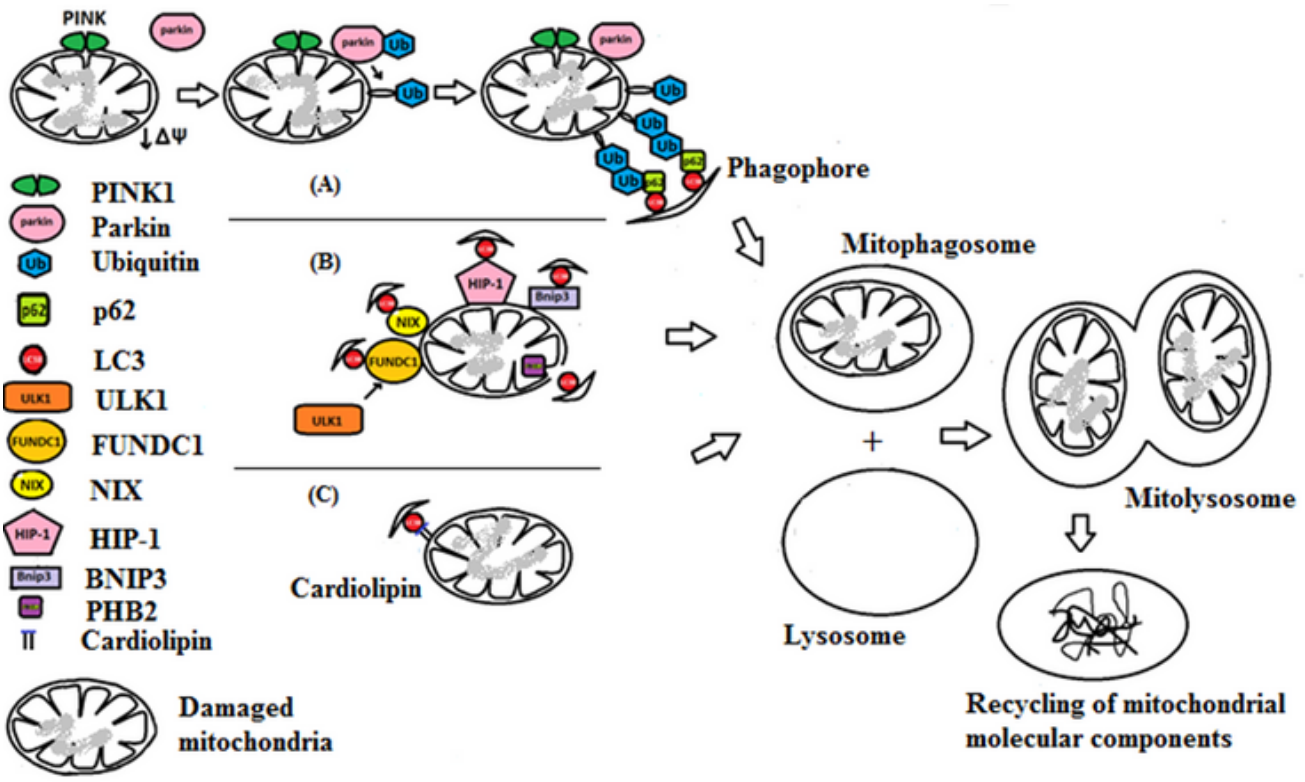

Figure 1 Different mitophagy pathways
Source: Jayatunga et al. (2020)

Basal mitophagy (type 1 mitophagy)

As proposed by Lemasters in 2014, mitophagy occurring due to nutrient deprivation is a different subtype. Aided by the mitochondrial fission process, type 1 mitophagy occurs without any mitochondrial membrane depolarization. Under conditions in which cellular ATP/adenosine monophosphate (AMP) ratios decline, such as during starvation, adenosine monophosphate-activated protein kinase (AMPK) activates and phosphorylates unc-51 like autophagy activating kinase 1 (ULK1), an initiator of autophagy/mitophagy. These proteins drive the mitophagy process by sequestering mitochondria into pre-autophagic structures and forming autophagosomes. After autophagosomes form and fuse with lysosomes, mitochondria are depolarized upon vesicular acidification, and mitochondrial contents are degraded.

PINK1/Parkin-mediated mitophagy (type 2 mitophagy)

In healthy mitochondria, the cellular protein PTEN-induced putative kinase 1 (PINK1) is imported into mitochondria with the help of an N-terminal targeting sequence and is cleaved by matrix processing peptidase (MPP) and presenilins-associated rhomboid-like protein (PARL). Cleaved PINK1 is re-located to the cytosol for degradation by the proteasome. When mitochondria are damaged, their membranes depolarize, and the mitochondrial membrane potential (MMP) dissipates. This change in MMP modifies PINK1 by the homodimerization and autophosphorylation events.

It ensures that PINK1 is stably associated with the translocase of the outer mitochondrial membrane (TOMM) complex. This promotes the recruitment of an E3 ubiquitin-protein ligase, Parkin to the OMM. Once positioned on mitochondria, Parkin ubiquitinates many OMM proteins, while PINK1 phosphorylates the Ub chains sequentially. The Parkin-mediated ubiquitylation initially occurs on the mitochondrial fusion proteins mitofusin 1 (MFN1) and MFN2, to promote their degradation through the ubiquitin-proteasome system (UPS). With the reduced effectors of the fusion events, mitochondrial fission is induced, segregating damaged portions of the mitochondria. Additionally, Parkin also ubiquitylates p97, an AAA-ATPase that degrades numerous other proteins on the OMM, including TOMM20, TOMM70, and voltage-dependent anion channel 1 (VDAC1).

Alternatively, ubiquitylation of mitochondrial proteins attracts numerous autophagy adaptors including nucleoporin 62/sequestosome 1 (p62/SQSTM1), neighbor of BRCA1 gene 1 protein 1 (NBR1), nuclear dot 10 protein 52 (NDP52/CALCOCO2), and optineurin (OPTN). Each of these adaptor proteins consists of an Ub-binding domain and a (LC3)-interacting region (LIR). The latter interacts with the LC3-II molecules in cup-shaped phagophores to form autophagosomes. There are many OMM- and IMM-related protein receptors that induce mitophagy without the involvement of Ub. In the OMM, the BCL2/adenovirus E1B 19 kDa protein-interacting protein 3 (BNIP3), BNIP3-like (BNIP3L) (also known as NIX), FUN14 domain containing 1 (FUNDC1), and SMAD ubiquitination regulatory factor 1 (SMURF) are expressed in response to hypoxia. They are transcriptionally and post-translationally activated by hypoxia-inducible factor 1 (HIF-1). FUNDC1 is also an OMM protein that is regulated in hypoxia with the aid of different kinases and phosphatases. Unc-51-like kinase 1 is reported to phosphorylate the LIR motif of FUNDC1. The activating molecule in BECN1-regulated autophagy protein 1 (AMBRA1) is also a mitochondrial-resident protein that has been documented to induce mitophagy, independent of Parkin and p62.

Mitochondrial vesicle-based mitophagy (type 3 mitophagy: micromitophagy)

A distinct mechanism has been reported to eliminate defective mitochondria which involves intracellular mitochondrial-derived vesicles transported directly to lysosomes or peroxisomes.

The final stage of all these types of mitophagy is the elimination of mitophagosomes. They fuse with lysosomes and mature into autolysosomes, more specifically mitolysosomes.

This maturation of lysosomes is mediated by LC3-binding proteins PLEKHM1, HOPS, and the lysosome membrane-associated protein, RAB7. The mitochondrial contents are then degraded through enzyme-mediated hydrolysis at acidic pH in lysosomes.

Mitophagy as a therapeutic target

To date, evidence is accumulating that mitophagy is impaired in many age-related and metabolic pathologies including Alzheimer's disease, Parkinson's disease, Huntington's disease, psychiatric diseases, type 2 diabetes, cardiovascular diseases, liver diseases, acute kidney diseases, and cancer. Thus, it serves as an important therapeutic target that can lead to newer avenues of therapeutic regimes for diseases for which there are no definitive therapies available to date. The deficits in the mitophagy process as claimed in many diseases demand its effective stimulation towards disease therapies.

When considering interventions for improving mitophagy, there are plant-derived compounds, such as urolithin A, spermidine, and tomatidine gaining much attention for enhancing the process of mitophagy. Exercise is also an important lifestyle intervention that increases mitophagy. Further research is needed to uncover pharmacological or dietary interventions that restore mitophagy homeostasis and facilitate the elimination of irreversibly damaged mitochondria, and thereby, could serve as potential therapies for many chronic diseases. However, it should not be forgotten that inducing mitophagy needs to be critically modulated as it can act as a double-edged sword in the cellular microenvironment.

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Unravelling the Genes of Longevity Hidden in Fish

Old age is a nightmare for many humans and a number of scientists struggle to find solutions to prevent phenotypical and metabolic changes due to old age. Senescence is mostly due to the telomerase activity and telomere length in vertebrates. Telomere shortening occurs due to DNA replication which leads to the formation of a cellular mitotic clock. Although telomerase enzyme is involved in the synthesis of telomere, it is limited to stem cell derivatives. However, in some fish species, the somatic cells proliferate throughout the life cycle and a study on rainbow trout (*Oncorhynchus mykiss*) revealed the activity of telomerase enzyme is present in every organ.

There are three types of senescence present among fish. Rapid senescence occurs in lampreys, eels, and salmon due to their neuro-endocrinal reaction. In most of the teleost species, gradual senescence is present, which is a slow, age-related mortality. Sturgeons, flatfish, and rockfish species show indeterminate growth, which drew the attention of many scientists to study the genes behind the long life of fish. A study on bigmouth buffalo fish (*Ictiobus cyprinellus*), which has a lifespan of over 100 years shows negligible senescence in multiple physiological systems.

Zebrafish (*Danio rerio*) is a multiple experimental model, which is also used in developmental, cancer, and regeneration studies (Figure 1). Recently, it has been considered as a suitable biomarker model for research on aging due to the expression of telomerase throughout their lives. Zebrafish were found to be maintaining the telomere length during regeneration, and upregulation of telomerase activity was observed in senile zebrafish. Another study using two varieties of zebrafish revealed an increase in skeletal length until the maximum lifespan, proving the indeterminate growth of zebrafish. However, they have observed spinal curvature due to muscle abnormalities at senile age. Hence, zebrafish varieties are a good model for studying aging.

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In Sri Lanka, since the first establishment of the zebrafish facility in 2013, a number of studies have been conducted, particularly following the zebrafish embryo toxicity test. As a tropical country, the natural water streams also harbour fish, which are similar to zebrafish. Sri Lanka is rich in biodiversity and is home to five *Devario* species including one endemic species (*Devario malabaricus*), which is related to zebrafish (Figure 1). *D. malabaricus*, also called Giant Danio, is widespread throughout the lowlands and central hills in the country. It is popular as an ornamental fish in Singapore, Thailand, and Hong Kong. However, it is considered an IUCN threatened species, and captive breeding has reduced the collection from the wild in recent years. However, due to lack of research on their abundance and usefulness, those species are not yet popular as model organisms.

The potential of *D. malabaricus* to be used as an alternative model for zebrafish in Sri Lanka was studied by Sumathipala and colleagues in 2015 and reported slow embryonic growth compared to zebrafish, but a faster hatching rate. Until now, there have been no studies conducted on *D. malabaricus* compared to zebrafish worldwide, although it has a huge potential to be used in a wide range of research.

Devario malabaricus

Danio rerio

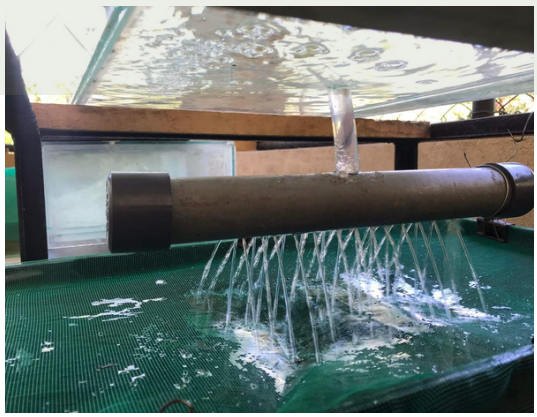
Figure 1 Appearance of *Devario malabaricus* (Giant Danio) and *Danio rerio* (Zebrafish) Photo credit: Ms. M. Madhushani, Uva Wellassa University, Sri Lanka

A research team comprising scientists from the University of Tokyo, Japan, Bangladesh University of Agriculture, University of Peradeniya and Uva Wellassa University, joined hands to determine the genes associated with the longevity of *Danio* varieties and their crossbreds. Giant Danio, which is abundant in the streams of Badulu oya was used for the artificial breeding experiment. There, fish were kept in cement tanks and provided artificial rain (to mimic spawning during the rainy season), aquatic plants (for pH balance) and live feed (*Daphnia moina*) (Figure 2).

In our study, the newly hatched fry will be monitored continuously, and transcriptomic analysis will be performed to examine the expression of genes involved in growth and longevity using next-generation sequencing methods. The outcomes from this study will contribute to aging studies by identifying the genes expressed during their life span, particularly involved with indeterminate growth.

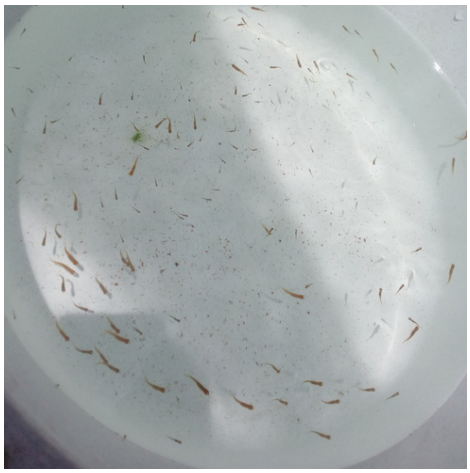
This ongoing international collaborative project is funded by the International Joint Research Acceleration Fund, Japan. The Principal Investigator is Associate Prof. S. Kinoshita and his team consists of Prof. S. Asakawa, Dr. Yoji Igarashi and Assistant Prof. K. Yoshitake from the University of Tokyo, Japan. Research collaborators from other countries include Prof. A. S. Ahamad (Bangladesh Agriculture University), Dr. S. S. S. De S. Jagoda (University of Peradeniya), Mr. N. P. P. Liyanage, Dr. D. P. N. De Silva (Uva Wellassa University) and Ms. H. M. M. Madushani (Research Assistant, University of Tokyo).

Cement tanks



Artificial rain

pH maintenance with plants



14 days old *D. malabaricus*

Figure 2 Enrichment of spawning tanks and the fry born under captive breeding
Photo credit: Ms. M. Madhushani and Mr. D. P. Dias, Uva Wellassa University, Sri Lanka

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Hand Sanitizers: The Frenemies of Humans

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Hand sanitizers played a crucial role in preventing the spread of the COVID-19 pandemic. Hand sanitizers, especially those containing at least 60% alcohol, are effective in eradicating a broad spectrum of viruses and bacteria, including the coronavirus responsible for COVID-19. The use of hand sanitizers helped to reduce the viral load on hands and consequently prevented potential transmission. These hand sanitizers provide a quick and accessible method for individuals to clean their hands regularly, reinforcing the importance of this preventive measure. Infected individuals could deposit viruses on surfaces they came into contact with, and subsequent individuals might pick up these viruses through surface contact and subsequent facial touching. The use of hand sanitizers following interaction with commonly shared surfaces substantially reduces the risk of transmission and contributes to flattening the infection curve.

Composition of hand sanitizers

Alcohol-based hand sanitizers which are recommended by the WHO are mainly made up of ethanol, isopropyl alcohols, and hydrogen peroxides in different combinations. These sanitizers contain ethanol or isopropyl alcohol as active reagents, typically at a concentration ranging from 60 - 95%. The presence of chemical additives in hand sanitizers, such as fragrances, preservatives, and emollients, is common in many commercially available products.

The roles of alcohol and chemical additives in hand sanitizers

In hand sanitizers, alcohol functions as an antimicrobial agent. Alcohol has the ability to denature and disrupt the structure of microorganisms' cellular membranes by damaging proteins and lipids. This denaturation process leads to the breakdown of the essential cell components and eventually causes the death of the microorganism. This rapid chemical process of alcohol on microorganisms is what makes them effective in reducing the number of pathogens present on the skin's surface.

When considering additives, fragrances are added to hand sanitizers to develop a pleasant scent, enhancing their appeal for use. Preservatives are added to prevent the growth of harmful and toxic substances, thereby maintaining the sanitizers' effectiveness and extending their shelf life. Emollients, which are moisturizing agents, are included to counteract the drying effects of alcohol. These emollients aid in maintaining skin hydration and preventing dryness and irritation. Some hand sanitizers may contain additional ingredients such as colorants, thickeners, or skin conditioning agents.

Potential health risks of alcohol

Hand sanitizers, particularly those with high alcohol content, can potentially have various impacts on the skin, including dryness, irritation, and dermatitis. While they are effective in eliminating germs, repeated and excessive use can strip the skin of its natural oils, leading to these undesirable effects.

Alcohol-based hand sanitizers have a drying effect on the skin. Because the alcohol in sanitizers can disrupt the skin's natural moisture barrier, decreasing its ability to retain water. Consequently, frequent use of hand sanitizers can lead to an overall loss of moisture from the skin, resulting in dry and rough hands. Moreover, excessive use of hand sanitizers can cause skin redness, irritation, and inflammation, particularly around the fingernails and fingertips, which potentially lead to contact dermatitis. Contact dermatitis is an inflammatory skin condition characterized by red, itchy, and sometimes painful rashes. Furthermore, allergic contact dermatitis may occur when an individual exhibits sensitivity or allergy to one or more ingredients in the hand sanitizer, such as fragrances or preservatives. The frequent use of hand sanitizers can compromise the skin's natural barrier function, which is crucial for protecting against pathogens and maintaining skin health. A weakened skin barrier may lead to increased susceptibility to infections and exacerbate skin-related concerns.

Ingestion or dermal absorption of a low concentration of hydrogen peroxide (3% solution) can result in minor gastrointestinal tract irritation, portal vein embolism, mild mucosal irritation and vomiting. Ingestion or dermal absorption of isopropyl alcohol can lead to severe respiratory and central nervous system depression. Ethanol toxicity is also associated with respiratory depression, which can result in respiratory arrest, hypothermia, cardiac dysrhythmias with possible cardiac arrest, hypoglycemia, ketoacidosis, and hypotension.


Designed by Freepik

Risks associated with chemical additives in hand sanitizers

Chemical additives are included in hand sanitizers for various purposes, although they can also present certain health risks. Some people can be hypersensitive or allergic to chemical additives, which can lead to skin irritation, rashes, or respiratory reactions. Among the additives, preservatives such as parabens and formaldehyde-releasing agents have been extensively used to extend product shelf life. However, currently, there are concerns about their potential long-term health effects, which include hormonal disruption and skin sensitization. Emollients, which are frequently included in hand sanitizers, are generally considered safe and beneficial, but these compounds can cause issues when used in high concentrations or if the product fails to be fully absorbed by the skin. In such instances, a greasy residue might be left behind, potentially compromising the effectiveness of the sanitizers.

Antimicrobial resistance

Antimicrobial resistance occurs when microorganisms, such as bacteria, viruses, fungi, and parasites, develop resistance to antimicrobial agents, thus making infections more challenging to treat. This has become a significant global concern. While a variety of factors contribute to this phenomenon, including the overuse of antibiotics, the use of alcohol-based hand sanitizers can also contribute to the development of antimicrobial resistance. Although hand sanitizers are effective in reducing the microbial population on the skin's surface, they might not eliminate all microorganisms, especially when these sanitizers are improperly applied or contain lower alcohol concentrations. Consequently, certain microorganisms can persist through the sanitization process, providing them an opportunity to survive and multiply.

The use of hand sanitizers can exert selective pressure on surviving microorganisms. Microbes possessing innate resistance or mutations that make them resistant to the sanitizing agent are more likely to survive the sanitation process. Through horizontal gene transfer, microorganisms have the capacity to exchange genetic material, including genes that confer antimicrobial resistance. This may facilitate the spread of resistance within microbial populations when exposed to hand sanitizers. Furthermore, the use of alcohol-based hand sanitizers raises questions about the possibility of cross-resistance to antibiotics and other antimicrobials. Prolonged exposure to alcohol can cause changes in microbial cell membranes, which can affect the susceptibility of microorganisms to other antimicrobial agents.

Additionally, some microorganisms have the ability to form biofilms on surfaces, including the skin. These biofilms serve as protective barriers, making microorganisms more resistant to antimicrobial substances such as hand sanitizers. Consequently, hand sanitizers might not be as effective at getting rid of pathogens when biofilms are formed. Recommendations and mitigation strategies

Choosing an appropriate hand sanitizer is important, as those with lower concentrations may not be as effective in killing a broad spectrum of microorganisms. To combat the drying effects of alcohol, products containing moisturizing or emollient ingredients prove beneficial.

As excessive usage of hand sanitizers may result in adverse effects (Figure 1), it is crucial to adhere to the manufacturer's recommendations for the recommended dosage. Avoiding excessive and prolonged use of hand sanitizers and using hand sanitizers only when soap and water are not readily available, such as when traveling or in public settings are recommended.

For individuals with sensitive or allergy-prone skin, performing a patch test before using a new hand sanitizer is recommended to assess the potential adverse reactions. Notably, hand sanitizers are for external use only and should be kept out of the reach of young children to prevent accidental ingestion, which can be harmful, especially if the product contains a high alcohol content. Regular handwashing with antimicrobial soap and water stands as the preferred method of hand hygiene, given its reduced likelihood of causing chemical irritation.

Our daily lives became completely dependent on hand sanitizers during the COVID-19 pandemic. However, it is important to recognize and take into consideration the potential risks linked to their usage. By being aware of the risks associated with hand sanitizers, users can strike a balance between maintaining effective hand hygiene and reducing potential adverse impacts on human health.

Figure 1 Side effects of hand sanitizer on the skin
Source:
https://img.perioimplantadvisory.com/files/base/ebm/pia/image/2021/07/16x9/Figure1.60e483833e380.png?auto=format,compress&w=1050&h=590&fit=clip (Accessed: 10 July 2023)

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X-ray Micro-Computed Tomography (µCT) Scanning: A Non-destructive, High-resolution 3D Imaging Technique to Visualize Morphological Structures

Flowers come in all shapes, sizes, and colors. Even though this plethora of variation is easily appreciated by the human eye, in order to quantify, visualize, and analyze this biological variation statistically, powerful and intuitive morphometrics are required. Developmental biology heavily relies on generating three-dimensional (3D) images of morphological structures such as flowers to reveal detailed internal tissue organization.

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Since the discovery of X-rays approximately 120 years ago, reconstructing 3D images of delicate biological material has undergone a revolution with the recent advances in modern scanning techniques. Computed tomography (CT) is a feasible and affordable technique that enables obtaining volumetric data. “Tomography” comes from the Greek word “tomos” for slice/section and implies obtaining cross-sectional images. “Compute” implies the synthesis of data from multiple images. Therefore, “computed tomography” refers to taking X-ray projection images of an object from many angles and mathematically converting this set of images into a stack of cross-sectional image slices, which collectively represent a 3D image. In 1979, Allan M. Cormack and Godfrey N. Hounsfield were awarded the Nobel Prize in Physiology or Medicine for the development of computer-assisted tomography (Figure 1).

Figure 1 Allan M. Cormack (left) and Godfrey N. Hounsfield (right)
Source: NobelPrize.org. (n.d.). The Nobel Prize in Physiology or Medicine 1979. [online] Available at: https://www.nobelprize.org/prizes/medicine/1979/summary/ (Accessed: 10 January 2023)

The most exciting aspect of CT is that images of internal structures can be obtained without damaging the specimen which is crucial when dealing with delicate biological material. Moreover, the technology provides the opportunity to undertake large-scale studies in a relatively short timescale. This non-destructive technique that visualizes interior features within specimens with 3D imaging is an effective characterization method that helps to alter the focus size from macro to micro to obtain reliable image data. Compared to CT (≈ 1 mm^3 voxel size), micro-CT/μCT (≈ 1 μm^3)has a higher spatial resolution. The viewing area of μCT is 1,000,000 times smaller than that could be viewed by CT. A typical μCT scanner consists of an X-ray generator (X-ray tube), a computer-driven step motor, an image intensifier, a detector/CCD camera, an image collector, and a computer to control all these components (Figure 2).

Figure 2 Table-top μCT scanner (SkyScan 1275, Bruker, Kontich, Belgium), equipped with a 100 kV microfocus X-ray source

How does micro-CT work?

The principle of the μCT involves detecting X-rays passing through the sample. In brief, the X-ray beam emitted by the X-ray generator passes through the sample, casting shadow projections on the detector. Since the detector cannot directly detect X-ray beams, a scintillator screen converts the X-ray energy to visible light. The detector captures these projections in 2D and displays them as a grayscale image (see Figure 3).

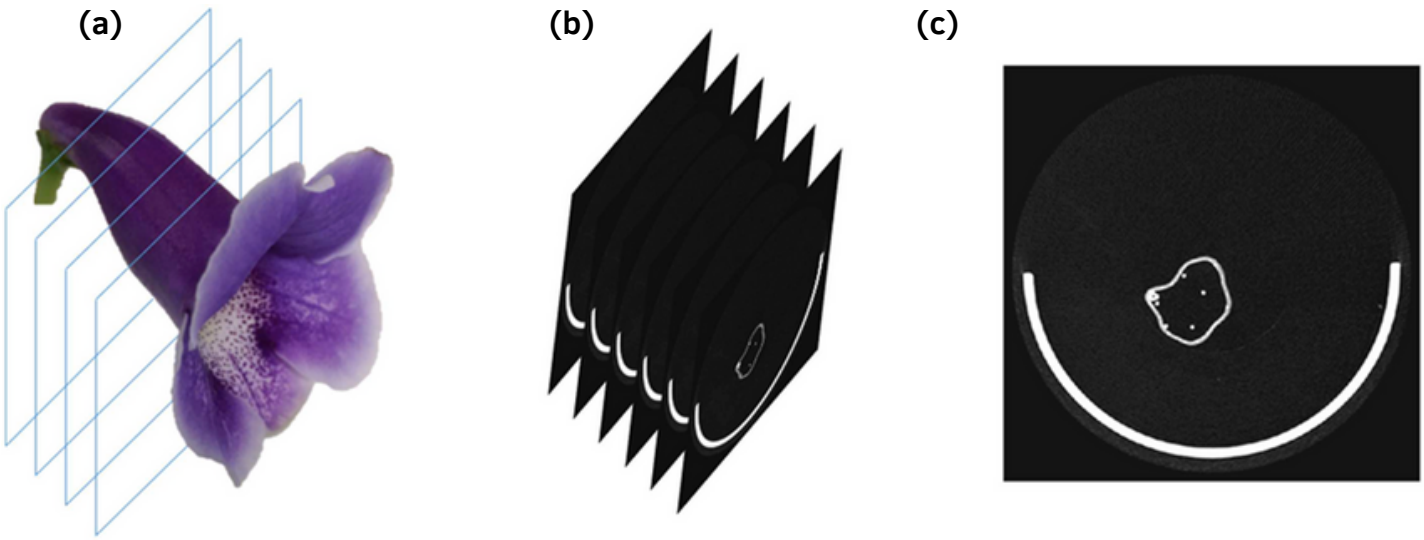

Figure 3 An overview of µCT scanning. (a), Illustration of the scanning; (b), Image slices from the scanning; (c), Raw image slice
Source: Wang et al. (2015)

In µCT systems, either the sample or the detector, along with the X-ray source, rotates (1800 or 3600) to obtain additional projections. Generally, more projections are required to obtain more accurate 3D structures. After acquiring a stack of projections, a mathematical reconstruction algorithm generates images in 16-bit (65,536 gray value) or 8-bit (256 gray value) format. These images can be further manipulated and analyzed using advanced image analysis software such as NRecon (Bruker, Kontich, Belgium) and Amira (Visage Imaging, Inc.). These computer programs enable advanced visualization techniques, including slice modules, volume rendering, and iso-surface modeling (Figure 4).

In recent years, the µCT technique has gained popularity in diverse areas of biological sciences including taxonomy, and evolutionary and ecological biology due to the high reproducibility and accuracy of findings.

As shown in Figure 4, an inflorescence architecture (i.e. hermaphroditism, number of flowers, number of stigmas, length, width and the distance between the flowers) can be easily studied using this X-ray imaging technique.

µCT scanning is a rapidly growing and important technique that provides a unique opportunity to capture morphological structures in 3D in a non-destructive way. This high-resolution X-ray imaging technique has the opportunity to support research in many areas of biological sciences.

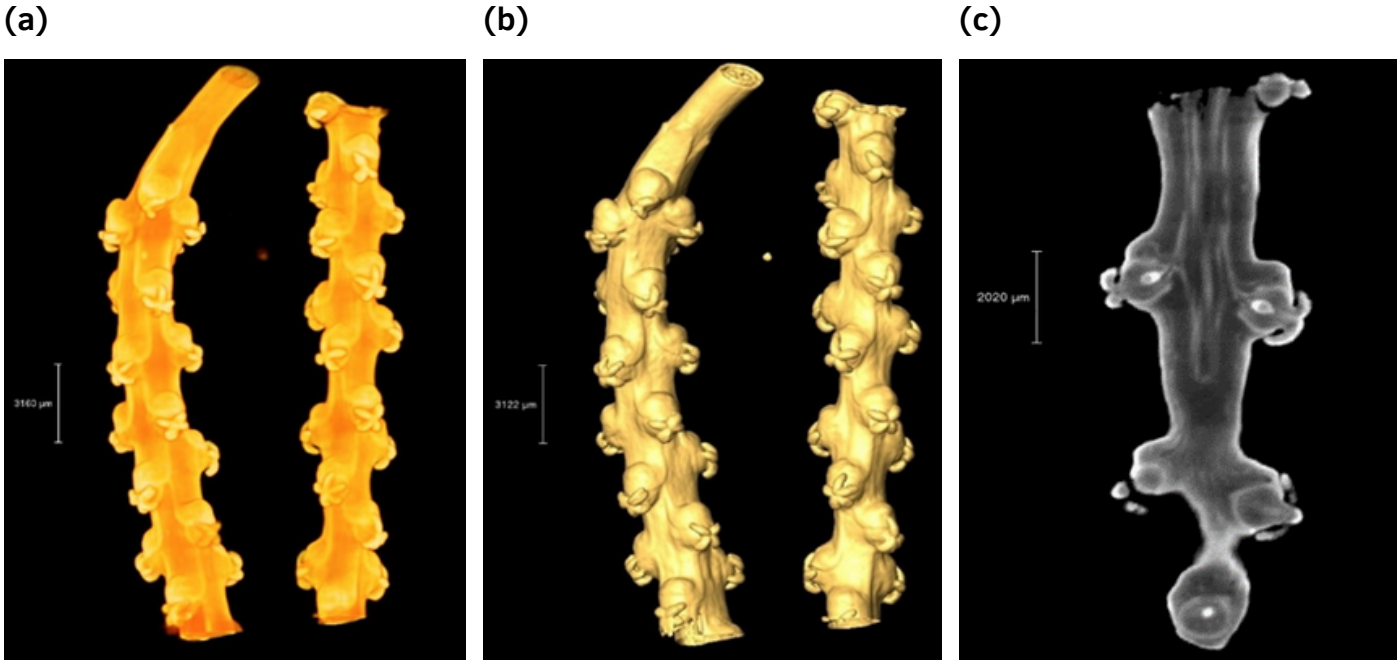

Figure 4 µCT images of a *Piper nigrum* inflorescence. (a), Volume rendering; (b), Iso-surface modeling; (c), Cross-section/slice

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DNA Helix

From the Cavendish laboratory of Cambridge
Watson and Crick and the brilliance of Rosalind Franklin holding
A piece of the evidence, stood Brigitte Bardot's poise,
Sophia Loren's curves, coming together
Like meandering lifelines in prayer, to turn heads
Of the molecular hunters, who no longer
Use longbow and arrow, only tabletop centrifuges
And long read sequencers, to embody life with what
May be seen as the ultrasound of genes, the alphabet
Of miracles, methylated islands from smoked cigarettes
That were imprinted, epi-remembered,
And the sheer enigma of special mutations, as we
All know now, travelling in character miles
And codons, that cascade to our eyes
As both beauties and beasts.

Onus that a party pooper,
Can crash the party of tumor suppressors
And proto-oncogenes, but can also gift resilience
To chickpea to withstand scorching droughts. The creation
And reciprocation of a helix, to have near and far,
Expression and regulation, and the only thing
That priest Mendel did not leave behind,
Just like lists of pious popes. The greatest mystery
In life is, "which organism had the first DNA helix?"
The puny little storage device called a cell
That coded for life and passed it on imperfectly
With methylated marks, mutations, memory and muses.

A helix that tells you your tanned skin tone,
MENSA score, your height, your imperfections and Achilles heels,
Even using the histocompatibility complex proteins
To the meteorology of a heart's intuitive counter-immunity.
The first base, the first hydrogen bond, the first string,
The first helix, the first histone, the first nucleus,
The first meiosis. The fairy tale of a special beginning,
A genius who became the talisman of inheritance.
Frankly, I see you everywhere; in coils of a candy stick,
The barber's pole, the climbing sweet pea tendrils,
The pink ribbon in the palms of a floor gymnast,
The mosquito coils, corkscrews, and fusilli pasta,
Gastropod shells and commonplace coil springs,
The twisty caduceus of Hermes and Asclepius's serpent,
And in its apotheosis of beauty, the spiral staircase
Of the tallest beacon of them all, the blinding radiance
Of Einstein's towering lighthouse; and the silvery roof on top,
The uncombable hair syndrome that was
Simply a messy hairdo: that too made
Of curving helices.

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Smart Media

NATURE CAPTURES

Zygonyx iris (Sri Lankan Cascader)
Photograph by Dr. Saminda Fernando
Species identification by Mr. Amila Sumanapala

The Sri Lankan Cascader, scientifically known as *Zygonyx iris*, is a dragonfly species endemic to Sri Lanka. It belongs to the insect order Odonata. They are comparatively larger than many other dragonflies in Sri Lanka. The abdomen length is about 40-43 cm while the hind wing length is about 50-52 cm. The Sri Lanka Cascader males generally appear black, but its thorax has a vibrant and metallic bluish-black colour with bright yellow spots and is covered by a coat of fine hair. A bright yellow dorsal stripe is present on the black abdomen while the basal segment having a few yellow spots laterally. The face is black, and its sides are yellow. The females however have more extensive yellow markings than males. Unlike in males, yellow stripes run laterally along the abdominal segments.

The Sri Lanka Cascader can be found mainly in the wet zone of the country and less frequent in the intermediate zone. The preferred habitats are streams with waterfalls and cascades. Male dragonflies cling on to vegetation or bare sticks when at rest, and can be observed flying over the cascades. Females are often found inside vegetation.

Dragonflies, like most insects, go through a process called molting as they grow and develop. Molting is the shedding of their old exoskeleton, so that they can emerge with a larger, more mature exoskeleton. During molting, dragonflies find a secure place to cling onto, such as a plant stem or a rock near the water. They remain still while the process takes place. First, they absorb water, which helps to expand their body and loosen the old exoskeleton. Then, they begin to wriggle and wiggle their body to break free from the old exoskeleton. Once the old exoskeleton splits open, the dragonfly slowly emerges. Its new exoskeleton is soft and it may take some time for the new exoskeleton to harden. After molting, the dragonfly's wings are also soft and crumpled, hence it pumps fluid into the wings to expand. This process can take a little while, and once the wings are fully expanded and dried, the dragonfly is ready to fly. It is an amazing natural process to witness and is captured in this photograph!

Dragonflies play a vital role in the ecosystem, acting as natural predators by controlling insect populations and maintaining ecological balance. Additionally, they also serve as indicators of water quality, as their presence indicates a healthy aquatic environment. The Sri Lanka Cascader however is under threat due to habitat destruction and is categorized by ICUN as a vulnerable species.

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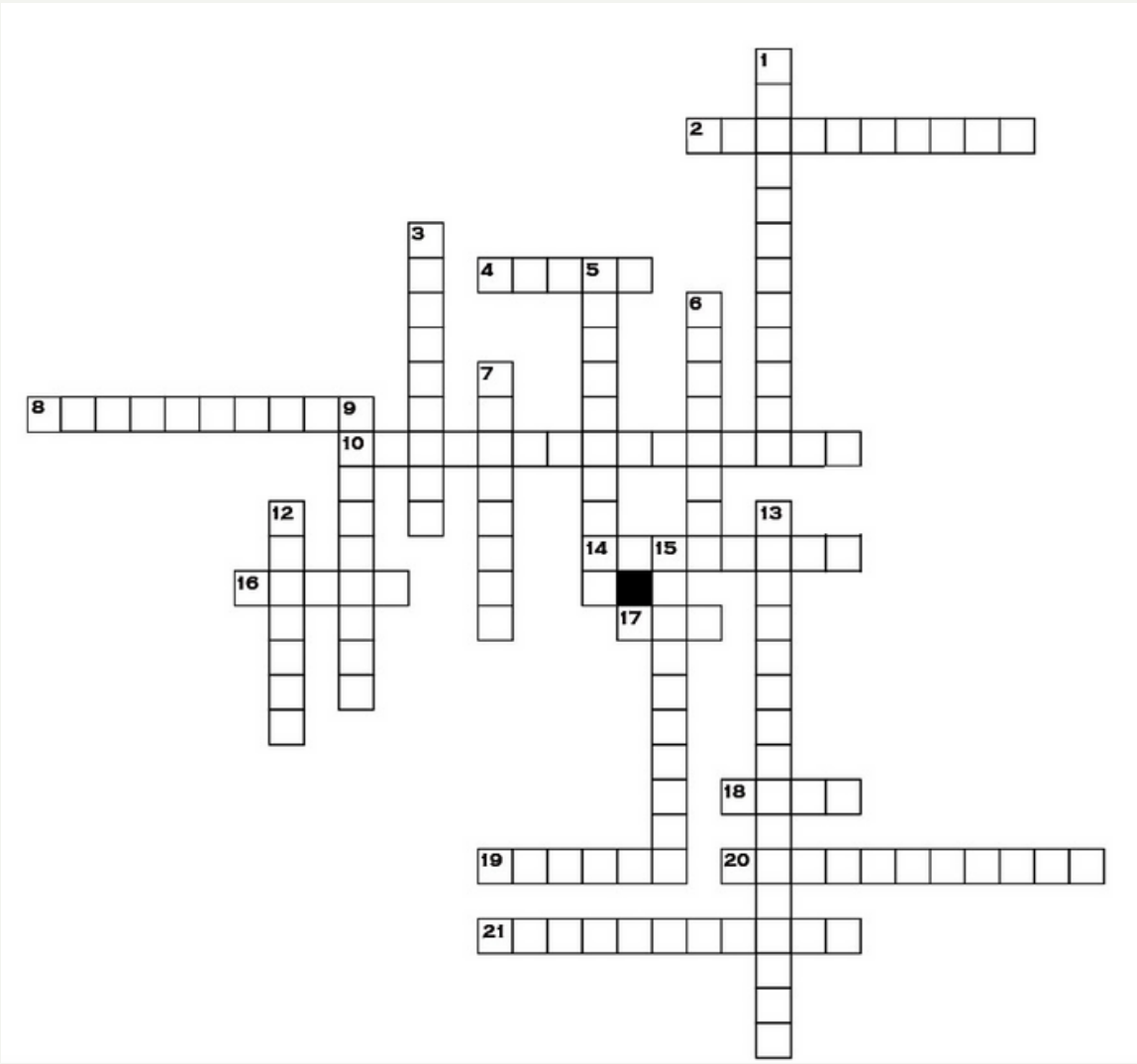
BIO-BrainBuster CROSSWORD



WORD BANK

TAXONOMY	ANTIBODIES	HYPOTHALAMUS	APOPTOSIS	ENDOCYTOSIS
AMAZON	PRIONS	AMPHIBIAN	DENDROCHRONOLOGY	ETHYLENE
THALANGAMA	CHRYSOPELEA	EMU	CORAL	NARWHAL
MAHAWELI	LUCIFERIN	PARTHENOGENESIS	IRIS	

ACROSS

2. Cold-blooded vertebrates that undergo metamorphosis and live both on land and in water.

4. A colorful marine invertebrate animal known for its symbiotic relationship with algae.

8. An urban wetland sanctuary in Sri Lanka, providing habitat for many bird species.

10. A form of asexual reproduction where an embryo develops without fertilization.

14. This plant hormone promotes fruit ripening and is used agriculturally to ripen fruit artificially.

16. An infectious protein that can cause neurodegenerative diseases in animals.

17. The second largest living bird in the world, after Ostrich.

18. The colored part of the eye that controls the size of the pupil.

19. The most diverse tropical rainforest on Earth.

20. The process by which a cell engulfs external particles to bring them into the cell.

21. "Flying Snake" or Gliding Snake belongs to this genus.

DOWN

1. The area of the brain responsible for regulating body temperature and hunger.

3. The light-emitting compound in bioluminescent organisms.

5. Specialized proteins produced by B cells that neutralize harmful pathogens by binding to them.

6. A branch of biology that involves classification of organisms into hierarchical groups.

7. Sri Lanka's longest river.

9. A distinctive and important mode of programmed cell death.

12. A rare, large marine mammal known for its tusk-like teeth.

13. The technique of dating events and environmental changes using tree rings (also known as tree-dating).

15. Iron-containing protein found in red blood cells that binds and transports oxygen.

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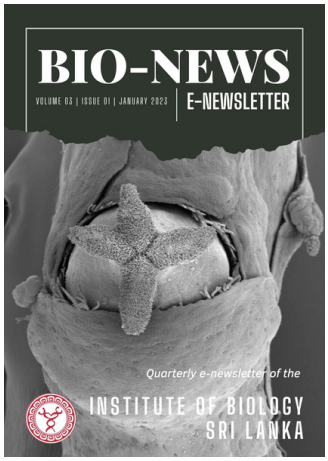

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