BIO-NEWS

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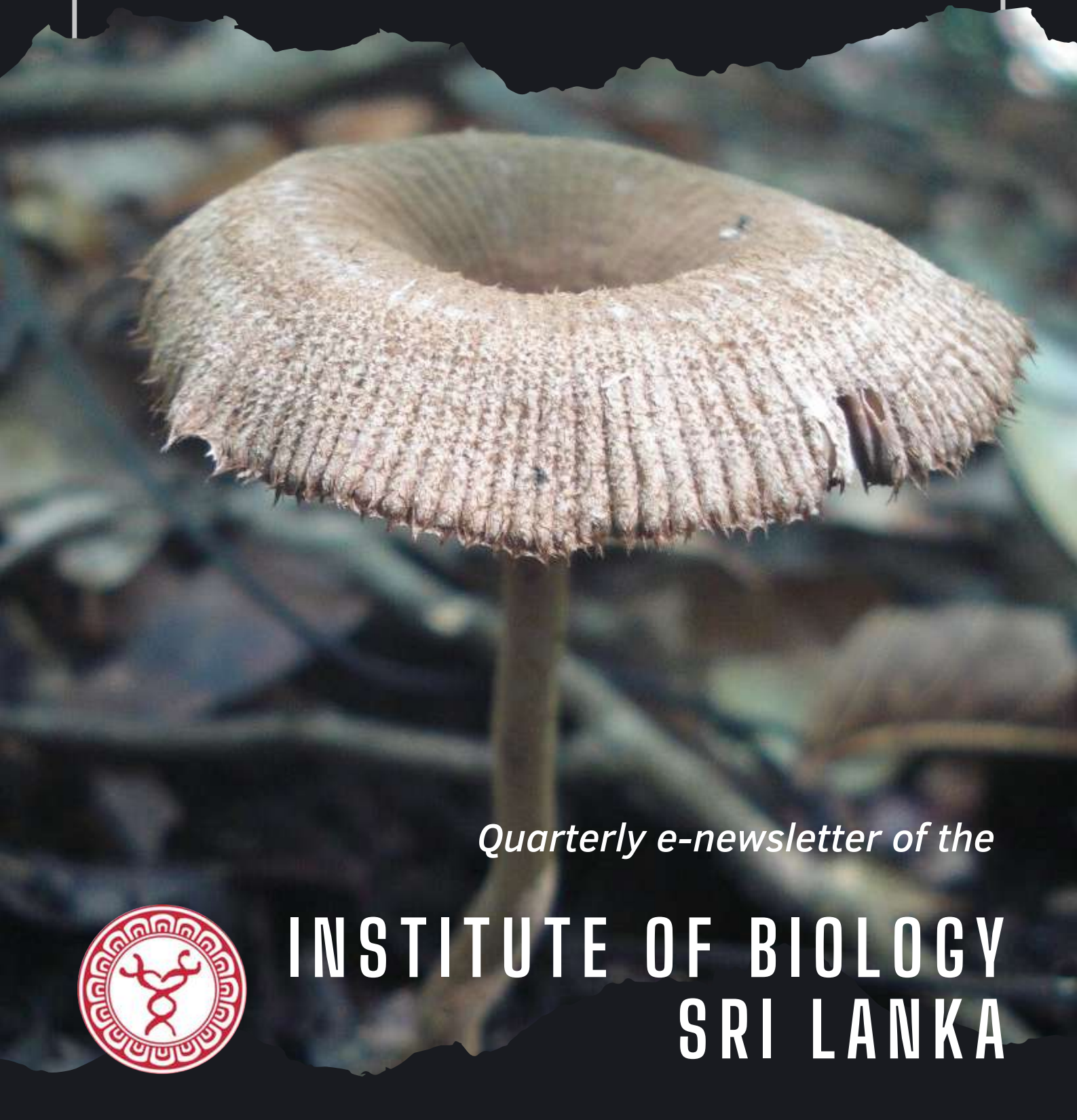
E-NEWSLETTER



Quarterly e-newsletter of the

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COVER STORY

Panus similis consists of solitary basidiocarps and a characteristic feature of this species is the strongly plicate striate pileus. Furthermore, both the upper surface of the pileus and the stipe are covered with fine hairs. This genus represents an independent origin of the agaricoid habit in the Polyporales, as such, *Panus* sp. is placed in the family Polyporaceae even though they are gilled mushrooms. This particular specimen was collected from the Sigiriya wilderness in Sri Lanka, on fallen angiosperm wood. In addition, this species has been reported in the Malaya, Borneo regions, Africa and India.

Photograph by Dr. Surani Ediriweera
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PRESIDENT'S MESSAGE

It brings me great pleasure to send this message to BIO-NEWS, the e-newsletter of IOBSL.

Since its inception in 1981, the Institute of Biology, Sri Lanka (IOBSL), the country's leading professional body for biologists, has played a pivotal role in Sri Lanka on a variety of fronts. The institute primarily seeks to develop biological sciences and promote biology education and their applications in the country. In keeping with this objective, IOBSL organizes a number of events and activities annually, including an inter-university biology quiz, a young scientist of the year competition, a thematic publication, the Biology Olympiad, and a variety of seminars and workshops at different levels. Consequently, at present, the IOBSL has grown to be a sought-after institute for scientists, scholars, and students in the country.

IOBSL currently has over 600 corporate members who are competent in a wide range of biological disciplines, and thus I believe it has a critical obligation to contribute to the country's long-term economic progress. In response to this pressing need, IOBSL will focus its activities in the coming year under the theme "Achieving a Circular and Sustainable Bioeconomy: The Role of Microbes". Sri Lanka has immense potential to establish a sustainable bioeconomy based on its biological resources. The IOBSL has planned a number of activities and programs centered on the selected theme, and we believe that our membership will actively participate in these efforts. The year's thematic publication will also center around the same theme, and we gladly invite our membership to respond positively by submitting chapters that will benefit the readership.

BIO-NEWS, launched by IOBSL in 2020, has evolved into a platform for the dissemination of knowledge, providing updates, and linking the institute with the community. Compiling the newsletter is a massive task, and I would like to convey my heartfelt gratitude to the editorial board and everyone who has contributed.

Finally, I would like to extend a warm invitation to all our stakeholders to share their thoughts with us and to stay involved with the IOBSL to take it to even greater heights.

Dr. Sameera Ariyawansa
President (2023/2024)
Institute of Biology, Sri Lanka (IOBSL)

Happy

New Year

2024

We wish all IOBSL members a very happy new year!

May this year bring you abundant joy, success, and countless opportunities for scientific exploration and achievement...

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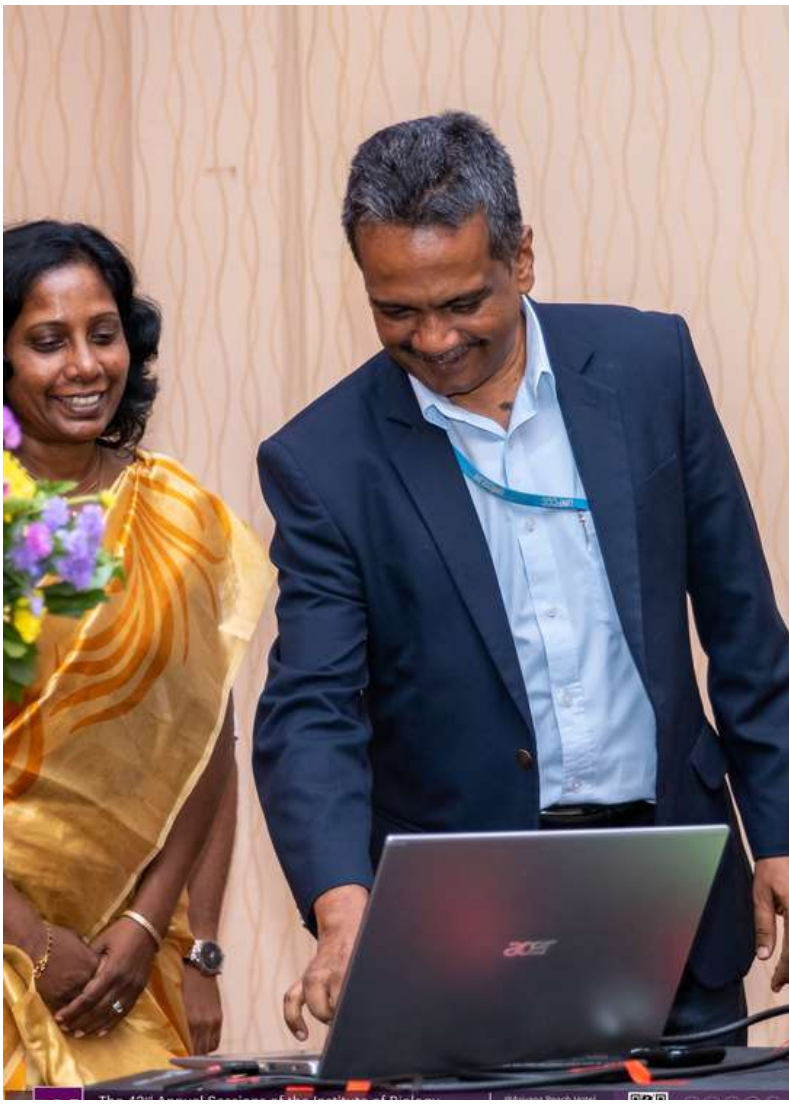
IOBSL NEWS AND EVENTS

IOBSL's 43rd Annual Sessions and the Annual General Meeting

The Institute of Biology, Sri Lanka (IOBSL), hosted its 43rd Annual Sessions and Annual General Meeting at the Ariyana Reach Hotel in Maharagama on September 22, 2023. A significant highlight of the event was the Keynote Address on 'Natural Capital Management,' delivered by Prof. Buddhi Marambe from the Faculty of Agriculture at the University of Peradeniya, Sri Lanka. His address provided valuable insights into the sustainable management of natural resources, setting the tone for a day of intellectual exploration.

In a noteworthy tribute, the IOBSL proudly honored Prof. D. P. S. T. G. Attanayaka this year for his exceptional contributions to the fields of Genetics, Plant Breeding, and Molecular Biology. This recognition added a profound dimension to the event, emphasizing the institute's commitment to acknowledging and celebrating noteworthy achievements in the biological sciences.

Another key highlight of the event was the official launch of the IOBSL thematic publication, 'Biological Wealth for Economic Prosperity'. This insightful eBook, co-edited by Prof. Chandrika Perera and Dr. Rinukshi Wimalasekera, promises to be a valuable resource, embodying the institute's commitment to promoting biological knowledge for economic advancement.



Furthermore, outstanding achievements of young biologists were formally recognized, with winners of the IOBSL Inter University Biology Quiz, Inter University Biology Challenge, *e*-photography competition, and the prestigious Young Scientist Award receiving their certificates and medals. Dr. Asanka Sanjeewa, from the Department of Biosystems Technology at the Faculty of Technology, University of Sri Jayewardenepura, was honored with the Young Scientist Award 2023 for his exceptional contributions in the field of Marine Bioresource Technology.


Annual Sessions of the Institute of Biology
y IOBSL (Institute of Biology Sri Lanka).
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The 43rd Annual Sessions of the Institute of Biology
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UPCOMING EVENTS 2024

Inter-University Biology Quiz Competition

e-Photography Competition

Inter-University Biology Challenge

Young Scientist Award

Courses Workshops Webinars

IOBSL Oration

Thematic Publication

Annual Sessions

For more information
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The Institute of Biology
Sri Lanka

Thematic Publication
2023

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Current Trends in Biopolymer-Based Food Packaging

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With rapid population growth, urbanization and industrialization, the utilization of petroleum-based plastics has been exorbitantly propelled over the last five decades or so. Plastics are almost indispensable and have become an integral part of our daily lives. However, the improper disposal and mismanagement of plastic waste, the toxic additives in various plastic materials, and their poor biodegradability have threatened the environment and human health. Numerous studies are underway to reduce plastic usage and pollution by developing environmentally benign and sustainable substitutes for petroleum-based plastics.

Biopolymers and their major classification

In recent years, biopolymers have received significant attention as an alternative to petroleum-based plastics. Biopolymers are polymeric materials of natural origin and are biosynthesized by living organisms or chemically synthesized by biological substances.

Therefore, according to their origin, biopolymers can be categorized as natural and synthetic. Natural biopolymers include polysaccharides, polypeptides, polynucleotides, lipids and natural rubber, whereas synthetic biopolymers include polyvinyl alcohol (PVA), polylactic acid (PLA), polyhydroxyalkanoate (PHA). Figure 1 shows the major classification of biopolymers.

Biopolymers possess intriguing characteristics such as relative abundance, renewability, low cost, non-toxicity, high chemical and physical properties, light-weight, and tunable surface characteristics. Interestingly, biopolymers and their derivatives are expected to replace many conventional plastics in various fields, including packaging, energy, construction, medical, and agriculture. Among those fields, biopolymers have been broadly investigated for novel food packaging applications, replacing conventional petroleum-based plastic, metal and glass packaging materials.

Current trends in biopolymer-based food packaging

Food packaging plays an imperative role in the food processing sector by safeguarding foods from their origin until the moment of consumption.

Food packaging helps to limit the addition of food preservatives, minimize post-harvest damage during transportation, handling and storage, and reduce food waste. Most importantly, food packaging protects food from chemical (moisture, carbon dioxide, oxygen, temperature, and light), physical (shock and vibration during handling and transportation), and biological damage (rodents, microorganisms, and other animals) while preserving its quality and improving the shelf life. Current trends in food packaging using biopolymers include edible food packaging, active packaging, and intelligent packaging.

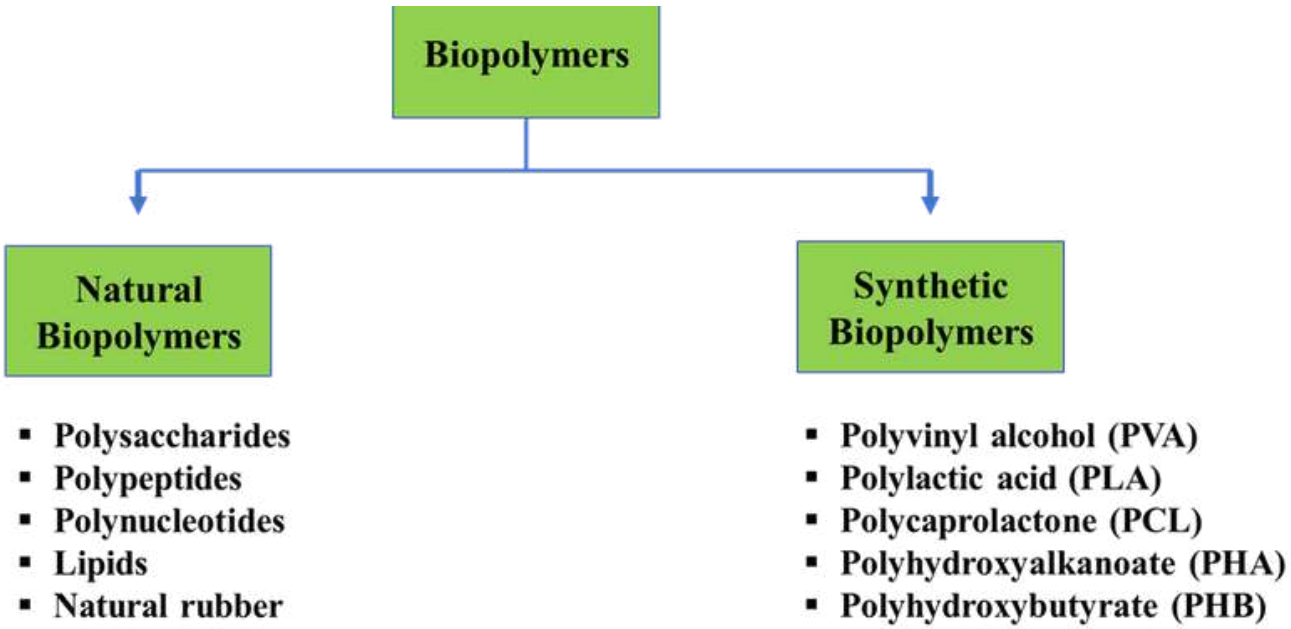

Figure 1 Major classification of biopolymers based on the source of origin

Edible food packaging

Edible packaging is a novel and sustainable food packaging system designed to be consumed or biodegraded after use. Edible packaging systems also possess the characteristics of regular packaging materials. The primary function of edible packaging is to reduce moisture loss, air permeability and exposure to light. This novel packaging technology enhances the safety and quality of highly perishable processed and fresh foods. According to future market insights (FMI), the biopolymer-based edible packaging market is expected to be USD 4.28 billion in 2033 as compared to USD 1.10 billion in 2023, with a compound annual growth rate (CAGR) of 14.31% over the forecast period. Biopolymers, including polysaccharides, proteins, and lipids, have been widely used to prepare edible packaging materials.

The most widely used polysaccharides for edible packaging include starch, cellulose, pectin, hemicellulose, chitin, chitosan, alginates, pullulan, and carrageenan. Edible packaging materials prepared from proteins include wheat gluten, whey protein, casein, gelatin, soy protein, sesame protein, and corn zein. Waxes, paraffin, and glycerides are the broadly applied lipids. Two major types of edible packaging systems are edible films and edible coatings. The terms edible films and coatings are used interchangeably; however, there is a clear distinction in how they are incorporated into the food product. An edible coating forms a thin layer of coating on a food product by immersing the food in a single or multicomponent solution matrix with biopolymers. On the contrary, an edible film is a thin film made of edible material, which is then placed on or between food products. Edible films are moulded into thin solid sheets and applied as wrapping paper. Figure 2 depicts different types of edible films in various foods.

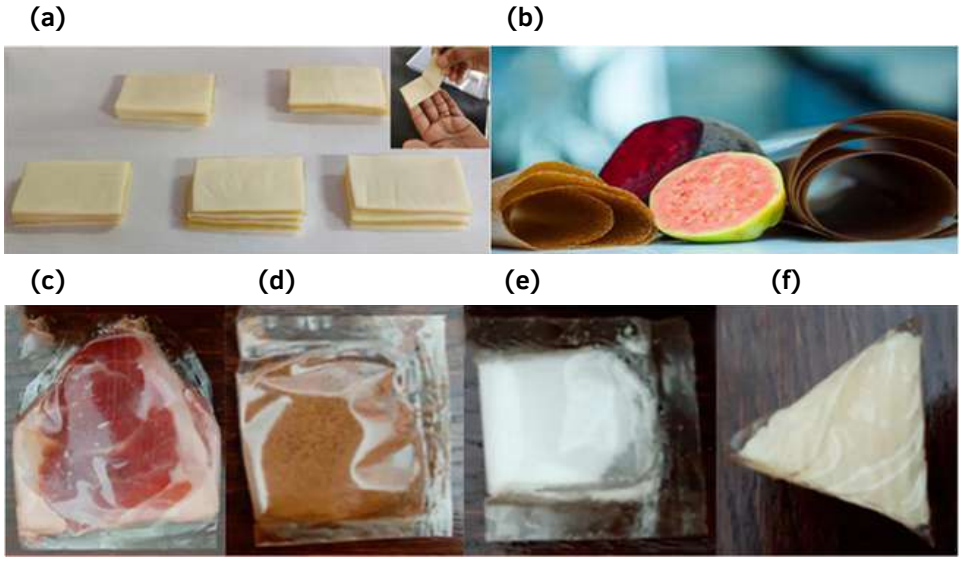

Figure 2 Application of different types of edible films in various foods. (a): Soybean aqueous extract-based nanocomposite edible film applied as cheese slice separator, (b): Guava (left) and beetroot (right) purees produced edible films, (c) – (f): Sodium alginate based edible film applied in meat slices, soluble coffee powder medicine and cheese slice, respectively.
Source: Kumar et al (2022)

Active food packiging

Active packaging (AP) is a novel food packaging technique that uses active ingredients, including nanoparticles, to prevent food spoilage and microbial contamination and extend shelf life. AP helps reduce foodborne diseases, food waste and electricity costs related to refrigeration. The AP technique involves the release of nontoxic antimicrobial agents, antioxidant agents, or agents capable of capturing gases such as oxygen that enhance food degradation. Natural flavonoids, polyphenols, and essential oils are some examples of active agents. The active agents are generally released directly onto the surface of the food or indirectly into the headspace between the packaging material and the food. The most broadly tested biopolymers for AP include cellulose, starch, chitosan, alginate, pectin, agar, carrageenan, dextran, whey protein, and casein.

Recently, encapsulation technology has also been employed in active food packaging, allowing the controlled release of active agents and subsequently improving the shelf life of food. Figure 3 depicts an overview of active packaging using biopolymers.

Intelligent food packaging

Intelligent packaging (IP) is another cutting-edge novel food packing system that monitors the condition of packed food and the surrounding environment in real-time. The IP system has the ability to communicate the condition of the packed food to the customer without directly interacting with the food product. IP systems work on different sensors and indicators that identify, record, and transmit the quality of the food and storage conditions while monitoring relative humidity, gaseous composition, temperature, pH, and time. Natural pigments such as anthocyanins, curcumins, and carotenoids have been used as pH sensors to monitor pH using colorimetric changes.

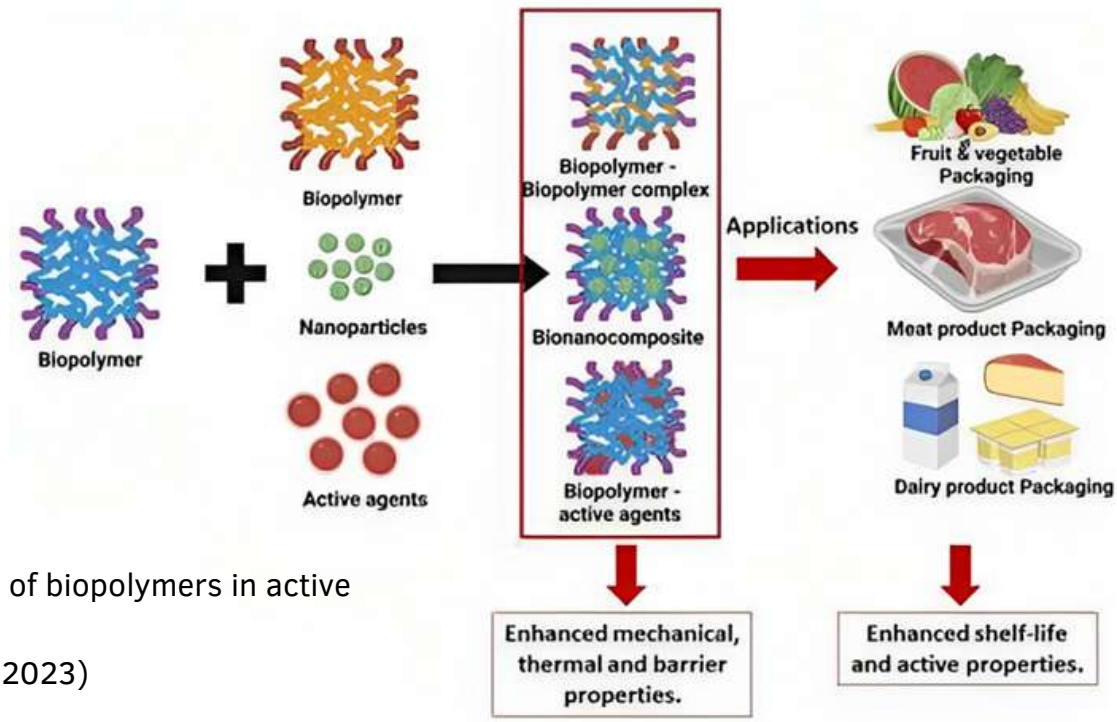

Figure 3 An overview of biopolymers in active food packaging
Source: Perera et al (2023)

Cellulose, chitin, chitosan, starch, gelatin, agar, pectin, carrageenan, casein, zein, and whey protein are widely used biopolymers in IP systems.

Furthermore, composite and multilayer films prepared from biopolymers are the most recent additions to the packaging industry. Composite films blend two or more biopolymers to achieve synergistic effects and functions of different matrices. Conversely, multilayer films are fabricated from two or more different biopolymer layers, enhancing mechanical, barrier, loading, and functional properties. The biopolymers used in producing composite and multilayer films include polysaccharides, proteins, and lipids.

In summary, biopolymer-based food packing systems offer simple, environmentally benign, energy-saving, cost-effective, renewable, and sustainable alternatives for petroleum-based food packaging materials. However, despite the recent significant improvements in the innovation and development of biopolymer-based packaging materials, there are still some limitations and challenges to overcome before they are implemented commercially.

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Biogeographical Influence on Avian Distribution

Biogeography is shaped by the integration of biological and geographical principles, encompassing the examination of the spatial arrangements of organisms and the various influences that determine these arrangements. This interdisciplinary field explores the impact of factors like geography, climate, ecology, geology, and evolution on the distribution patterns of living organisms.

After the extinction of non-avian dinosaurs and pterosaurs at the Cretaceous-Paleogene boundary, numerous modern bird orders emerged and diversified, exhibiting a range of adaptations. The species richness of birds is extensive in tropical areas near the equator and diminishes towards the poles, a phenomenon explained through evolutionary, ecological, and historical theories. The geographical shift in resource availability leads to a decline in the capacity to support species with increasing latitude. According to the evolutionary hypothesis, the rates of speciation, extinction, and immigration vary across latitudes. Historical hypotheses propose that greater diversity in older ecosystems results from the extended time available for species accumulation, and the reduced frequency of repeated recolonization at lower latitudes contributes to higher species diversity.

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The establishment of species richness in a specific region is shaped by dispersal, extinction, and speciation processes. Speciation initiates with the accumulation of genetic differences among populations, leading to reproductive isolation. Allopatric speciation is characterized by the geographical separation of populations without any contact (Figure 1). Parapatric speciation occurs between populations with continuous gene flow. Additionally, a rare (probably only theoretical) occurrence in birds is sympatric variation, where reproductive isolation evolves without geographical separation.

The geographical separation of a population by a geographical obstacle, such as the oceans created through tectonic rifts or historical events like mountain uplifts, is termed vicariance. This process gives rise to allopatric speciation, creating similar biogeographic patterns among the separated populations. The ability of bird groups to disperse across geographical barriers results in the accumulation of genetic variations among these populations.

Various bird species occupy a range of habitats, and to optimize their utilization of these environments, birds exhibit anatomical adaptations such as beaks, feet, and plumage patterns, physiological adaptations including salt excretion, and behavioral adaptations like migration and diving. Physiological adaptations enable them to thrive in challenging environmental conditions such as cold regions and deserts. Anatomical adaptations assist in efficient food consumption, while plumage patterns aid in camouflage, helping birds avoid detection by predators.

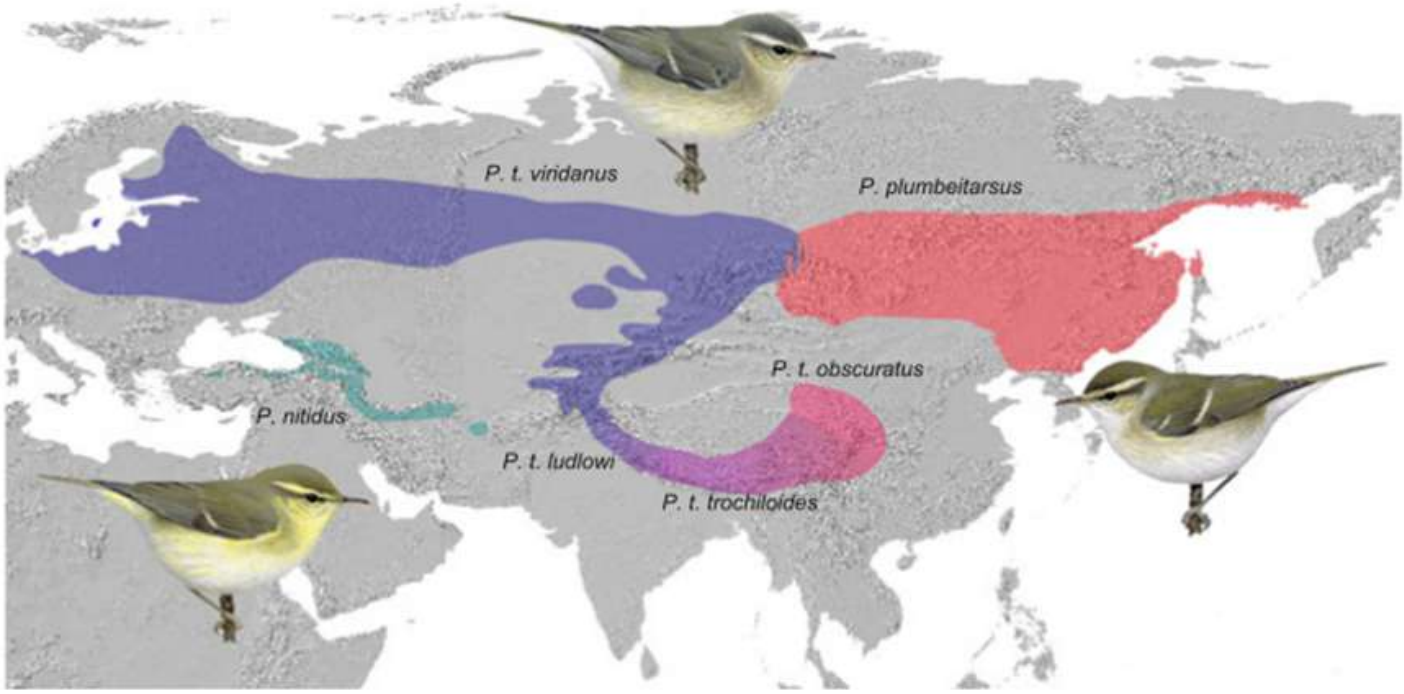

Figure 1 Geographical distribution of different taxa of Greenish Warbler
Source: Irwin et al (2002), Schweizer and Liu (2018)

Habitat

A habitat refers to a geographic region that a species utilizes to meet one or more of its fundamental needs, whether on a permanent or temporary basis (Figure 2). These needs encompass essentials like water, food, shelter, mates, and favorable conditions for reproduction. Birds, having adapted to various habitats, are found across continents. The distribution patterns exhibit considerable diversity, ranging from species confined to a single oceanic island or a specific habitat in a limited geographic area (endemics) to those with a cosmopolitan presence across continents.

No bird species is entirely cosmopolitan. However, the Peregrine Falcon (*Falco peregrinus*) nests on every continent except Antarctica, and the Osprey (*Pandion haliaetus*) breeds on five continents, with the sixth (South America) being visited during migration (www.eBird.org). Endemic species are confined to limited geographic regions, such as Yellow-eared Bulbul, which can be seen from mid-hills to high hills in the montane region of Sri Lanka.

Different bird communities exist across different levels of habitat subdivision. Terrestrial habitats, which are one of the major categories, can be further divided into forest and non-forest habitats. Forests, characterized by canopies with multiple strata, differ from non-forest habitats, that include open scrub, grasslands, and human-constructed areas. Aquatic habitats, distinguished by seasonal or permanent water coverage, can be categorized as seasonal or perennial aquatic habitats.

Birds exhibit strong associations with their preferred habitat types, making subtle changes in habitat influential in altering the bird composition of a particular area. The dynamic movements of birds across different habitats are observable with seasonal changes. Habitat parameters and fragmentation play pivotal roles in influencing the distribution of bird communities, reflecting inter-specific dynamics and population trends tied to habitat characteristics.

Distinct bird communities are found in various habitats, including dense forests hosting species like Flycatchers and Pigeons, grasslands featuring Cisticolas, shrubs inhabited by Warblers, paddy fields with Pipits, streams with Kingfishers, and mountain ranges hosting Raptors. Forests characterized by diverse habitat conditions support a greater variety of bird communities. Shifting from medium to poor ecological conditions, such as transitioning from forests to non-forest areas, coincides with changes in bird communities.

Elevation

In general, species richness is more pronounced at lower elevations and decreases as elevation rises. Moreover, there is a shift in species assemblages at higher elevations. However, when considering a continuous gradient from sea level, the highest species richness occurs at mid-elevations due to a blending effect, combining species from both low and high-elevation assemblages. Consequently, the diversity of numerous bird clades reaches its highest point in low to midland tropical regions.

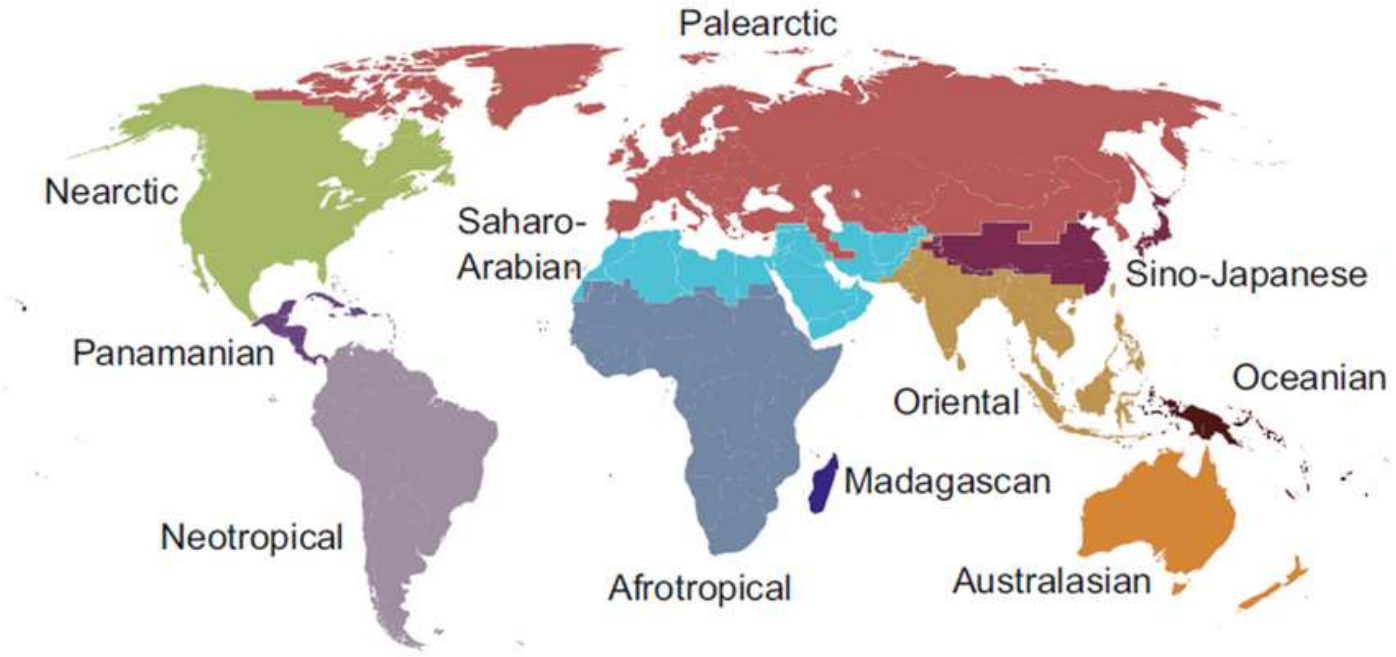

Figure 2 The world map illustrating updated biogeographic regionalization depending on global distribution data and phylogenetic data of non-pelagic birds, non-marine mammals and amphibians by Holt et al (2013).
Source: Schweizer and Liu (2018)

Additionally, studies indicate a decline in tree growth rates and fruit crop production with increasing elevation. Tropical montane birds exhibit limited elevation distributions influenced by various abiotic and biotic factors or processes.

Birds along elevation gradients exhibit constraints on their ranges, with closely related species reported to limit their distribution due to interspecific competition (Figure 3). In replacement zones, where different species overlap, aggressive territorial behaviors are observed in response to the songs of congeners. Interspecific competitive interactions in Neotropical birds result in these species being confined to narrow ranges. Warming of montane landscapes leads to upslope range expansion by generalist competitors, resulting in high-elevation specialist species being squeezed into smaller mountaintop habitats.

Vegetation

The number of tree species tends to decline as elevation increases. Vegetation plays a crucial role in shaping terrestrial habitats and influencing habitat selection. Moreover, it serves as a source of food and substrate for foraging, as well as providing shelter. The composition and structure of vegetation undergo changes as elevation increases. Consequently, the distribution ranges of certain birds are constrained by alterations in vegetation associated with different habitats along the elevation gradient.

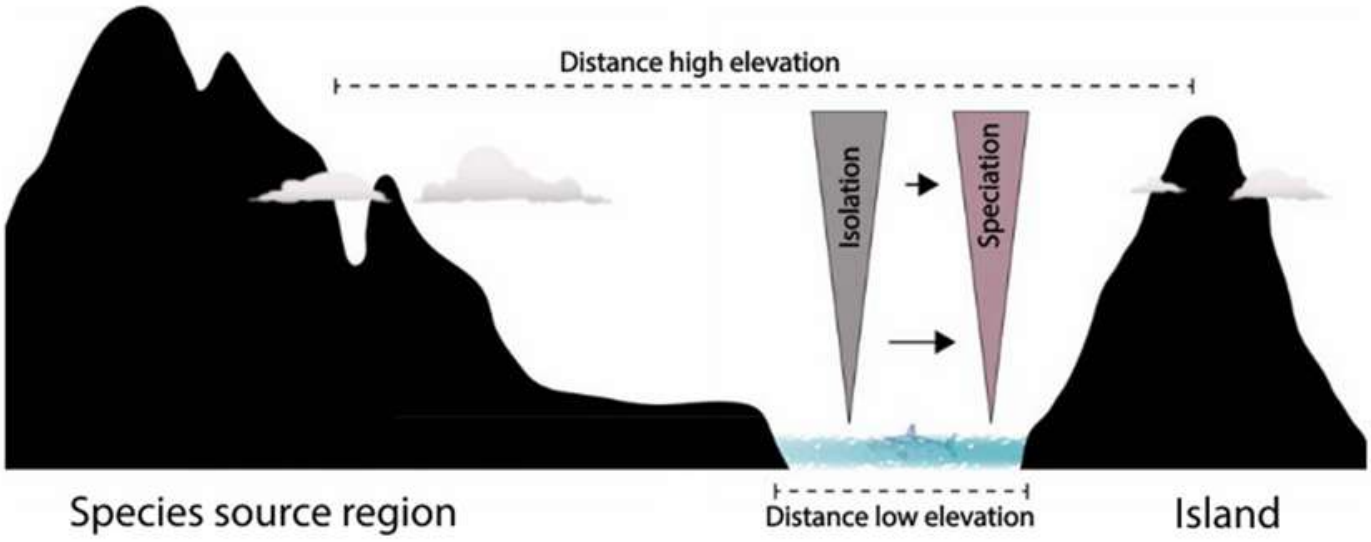

Figure 3 Higher elevations or on islands more isolated ecosystems are available. Higher speciation rate can also be seen with greater isolation.
Source: Steinbauer et al (2016)

In considering the foraging guilds of birds, the configuration of vegetation significantly influences the habitat preferences of both insectivores and omnivores. Insectivorous birds, characterized by species-specific, inflexible, and time-intensive foraging behaviors aimed at locating elusive prey, are affected by diminished productivity.

At higher elevations, compensating for lower productivity by increasing the foraging area is more feasible from an energetic perspective for frugivores, granivores, and trap-lining nectarivores. Open canopy areas exhibit higher avian species richness and diversity compared to the interior of closed-canopy forests. To comprehend the impact of biotic interactions on the distribution of bird species, it is crucial to investigate the relationship between birds and vegetation. Conversely, certain birds play a vital role in the survival of vegetation as they contribute to pollination and fruit dispersal.

The composition of tree species is a key predictor for avifaunal foraging guilds, particularly for frugivores, granivores, and nectarivores, with less significance placed on vegetation structure compared to tree species composition. In temperate regions, a strong correlation exists between the structure and species composition of vegetation and avian assemblages.

Overall, the distribution of life varies according to factors like geography, geology, climate, ecology and their evolutionary past. The decline of birds towards the polar regions is described in historical, ecological and evolutionary hypotheses. Birds select particular habitats to ensure they can meet their basic requirements such as food, water, shelter and reproduction. Along the elevational gradients, species availability is higher at mid-elevations, probably due to the mid-domain effect. The habitat diversity, elevation, and vegetation cover inevitably influence the distribution of birds across varied landscapes.

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UPDATES ON THE LATEST RESEARCH

From Diapers to Delicacies: Transforming Diaper Waste for Sustainable Cultivation of *Pleurotus* Species (Oyster Mushrooms)

Among the Basidiomycetes, the *Pleurotus* genus, colloquially known as oyster mushrooms, holds a distinguished status. The origins of *Pleurotus* cultivation trace back to Flank's pioneering efforts in Germany during the year 1917. Within the diverse array of cultivated mushrooms, the *Pleurotus* genus stands out significantly due to its wide variety. These mushrooms, revered for their culinary excellence, stand as prominent figures within the global fungal landscape, contributing impressively to over 25% of the world's total mushroom yield. Rich in proteins, fibers, carbohydrates, vitamins, and minerals, *Pleurotus* species emerge as a notable dietary choice. They boast a well-rounded nutritional profile, low in calories, fats, and sodium, while also offering a pleasant aroma and culinary versatility.

Different nutritional compositions of the *Pleurotus* species have been widely reported. *Pleurotus* species are notably regarded for their substantial protein content, ranging from 11 to 42 g per 100 g dried fruit bodies, which have been reported from different studies with different species of *Pleurotus*. In contrast to protein-rich sources like meats and poultry, *Pleurotus* species stand apart by lacking cholesterol and instead containing ergosterol. This compound, linked to various biological functions, can be transformed into vitamin D through irradiation, serving either as a dietary supplement or as a valuable addition to food products.

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Pleurotus species have captured scientific attention due to their promising therapeutic attributes. Over the past decade, there has been an exponential surge in patents and scientific publications dedicated to this genus. Investigations have underscored the therapeutic potential of these mushrooms, spanning a spectrum of benefits including antihypercholesterolemic, antihypertensive, antidiabetic, antiobesity, antiaging, antimicrobial, antioxidant, and hepatoprotective activities. With these manifold potential advantages in mind, the applications for *Pleurotus* mushrooms are indeed numerous.

Pleurotus species display a distinctive morphology. Their caps are fan-shaped or oyster-like, often ranging in size from small to medium. The cap's surface can be smooth or slightly textured, and it usually exhibits various shades of white, cream, brown, or gray, depending on the species.

Beneath the cap, the gills or pores are a defining feature. These structures radiate from the stem and contribute to spore production. Oyster mushrooms typically have decurrent gills, meaning they run down the stem to varying degrees. The gills can appear whitish to pale gray, and in some species, they may develop a pinkish tint as they mature. The stem of *Pleurotus* mushrooms is often eccentrically attached, meaning it is off-center. The stem's color tends to match the cap or be slightly lighter, and it can vary from cylindrical to slightly flattened. Overall, the morphology of *Pleurotus* species is characterized by their unique cap shape, gill arrangement, and color palette, making them easily recognizable within the fungal kingdom.

Oyster mushroom cultivation in Sri Lanka

Oyster mushroom cultivation in Sri Lanka has garnered high interest due to its potential as a sustainable and economically viable agricultural practice. The tropical climate and abundant agricultural residues in Sri Lanka offer favorable conditions for oyster mushroom cultivation. The cultivation process typically begins with substrate preparation. Locally available agricultural wastes such as rice straw, paddy husk, coconut coir, and banana leaves are commonly used as substrates. These materials are usually treated through processes like soaking, boiling, and drying to reduce microbial contamination and enhance substrate properties. Spawn, which is essentially fungal mycelium grown on a suitable substrate, is then introduced to the prepared substrate. This inoculation process initiates mycelial growth within the substrate, facilitating the colonization of the substrate by the oyster mushroom mycelium.

Temperature and humidity control play crucial roles in the cultivation process. Oyster mushrooms thrive in the temperature range of 25-30°C (77-86°F) with relative humidity maintained at around 80-90%. Adequate ventilation is essential to prevent the buildup of carbon dioxide and promote healthy mushroom growth.

As the mycelium spreads through the substrate, primordia, or small mushroom pins, start to develop. These primordia grow into mature mushrooms within a relatively short span of time, typically 1-2 weeks. Harvesting occurs when the mushrooms are at their optimal size, just before the caps flatten out completely. Mushrooms are harvested by carefully cutting them at the base, leaving a portion of the stem intact to ensure that new primordia can develop for subsequent flushes. Oyster mushroom cultivation in Sri Lanka not only offers edible yields but also contributes to waste recycling and livelihood enhancement. The spent mushroom substrate can be further utilized as compost or organic fertilizer. Additionally, the cultivation process can be integrated with existing agricultural practices, creating a sustainable and diversified agricultural system.

Use of diaper waste as a substrate material for mushroom cultivation

Diaper waste, stemming from its widespread usage, has raised concerns due to its potential environmental impact. The intricate composition of disposable diapers, often comprising plastic, cellulose, superabsorbent polymers, and other materials, can result in varied consequences when improperly managed.

Plastic components within diapers pose a substantial challenge, as they are non-biodegradable and contribute to long-term litter and pollution. When discarded in landfills or improperly managed, plastic components can persist for decades, detrimentally affecting terrestrial and aquatic ecosystems. Efforts to mitigate these impacts have included exploring sustainable waste management practices and alternative diaper materials. The utilization of diaper waste as a substrate material for mushroom cultivation presents an innovative approach within the realm of sustainable agricultural practices. Diaper waste, rich in cellulose and absorbent polymer materials, holds potential as a substrate due to its fibrous and organic composition.

In 2022-2023, research conducted at the Department of Plant and Molecular Biology, University of Kelaniya started investigating the potential utilization of diaper waste as a substrate material for *Pleurotus* cultivation presenting an innovative approach within the realm of sustainable agricultural practices. Diaper waste, rich in cellulose and absorbent polymer materials, holds potential as a substrate due to its fibrous and organic composition. *Pleurotus ostreatus*, *P. eous*, *P. djamor* and *P. cystidiosus* are the selected species based on their popularity among consumers.

The cultivation process begins with the collection and preparation of diaper waste. This involves the segregation of used diapers, removal of plastic components, and manual shredding to achieve a suitable particle size for fungal colonization. Prior to use, sterilization is carried out to eliminate potential contaminants and pathogens present in the diaper waste. The prepared diaper waste in different ratios (1%, 2%, 4% and 6%) is mixed with the prepared substrate using sawdust of rubber, rice bran, Quicklime CaO, Epsom $MgSO_4$ and soya flour on a dry weight basis (Figure 1). The diaper waste-containing substrate is then inoculated with mycelium from selected *Pleurotus* spp. due to their ability to degrade cellulose-rich materials. Mycelial inoculation is conducted using established techniques such as spore inoculation or grain-to-substrate inoculation.

Controlled environmental conditions are crucial for successful mycelial colonization and subsequent fruiting body formation. The temperature and humidity range conducive to mycelial growth varies depending on the species selected and the specific diaper waste composition. Proper ventilation and airflow management are maintained to prevent the accumulation of carbon dioxide and ensure optimal mycelial development. As mycelial growth progresses, primordia, or early stages of mushroom development, begin to form within the diaper waste substrate. Fruiting body formation follows, and once mature, the mushrooms are harvested by carefully detaching them from the substrate (Figure 2).

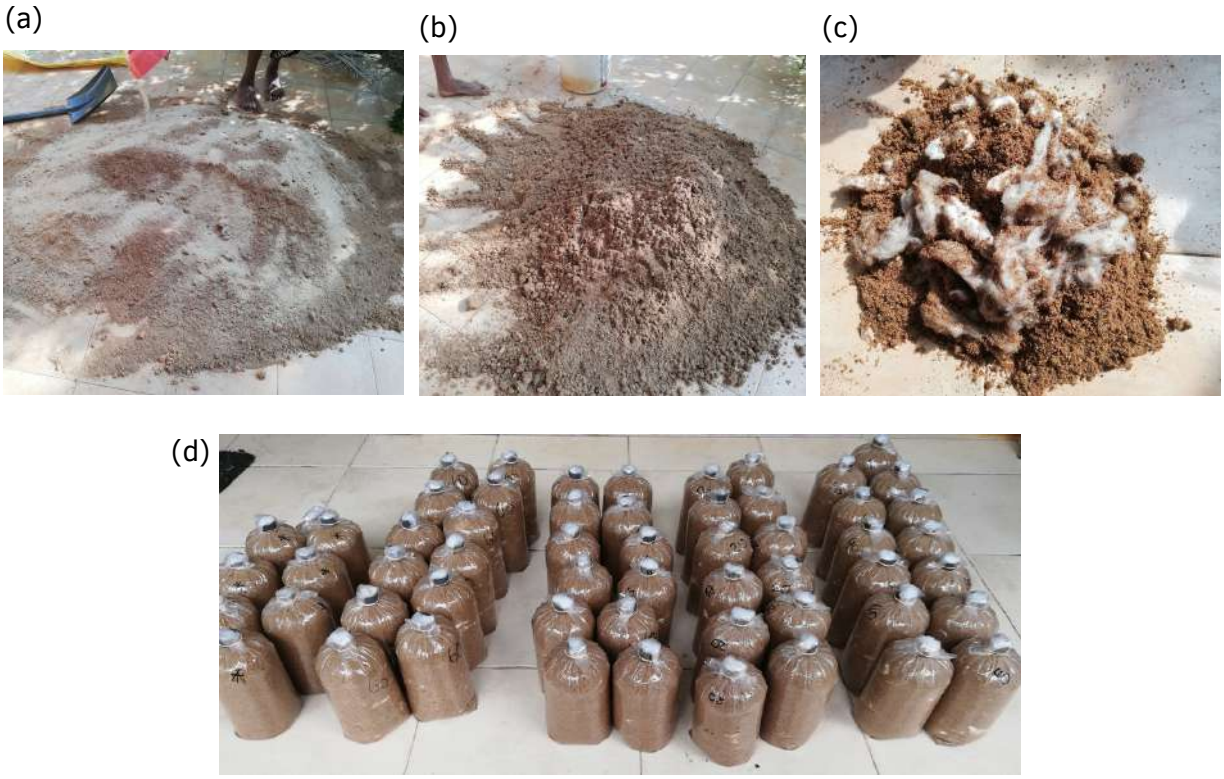

Figure 1 Preparation of mushroom growth substrate. (a): Mixing of the ingredients, (b): Addition of water in the required quantity, (c): Mixing of diaper waste in specific quantities, (d): Packing into polypropylene bags for sterilization.
Photo Credit: Ms. Irani Nawarathna, Department of Plant and Molecular Biology, University of Kelaniya, Sri Lanka

Figure 2 Developmental stages of fruiting bodies of *P. djamor* in the highest-yielding treatment (4% (40 g/kg) of diaper waste). (a): Primodia development, (b) and (c): Early stages of mushroom development, (d): Harvesting stage.

Photo credit: Ms. Irani Nawarathna, Department of Plant and Molecular Biology, University of Kelaniya, Sri Lanka

The integration of diaper waste as a substrate material for mushroom cultivation presents several potential benefits. Firstly, it addresses waste management challenges associated with disposable diapers, repurposing them into a value-added agricultural product. Secondly, the cellulose-rich nature of diaper waste aligns with the nutritional requirements of certain mushroom species, facilitating efficient degradation and nutrient uptake. Lastly, this approach contributes to the circular economy by transforming waste materials into renewable resources.

In conclusion, the use of diaper waste as a substrate material for mushroom cultivation embodies a sustainable and resourceful approach to waste management and agricultural production. This practice showcases the capacity to harness unconventional substrates to support mushroom growth while addressing environmental concerns associated with waste accumulation.

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Ancient Human: Predator or Prey?

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Humans undoubtedly are the dominant species of the modern world with a population of around 8 billion and rising. The path to the top was certainly not easy. Competition from the animals who shared a similar lifestyle and the constant threat of predation compelled our ancestors to evolve into more intelligent and adaptable organisms.

The human ancestors originated in Africa, and much of human evolution happened within the continent. One of the oldest-known hominids *Sahelanthropus*, began the slow transition from ape-like movement somewhere between 6-7 million years ago. Henceforth, they evolved into several genera such as *Australopithecus*, *Paranthropus*, and finally, the genus of modern humans: *Homo*.

Theories and evidences

Whether humans were at a higher trophic level since the beginning has always been an interesting topic. Previously, it was believed that even the earliest hominids were in fact, predators. Dr. Raymond Dart, who first described the species *Australopithecus africanus* supported the idea of it being a predator. He originated the "Killer Ape Theory'', which suggested that war and interpersonal aggression were the driving force behind human evolution. He used his findings from the Makapansgat caves in South Africa to support his arguments. Most of the other fossils were from antelopes and Dart made assumptions about how they got there in the first place.

In his publications, he argued that the ape men were once mighty hunters that had undergone a predatory transition from ape to man. The remaining bones of their prey may have been carved into handy tools and weapons. The idea was further developed by Robert Ardrey in his book "African Genesis". Dart's manner of presenting his view of "the blood-bespattered archives of humanity" managed to facilitate further research on the ways that bones were accumulated in African caves.

However, recent studies have shown the story to be quite the opposite. Re-examination of Taung child's skull in 2005 showed puncture marks in the orbital floors. These punctures are similar to the talon marks made when modern eagles hunt monkeys. This evidence, along with the bone accumulation of small animals at the site with unusual damages strongly supports the hypothesis that a bird of prey was responsible for the trauma of the Taung child (Figure 1).

Another piece of evidence is the SK-54 juvenile skull of *Australopithecus robustus*. Discovered by R. Broom and J.T. Robinson, it was initially used to support the killer ape theory. Later as C.K. Brain suggested, the owner of the skull might have been an unfortunate prey of a leopard. He determined this by matching the lower canines of an African leopard skull SK-349, with the two wounds on both parietals of the skull. The distance between the leopard's canines and the puncture marks was found to be equal (33 mm) (Figure 2).

Figure 1 Taung child skull
source: Clark, C. The Smithsonian Institution's Human Origins Program. (n.d.) Taung Child [online] Available at: https://humanorigins.si.edu/evidence/human-fossils/fossils/taung-child (Accessed: 31 December 2023)

Figure 2 SK-54 skull
Source: Ditsong Museums of South Africa. (n.d.) Picture of Paranthropus robustus, SK 54 showing the puncture marks caused by the lower canines of the leopard. [online] Available at: https://ditsong.org.za/en/fossils-and-the-evidence-they-provide-the-tale-of-sk-54-and-sk-349/ (Accessed: 31 December 2023)

Fossil remnant OH-8, unearthed by Louis Leakey and his team further supports the fact that humans were preyed upon. The teeth marks on the ankle bone are similar to those of a crocodile. The back of the heel is also bitten off (Figure 3).

The earliest hominids were smaller in size and usually had long arms and short legs. Their diet was almost exclusively plant-based, similar to modern gorillas. Therefore, they mostly lived on trees or roamed around the savannahs or grasslands. Later, around the origin of the genus *Homo*, they adopted a more meat-based diet practicing a hunter-gatherer lifestyle. However, there was a constant threat from then-existing carnivores such as saber-toothed cats, carnivorous kangaroos, hyenas, etc. The risk prevailed even when they began to live in caves. Thus, our predecessors were under constant burden, facing not only competition but also the threat of predation.

Figure 3 Fossil OH-8
Source: Clark, C. The Smithsonian Institution's Human Origins Program. (n.d.), OH 8. [online] Available at: https://humanorigins.si.edu/evidence/human-fossils/fossils/oh-8 (Accessed: 31 December 2023)

Rise as apex predators

A recent contradictory study shows that humans have been apex predators for around 2 million years. According to Ben-Dor et al., humans hunted large animals such as wooly mammoth but were forced to switch to a more plant-based diet with the extinction of those megafauna (Figure 4). To lend credence to their theory, they use several factors based on metabolism, genetics, morphology, and physiology.

Dr. Ben-Dor and coworkers point out that humans show a high level of acidity in the stomach which resembles a carnivore more than a herbivore. The reduction in the length of the gut further strengthens this argument, as meat requires less grinding and absorption adaptations than plant materials. Having higher fat reserves than any carnivore or herbivore might have also been advantageous in the path to becoming the apex predator.

Influence on general behavior

Millions of years of being targeted have certainly influenced our behavior. The flight or fight response, intuitive feelings we experience in a doubtful or threatened situation probably evolved as necessities to protect ourselves in the past. Anxiety is an emotion that helped to protect humans in what scientists call an "immediate-return environment" where actions convey clear and immediate outcomes. Stress and anxiety helped them to make quick decisions accordingly. "The range of our color vision evolved partly due to our ancestors who could see more colors and were more likely to spot snakes", says Dr. Lynne Isbell. Another recent study has shown that although not as fast as adults, children are more capable of identifying snakes quickly than they are of identifying other inanimate objects.

Even though most of the truth is yet to be discovered, the already-unveiled information gives us an idea about the diet and the lifestyle of our predecessors and what helped them to survive the long and perilous journey from ape to man.

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Understanding *Toxocara* spp. Infections: Risks and Precautions

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Toxocara is a genus of intestinal roundworms that can infect a variety of mammals. Some of the largest intestinal nematodes belonging to the order Ascaridida, the superfamily Ascaridoidea, and the family Toxocaridae include *T. canis* and *T. cati*. *Toxocara cati*, commonly known as the feline ascarid infects cats while *T. canis*, the canine ascarid, is commonly found in dogs. However, it is important to note that these parasitic nematodes are not limited to furry companions, posing a zoonotic threat to humans as well. In humans, infections caused by either *T. canis* or *T. cati* are referred to as human toxocariasis. This zoonotic disease is mainly transmitted to humans through the ingestion of contaminated food or water. It is prevalent worldwide and is more commonly found in children living in impoverished conditions. Even in highly developed countries, toxocariasis is increasingly recognized as one of the most common zoonotic parasitic infections.

Life cycle and transmission

Understanding the life cycle of *Toxocara* worms is important for finding their impact on hosts and potential transmission to humans. These intestinal roundworms exhibit fascinating life cycle dynamics within their definitive hosts, dogs (canids) and cats (felids). The adult forms of both *T. canis* and *T. cati* reside in the upper digestive tract of their definitive hosts, canids and felids, respectively. Female worms can produce a substantial number of eggs, up to 200,000 per day. When excreted in feces, these eggs are non-infective and require a period in the soil to undergo embryonic development. The ingestion of infective eggs by adult dogs or cats leads to the presence of adult *Toxocara* worms in their digestive tract. The embryonated eggs hatch in the small intestine, releasing larvae that penetrate the intestinal wall (Figure 1). These larvae then enter the bloodstream and pass through the liver and lungs to reach the left side of the heart, from where they are distributed throughout the body via the circulatory system.

Figure 1 Initial stages of *Toxocara canis* development. Eggs in interphase mitosis, embryonated egg with larvae inside, and larvae reaching egg. Phase contrast microscopy, 200X. [online] Available at: https://www.researchgate.net/figure/Initial-stages-of-Toxocara-canis-development-Eggs-in-interphase-A-mitosis-B-and-C_fig1_5304330 (Accessed: 10 November 2023)

These larvae can then infiltrate various tissues, where they can remain dormant for extended periods, a phenomenon referred to as "hypobiosis". In pregnant female dogs, hormonal changes can reactivate these dormant larvae, leading to their migration to the developing fetus through the placenta. This explains why newborn puppies are often infected. However, this transplacental migration of larvae does not occur in cats. In kittens, the primary route of infection is through transmammary transmission, where larvae present in the mother's milk are transmitted to the kittens.

In dogs, this type of transmission is less significant. Infective eggs that are ingested by non-canid and non-felid species follow a similar somatic cycle, ultimately leading to the presence of larvae in tissues, potentially infecting predators that prey on these animals. This mode of transmission is known as "paratenesis". When a dog or cat preys upon an infected paratenic host, the larvae are released from the tissues during the digestion process and complete their development in the host's intestinal tract (Figure 2).

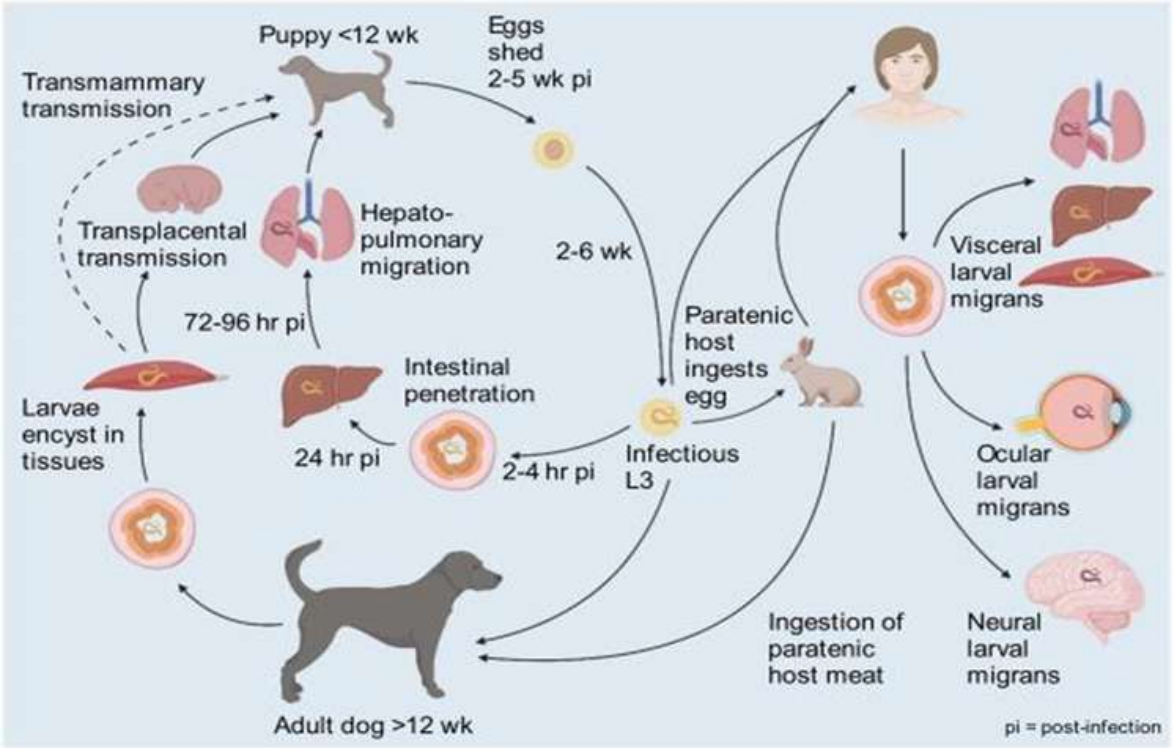

Figure 2 Life cycle of *Toxocara canis*. [online] Available at: https://www.cell.com/trends/parasitology/fulltext/S1471-4922%2822%2900003-4 (Accessed: 10 November 2023)

Symptoms and diagnosis of toxocariasis in cats and dogs

Toxocariasis can manifest with a range of severe symptoms, each presenting unique challenges for both the affected animals and their caregivers. The symptoms in young puppies may include poor growth, an overall decline in condition, and abdominal swelling, giving the appearance of a potbelly (Figure 3). Sometimes, puppies may expel worms in their feces or vomit. Other potential signs of infection include diarrhea, constipation, vomiting, flatulence, coughing, or nasal discharge. Chronic inflammation of the intestines can lead to the thickening of the intestinal wall or intussusception. In severe cases, puppies may experience complications such as gallbladder, bile duct, pancreatic duct obstruction, or even intestinal rupture resulting in peritonitis.

Although infections may be asymptomatic when there are only a few parasites in the intestines, the migration of larvae through the lungs can cause varying degrees of respiratory distress and inflammation, potentially leading to pneumonia, especially if the puppy was infected before birth. Severe infections can also result in complications like ascites, fatty liver degeneration, secondary bacterial pneumonia, or long-term growth impairment. Symptomatic infections are rare in adult dogs, but larval migration may cause elevated liver enzyme levels. Ocular symptoms such as orbital cellulitis and multifocal retinal disease may also occur.

It is important to note that misconceptions about intestinal worms in kittens can lead to underestimating their health risks.

Figure 3 Pot belly – Roundworm infected puppy. [online] Available at: https://parasitesandvectors.biomedcentral.com/articles/10.1186/1756-3305-5-91(Accessed: 10 November 2023)

Severe infections in kittens can manifest as appetite loss, vomiting (especially after eating), alternating diarrhea and constipation, and growth disturbances. Kittens are especially vulnerable, as appetite loss and growth stunting can increase the risk of mortality. Adult cats typically exhibit milder symptoms, but severe infections can lead to life-threatening conditions like stomach perforation, resulting in peritonitis.

There are various methods used to diagnose *T. canis* infections in dogs, such as the fecal flotation technique for patent infections and enzyme-linked immunosorbent assay (ELISA) for non-patent infections. Immunological tests (IHAT) are used to diagnose infections in both dogs as definitive hosts and mice as paratenic hosts. Scanning electron microscopy provides more accurate images of adult *Toxocara* worms compared to direct photography.

Symptoms and diagnosis of human toxocariasis

Turning attention to the human dimension of toxocariasis, exploring its transmission and impact on individuals, particularly children, in various settings is crucial. *Toxocara canis* is the primary causative agent of human cases. Human toxocariasis primarily results from soil transmission, as it is a zoonotic disease. Activities such as geophagia, the consumption of soil, especially in children living in households with untreated puppies, increase the risk of toxocariasis.

Additionally, poor personal hygiene practices and the consumption of raw vegetables grown in contaminated gardens can lead to chronic low-dose infections. Less commonly, zoonotic toxocariasis may be associated with the consumption of raw meat from potential paratenic hosts like chickens, lambs, or rabbits. In humans, *Toxocara* species do not reach the adult stage, and clinical symptoms arise due to the migration of larvae.

The severity of the disease depends on factors like tissue damage, affected organs, larval quantity, age, and the immune response of the individual. Primary clinical syndromes associated with toxocariasis include visceral larva migrans (VLM) and ocular larva migrans (OLM). Other syndromes like covert, neural, and atopic toxocariasis are also recognized. VLM impacts vital organs, is particularly prevalent in children, and is characterized by symptoms such as fever, malaise, and abdominal pain, affecting organs like the liver, lungs, heart, and nervous system. OLM impacts vision, especially in children aged 5 to 10, causing impaired sight, light perception, squinting, and glaucoma. Covert toxocariasis (CT) is milder and often linked to chronic exposure. In adults, it may lead to breathing difficulties, abdominal pain, weakness, rash, itching, and sleep disorders. Children with CT can experience symptoms such as vomiting, lethargy, behavioral issues, coughing, wheezing, limb pain, and skin conditions like eczema, itching, and urticaria.

For diagnosing human toxocariasis, serodiagnostic tests widely employ excretory-secretory antigens of *T. canis* larvae (TES). These antigens are obtained from maintaining infective larvae, and modified protocols have improved antigen yield and purity. Validated serodiagnostic tests using TES antigens help determine the prevalence of human exposure to *Toxocara*. Usually, asymptomatic, human toxocariasis is detected using ELISA to identify anti-Toxocara IgG antibodies. Molecular diagnostic investigations focus on secreted proteins in migrating juvenile *Toxocara* stages, which are relevant for immunodiagnosis.

These proteins are believed to aid the worm in evading host immune responses due to their shedding behavior.

Prevention and control strategies

Preventing the transmission of *T. canis* infection to puppies is crucial. Early and routine medication, such as piperazine compounds and fenbendazole, is effective against the infection. In cases of severe human infections, anthelmintic drugs are used for treatment, often accompanied by anti-inflammatory medications to manage hypersensitivity reactions caused by dying larvae. Ocular disease treatment may involve various approaches, including surgery, laser photocoagulation, and medications to mitigate further eye damage. Control strategies emphasize avoiding egg contamination and minimizing exposure. Molecular vaccines, such as *T. myosins*, show potential for infection control in domestic dogs and cats. Preventing *Toxocara* infections in animals includes deworming puppies and kittens and practicing good hygiene. Adequate removal of dog feces before egg embryonation is vital, with measures like burning, burying, or proper disposal. Promoting personal hygiene, such as handwashing and preventing soil ingestion, is crucial, particularly for children.

To summarize, understanding and treating infections of *Toxocara* spp. is important for the health of our pets and our communities. Prevention and control techniques are critical in the fight against these dangerous parasites. By putting these safeguards in place, we can make our animal companions and ourselves safer, resulting in a healthier and happier relationship.

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INK & IMAGINATION

Kingfishers

Pygmy & three toed to stout billed
To pied and of course the
Commonest of them all - the
White breasted.
A rocket to water and out
Of a disturbance comes out
A turquoise jumper made
Of feathers, and perched on
Top of a street light
With crown or crest, they watch
The water ripple with the
Meditation of a Tibetan monk,
Indulging in a meal fit for a king.
The lesson is all this is, when
A rocket and an ichthyic-submarine
Crash, there is a sense
Of serendipity, a food chain
Going up a rung. A fishtail
Pendulum no longer the entirety of
A scaled torpedo beneath
A lake meniscus. The perfect enigma
In color and etymology,
Splashing out of shallow water,
Like a sprouting fountain,
The art of self-preservation,
To a Zen philosophy.
The newly dappled dew on
A plumage, jeweled like
Faberge eggs and royal scepters.
Finally, a ball of fish bones
Coughed out from the belly
From inside an enclosure at
The very end of a tunnel.

A creature, monk and myth,
In the hermitage of a branch
To a floral splash, before
The wings shatter the
Airborne dust, as through
The mists and dust bowls emerges
A beauty in true blue, bluer than
A cornflower that turns
Into a cloak of kerosene,
Blue that turns a shade darker
Dappled with water, and sublimes
From the brink of sight
To memory's democratic
Oath to pacify beauty.
The type that remembers
And swells until life abdicates
Evolution's paragon, to be
Brought back down to earth.
Not just any bird, but a halcyon,
What calms our temperaments,
And lifts our spirits, to tame
The world around us to
One moment of composure.
Where there are no shoes
Or facemasks, no soup bowls
Or cups of tea, only a bird
Resting on top of a corpus callosum,
Asking for a morsel of respect;
To mercify a race that
Takes a pill to demystify,
Those perched blues.

Dr. Dilantha Gunawardana
M. I. Biol. (Sri Lanka)
Smart Media

NATURE CAPTURES

Mr. Nilanga Ranatunga
Best Biology Photographer of the Year – 2023
IOBSL *e*-Photography Competition

Mr. G. A. Thusitha Lakmal
First Runner-Up (18 years and over) | IOBSL IOBSL e-Photography Competition

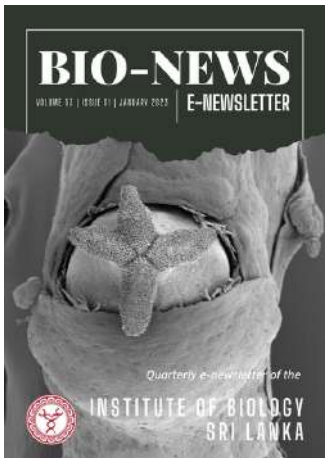
Mr. Thilina Dilsara Roshanara
Second Runner-Up (18 years and over) | IOBSL e-Photography Competition

Mr. Achchuthan Seetharan
Most Popular Biology Photograph of the Year – 2023
IOBSL e-Photography Competition

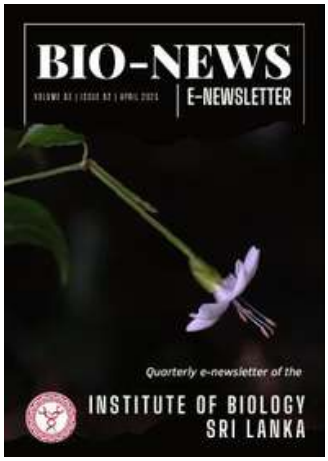
BIO-NEWS

PAST ISSUES

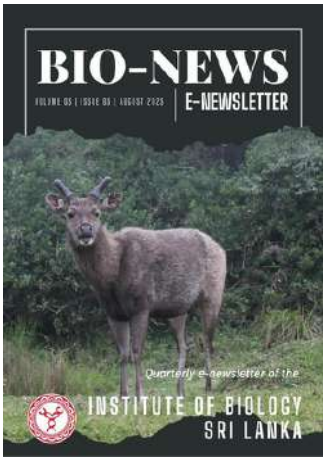
2023



Issue 1



Issue 2



Issue 3

2022

Issue 1

Issue 2

Issue 3

Issue 4

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