GREEN HORIZON

E-Newsletter

Volume 2 Issue 1 21 June 2021

YENEPOYA
[DEEMED TO BE UNIVERSITY]
Recognized under Sec 3(A) of the UGC Act 1956
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Centre for Environmental Studies

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Centre For Environmental Studies

General Information

Green Horizon is a peer reviewed e-newsletter published in English by the Centre for Environmental Studies, Yenepoya (Deemed to be University), Mangalore in two issues per year during June and December. This newsletter publishes manuscript of different categories like original articles, short communications, opinions, research communications, case study etc. We invite original contributions significantly advancing fundamental understanding and that focus on the interconnection of multiple environmental spheres of environment and nature (biodiversity, plants, animals, microbes, conservation, soil, air, water, climate, pollution, waste management, compost, environmental protection, environmental management and ecofriendly approaches). The authors, editors and reviewers need to adhere to the research and publication ethics to enhance the quality of the newsletter.

Aim and Scope
Green Horizon intends to project and share the knowledge on our environment and its protection for the benefit of society. It brings out quality and original materials exclusively on the environment and welfare of the biodiversity. Emphasis should be given to biodiversity, ecology, conservation, waste disposal, prevention of pollution and innovative ideas to protect and nurture our environment towards prolife.

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Printed at
Yenepoya Printers & Publishers, Balmatta, Mangalore 575 001, Karnataka, India

Published by
Yenepoya (Deemed to be University), Deralakatte, Mangalore 575 018, Karnataka, India

Newsletter Design:
Yenepoya Printers & Publishers

Cover page photo credit: Dr. Uma Kulkarni

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CONTENTS

EDITORIAL COMMITTEE

EDITORIAL

We are pleased to release the third newsletter GREEN HORIZON (GH) (Volume 2, Issue 1) of the Yenepoya (Deemed to be University) (YU). With this issue, we are entering the second year of the newsletter! I offer my profound gratitude to the contributors as well as referees for the contributions and suggestions made on time in spite of the second wave of COVID. Most of the discussion about the newsletter was through virtual interviews and interactions. Those who belong to YU and are interested in offering short articles pertaining to the environment for the upcoming issue may submit to greenhorizon@yenepoya.edu.in.

In this issue, we present seven articles and three poems pertaining to the environment. The first article, by the YENCOURAGE group (Yenepoya Psychiatric Rehabilitation and Day Care Centre), deals with green initiative, developing 'green space' around us and its benefits. Now, it is important for all of us to generate more and more oxygen through plants for our survival. The second article discusses the importance of seagrasses in marine environments. Birds attract many people; three articles on birds (full and partial) were dealt with in the earlier two issues, while this issue adds two more articles. The first article narrates a personal experience. It deals with the care provided to a White Cheeked Barbet during the rainy season by Hemanth Prakash and his pet dog. The second is a technical article by Abhishek. It details the management of wing fracture sustained by a Brahminy kite during a kite festival. Likewise, many birds meet with accidents. Aren't they neglected? The article 'Observations on the landslide region in Kodagu (Karnataka)' deals with the causes as well as the natural and artificial rehabilitation tasks undertaken in the last three years.

We read in earlier two issues of GH on the burning problems of COVID throughout the world. This issue projects detailed technical knowhow on waste management during COVID, thanks to Rouchelle Tellis. Of late, the COVID situation is associated with Black Fungus Attack (called mucormycosis), especially the immunocompromised patients. It gives a negative image of fungi although we are benefited by many fungal products like enzymes (e.g. cellulase and xylanase), antibiotics (e.g. penicillin and griseofulvin). The article 'new dimensions in mycology' in this issue projects environment friendly benefits of fungi beyond nutrition and health provides different image to use fungi for the production of variety of merchandise. The first and second waves of COVID taught us clearly how crucial is the oxygen produced by the plants. Now is the time to learn the lessons and to follow afforestation to meet the oxygen requirement of all of us.
'Book News' is an additional feature of this issue to project the new items in books pertaining to the environment published by YU.

I remain in anticipation of suggestions from the contributors and readers to improve the GH to the best extent possible…

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Green Initiative at YENCOURAGE

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Plant Seeds of Happiness, Hope, Success and Love: *It Will All Come Back to You in Abundance*

Plants are an integral part of human life. From securing food source to decorating houses with the best timber, vegetation is quintessential to life. In Indian context, vegetation is akin to a deity! "How felling or cutting of trees was considered as sin and hazardous have been discussed in ancient Sanskrit literature" (Dwivedi, 2017). Pertaining to the Indian culture, plants play a role that goes beyond the colour green. On special occasions, we all use flowers and leaves to decorate our homes. They not only provide us clean air to breath but also a bounty of food, fibre, fuel and so much more. Just the sight of green lush flora boosts our mood, productivity, concentration, creativity and reduces stress, fatigue, absorb toxins, increase humidity and produces oxygen. In ancient civilizations, it was proclaimed that "By planting any kind of trees, useful for fruits and flowers, a person gets a reward of thousand cows adorned with jewels, while cutting a green tree was an unforgiving offense." All religions respect and worship plants in more than one way. According to Buddhist scriptures, "Nature creates as well as preserves life; it is the duty of people to preserve plants considering them as living beings". The Jains consider plants to be important parts of the human existence. In Islam it is encouraged to plant trees and are warned about cutting them down for instance, 'Whoever plants a tree and patiently maintains it and tends to it until its fruition, every single fruit consumed from that tree is regarded by Allah as charity', and the holy Bible says "God made the trees with seed-bearing fruit. He gave us the possibility to increase their number by planting the seeds; we need to learn to do this to continue receiving their benefits" (Mashritha, 2021).

Green spaces like gardens or parks are considered as important determinants of physical and mental health (of a society). They help promote the health and wellbeing in children and adults (McEachan et al., 2018). Therefore, having a green space is a cost effective technique to improve the health and reduce the health disparities (Beyer et al., 2014). Studies suggest that the green acts as a protective factor; there is a direct association between green space and depression, anxiety and stress (Beyer et al., 2014).

Several studies concluded that green spaces help in the restoration and they create opportunities for stress reduction plus positive promotion of mental health through different ways. The studies conducted in western countries suggested that green spaces promote memory recall, relaxed wakefulness, altered cerebral blood flow and brain activation patterns consistent with relaxation, physical (and probably also social) recreation in environments with green space also reduces the risk of minor psychiatric morbidity and facilitates an enhanced sense of self and connectedness with nature (Feng and Astell-Burt, 2018). It arouses forward-looking, pro-social thinking and reduction in association with depression and negative health behaviours. Enhance stress reduction and cognitive restoration benefits for immune and central nervous systems, treatment of depression and increased exposure to lactic acid bacteria and microbial genera, which are ubiquitous in the natural environment and could influence depression, fatigue and cognition (Feng and Astell-Burt, 2018).

"Provision of urban green space in compact city environments and during densification processes is described as a major challenge" (Haanalnd and Bosch, 2015). In current infrastructure development model, most if not all developing societies, maintaining a green space are a wish but an unfulfilled challenge. With every passing year we are adding building complexes by tens of hundreds across the globe. Human settlement found an easy way to encroach upon the limited free spaces metropolitan city offers, while the small cities follow suit. General public is unaware of the importance of having residential green space. The lack thereof leads to higher temperature indoors and outdoors, direct sun scorching the concrete and steel. On the contrary, they presence thereof provides quality of life to residents by providing fresh air, a clean space and an opportunity for relaxation. By and large, we lack community support at times and political unwillingness at other times. We need to educate the public. We need to start from schools by educating and encouraging school children to create their own green spaces either in their own balcony or in their school terrace. Sooner the seeds of going green are planted the better the community response is; the logic is simple - today's kids are tomorrow's future.

To enable us convey the green vision message to the public and also to provide a healthy ecofriendly environment to our patients and staff, the team created a green zone within one part of the rehabilitation centre operated under YENCOURAGE (Yenepoya Psychiatric Rehabilitation and Day Care Centre).

This space was made lively by planting a variety of saplings. As a part of vocational training, we also made the patients to plant them by providing the required care under our supervision. Currently the centre has planted some vegetables, floral garden and shrubs with medicinal properties. Patients have been guided

to water the plants on daily basis, put manure once a month. We also help them understand how they can turn their free time into some useful activity. Not only plants but we also have placed an aquarium, nesting area for birds along with bird feed within the same zone. We will be taking the patients in the garden for a walk and allow them to spend some personal quality time in the midst of nature.

As a further step in this direction, the centre has also planned to step forward and create manure from the food waste by using earthen pots. This organic manure will be used for nurturing the plants and vegetables and create an effective way of handling organic wastes within the premises.
Conventional wisdom has always affirmed the value of animals in promoting human wellbeing, only recently has their therapeutic role in medicine become the focus of dedicated research. A study done by Munoz et al. (2011) have shown beneficial effects of animal assisted therapy, the centre is additionally providing animal assisted therapy for the patients.

In the centre, we enrol patients in spending time seeing the fishes for a certain period of time, also to feed the fishes and the results show enhancement of socialization, reduction of stress, anxiety and loneliness, improvement in mood and general well-being of the patient.

One more important initiative related to creating an eco-friendly space within the centre has been implemented recently. This initiative involves making handmade paper covers and cloth bags out of easy biodegradable materials. Vocational trainers have been involved with training the patients to make those paper cover and cloth bags as a part of a sheltered workshop. These handmade paper covers are used at Yenepoya Nursing Home pharmacy

Staff at YENCOURAGE terrace garden
Sitting: Left to right – Mrs. Sowmya Puthran, Dr. Anil Kakunje, Dr. Rajesh M
Standing: Left to right – Ms. Anjana Joy and Mrs. Shwetha Shetty.

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Seagrasses

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Seagrasses are marine angiosperms grow under submerged photic habitats in ocean forming a dense meadows, which provide habitat for commercially important fishes, shellfish, crustaceans and others (Fig. 1).They evolved from terrestrial plants about hundred million years ago and are widely distributed along the coasts of all continents in the world except for Antarctica. Although it consists of a low species diversity (about 72 species), it forms large patchy vegetation that extends up to thousands of kilometres of coastline.

Seagrasses inhabit shallow waters of temperate and tropical coastal regions. There are six bioregions of seagrass meadows worldwide and they are Temperate North Atlantic, Temperate North Pacific, and Mediterranean, Temperate Southern, Tropical Atlantic and Tropical Indo-Pacific oceans. The temperate region has low to moderate seagrass diversity, whereas the tropical bioregions consist of high diversity of seagrasses. Tropical Indo-Pacific Ocean has the highest diversity of seagrass as many as 14 species. The most widely distributed seagrass is *Ruppia maritima (widgeon grass)*, which is found in tropical as well as temperate regions. The estuarine systems of Karnataka like Swarna-Sita, Chakra, Haladi, Kollurand Venkatapur are the potential habitats of seagrasses. So far only two species of seagrasses (*Ruppia maritima* and *Halophila beccarii*) are observed in Karnataka coast (Kaladharan et al., 2011).

In India, they are found in east and west coasts, Lakshadweep, Andaman and Nicobar islands. Large seagrass meadows are seen in Palk Bay and Gulf of Mannar. Some of the predominant species found in Indian Ocean are sea cow grass, thread seagrass, needle seagrass, flat-tipped

Fig. 1. Seagrass in ocean (https://www.istockphoto.com/photos/seagrass)

seagrass, spoon seagrass and ribbon grass. The coastal communities of India use seagrass as food, fertilizer and livestock feed. The leaves and rhizomes of seagrasses are used as medicine to treat ailments such as heart disease, skin disease, iron deficiency, wounds and indigestion. The phytochemical analysis of seagrass has shown presence of antioxidants, antibacterial compounds and minerals. The phytochemical compounds isolated from *some seagrasses* have been shown to exhibit significant biological activities like antiproliferative, anti-human immunodeficiency virus (HIV) and skin regenerating properties. Seagrasses also have aesthetic and cultural values by providing leisure tourism activities like snorkeling, diving, fishing and fauna watching. The litter of seagrass is used as mattress filling, roof covering and house insulation. It has also been used historically for the formation of dykes to prevent beach erosion.

Ecological services

- Seagrasses are the primary producers in marine ecosystem and are also called 'the

lungs of the sea' as they release oxygen into the water. They provide a stable habitat for worms, seahorses, lizardfish, crabs, starfishes, sea cucumbers, sea urchins and others. They protect sea fauna against large predators and strong currents. Dugong and green turtle are endangered marine organisms they are dependent on seagrass for nutrition.

- Seagrass play a significant role in sedimentation of particles and increase water clarity. The absence of seagrass can decrease the water quality and affect marine organisms. The European Water Framework Directive and United States Environmental Protection Agency have enlisted seagrasses as one of the bioindicators in assessing the quality of coastal water bodies.
- The vertical and horizontal root system of seagrass stabilizes the sea bottom. The leaves slow down the water currents and hence protect shorelines from storms.
- Seagrass helps in tackling climate change by acting as major carbon sinks. They contribute 10-18% of the ocean's carbon sequestration. They absorb 83 million tonnes of atmospheric carbon annually which is 35 times faster compared to the tropical rainforests.
- According to a recent study, seagrass helps in trapping plastics, thus counteracting marine plastic pollution. The study investigated natural debris of *Posidonia oceanica* (Neptune grass), which is an endemic seagrass of Mediterranean Sea. It has ribbon-like leaves which are attached to the rhizome. The shredded leaves form stiff fibers that intertwine to form a ball-like structure called Neptune balls or aegagropilae. The stiff lignocellulosic fiberscan trap plastics in the water and eventually carry them to shoreline (Fig. 2).

Fig. 2. Neptune balls (https://www.theguardian.com/environment/2021/jan/15/seagrass-neptune-balls-sieve-millions-of-plastic-particles-from-water-study-finds)

Threats to seagrass

The seagrass meadows have been disappearing globally at a rate of 7% per annum with approximately 30,000 km^2 lost during recent decades. According to IUCN Red list, 10 *seagrass species* are at the risk of extinction with *three species* listed as *endangered: Phyllospadix japonicas* (Asian surfgrass), *Zostera chilensis* (Chilean eelgrass) and *Zostera geojeensis* (sub-nod eelgrass).

The decline in seagrass affects organisms which dependent on seagrasses including endangered green sea turtles, chinook salmons, manatees and dugongs. Seagrasses face natural disturbances such as storms, grazing, ice-scouring and desiccation. However the major causes for the decline in seagrass meadows are due to following human activities:

- The fertilizer runoff from the agricultural land triggers algal bloom in water bodies leading to blocking of light, which is required for growth of seagrass.
- The coastal development projects cause topsoil runoff into marine bodies affecting photosynthesis of seagrasses.
- The destructive fishing methods can uproot the grasses. Overfishing of large predators can disrupt the food chain and result in excessive feeding of worms that generally feeds on the algae.
- Climate change is a one of the major threat to seagrasses. The rising sea temperature affect the seagrass growth and strong storms can uproot entire meadows.

Restoration of seagrass

There is a great need to conserve seagrasses by creating public awareness, monitoring seagrass habitats, conserving existing resources by

restoration projects. The restoration of seagrass could be possible by different methods like manual transplanting, mechanical transplanting and distribution or planting of seagrass seeds. Restoration of seagrasses has been initiated at global level, which monitors seagrass ecosystem and also focuses on raising awareness in local and global communities. The seagrass restoration campaign in UK has developed a smartphone app 'SeagrassSpotter', where the public can report the seagrass locations.

Further reading

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A Bird in My Backyard

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I remember, it was a rainy afternoon, just like every day I went home from work for lunch. I live with my pet dog, who is always happy to welcome me home. But on this particular day, I don't see my dog at the gate, who always be there when I reach home. I got inside the house a bit worried and went directly into the backyard to check on him. There he was in the backyard completely wet from the rain, I went to get him back inside, but to my surprise, there was a green little bird next to him, I was in shock. I reacted, what have you done?! And shooed him off that place.

The bird was wet from the rain, standing on its legs but unresponsive. After a few minutes of shooing and trying to wake up the bird, I tried holding it in my hand, I never took a bird in my hand before and I was scared too. I was afraid that my dog might have harmed the bird, but I see no such hurt marks on it. I guess he was just watching over the bird.

I didn't know what happened! I was unaware what I have to do next. I let the bird go but it was still unresponsive. Later, I went to my kitchen to get some grains and failed to feed the bird and I had no idea how to feed a bird. I thought, at least I can feed some water, accidentally I spilled water all over it and to my surprise the bird opened its eyes wide and started shaking its head and legs.

I was happy to see the bird responding. It was time to let the bird go. Before letting it go, I blow-dried the bird with a hairdryer took a picture for Instagram and left it on the compound grill, so that it can find its way back wherever it came from. After a few seconds of watching here and there, the bird just flew to the sky-high as me and my dog watched happily.

There was a different sort of feeling I had on that day. I was happy that my dog and I helped a bird, which I never thought will do in my entire life. Out of curiosity, I googled to find out: it was a White Cheeked Barbet, which is commonly found along the Western Ghats in southern India!

Clinical Management of Wing Fracture in Brahminy Kite

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The problem

Avian fractures are often open and frequently comminuted, especially in zoo and wild-birds specimens because of orchestra of flight. These injured birds are then treated in charity hospitals with inadequate equipment and knowledge. Most of such injured birds either die or they are bound to spend rest of their life in rehabilitation centers as flightless amputees. Over the last few decades, a good number of modalities for fracture management in humans and domestic small animals have been evolved. However, they did not get desired acceptance in avian species, often external coaptation method was the sole treatment line followed with outcome of inability to fly because of compromised joint motion. The ability of a treatment modality to provide full return of flight is significantly important in orthopaedic applications. Hence avian fracture management by modern methods like polypropylene rods insertion by shuttle technique, intramedullary polymethyl methacrylate and recently biodegradable Mg-based implants are trustable development in the field of avian orthopaedics (Abhishek et al., 2020).

The practicing veterinarians sometimes encounter avian orthopaedic cases, but no patient-friendly modalities have been developed for the osteosynthesis of avian fractured patients. There are regular newsflash about increased incidence of fractures to birds especially during natural calamities and sometime during the kite festival like Makar-Sankranti. Fracture repair has always been a subject of interest in human as well as veterinary practice, and its repair in birds often presents a significant challenge to the veterinary surgeons. This report describes pre-established technique of intramedullary pinning and provides brief note regarding a novel fracture of both ulna and radius and their management in Brahminy kite (*Haliastur indus*).

Observation and treatment

A Traumatic Winquist-Hansen Type-II fracture of left radius and ulna in a free-living rescued Brahminy kite of unknown age and sex with BMI of 4/5 was presented to veterinary clinic. Similar to companion and small mammals (dogs, cats, and rabbit), avian ill patients also presents early compensatory phase of shock, tachycardia and dehydration. Hence the bird was stabilized first by giving fluid at the rate of 10ml/kg BW subcutaneously (Forbes, 2016). Prophylactically antibiotic was administered by using amoxicillin (125 mg/kg BW IM). Anaesthesia protocol of combination of Ketamine (30 mg/kg BW IM) and Xylazine (6 mg/kg BW IM) in a single barrel of syringe was used for both induction and maintenance throughout the procedure (Doneley, 2020). The fracture was reduced by retrograde intramedullary implantation of 1.2 mm and 1.0 mm Kirschner's wire to ulna and radius, respectively. Implant associated trauma and ankylosis of joint are more common in birds. Hence, pins were inserted, between second and third primary feathers from elbow joint towards carpal joint for ulna and from carpal joint to elbow joint for radius bone (Fig. 2). To prevent the consequences of self-trauma due to brittleness of bone and of fractious patient wing-wrapping was performed using vet wrap and cage rest was given with post-operative analgesic and antibiotics during convalescent period (Meloxicam 0.2mg/kg BW and Enrofloxacin 10mg/kg BW IM) (Redig and Ponder, 2016). Outcome of the surgery based on experience of the surgeon, post-operative rehabilitation and response of the bird was predicted to be good.

Intramedullary pins were extracted from bones on 4th week of recovery period. Birds improved from the trauma after a month of rehabilitation with deviation in flight and moderate wing dropping due to some degree of damage to petagium.

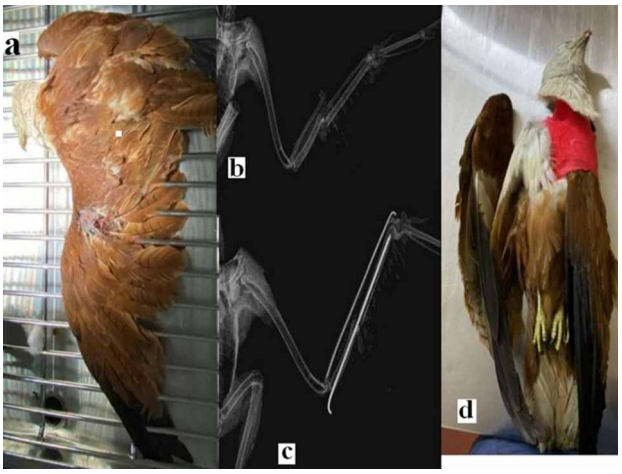

Fig. 1. Photographs of Brahminy kite showing: pre-operative traumatic thoracic limb (a), midshaft radius and ulna fracture with small butterfly fragment (b), radiograph of intramedullary pin placement to ulna and radius (c) and immobilization by wing-wrapping to body (d).

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New Dimensions of Mycology

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Mycology

Mycology is the study of fungi and fungi-like organisms. Fungi coevolved along with plants and animals, but devoid of photosynthetic ability as well as digestive system. Major function of fungi is decomposition and recycling of organic matter, thus they are an integral part of biogeochemical cycles. The current global estimate of fungal diversity spanned around 2.2 to 3.8 million based on angiosperm/fungi ratio (Hawksworth and Lücking, 2017). However, only 3.7 to 3.8% of fungi have been explored globally and major part of fungal diversity is still remained as a black box. Fungi are known to cause several diseases in plants as well as plant produce causing major economic loss (Fig. 1). They also responsible for many diseases in animals, unlike bacterial diseases fungal diseases have a fewer therapeutic alternatives. Substantial developments have been made in the field of mycology particularly plant destruction, animal diseases, air-borne pathogens, production of mycotoxins in food commodities and biodeterioration of commercial products (wood, leather and fabrics).

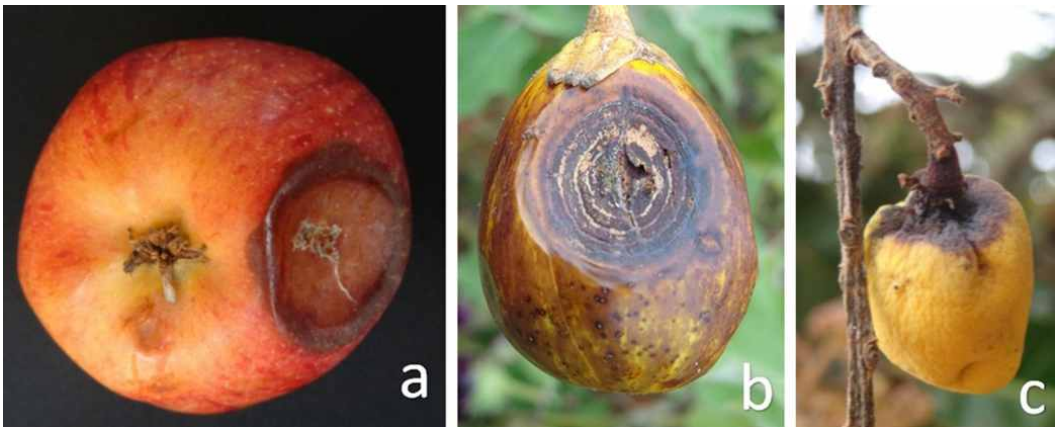

Fig. 1. Fruit rot of apple by *Penicillium* sp. (a), fruit rot of brinjal by *Colletotrichum* sp. (b) and anthracnose of mango by *Colletotrichum* sp. (c) (photo credit: Dr.S. Mahadevakumar, Department of Botany, Manasagangotri, University of Mysore).

Applied mycology

The positive aspect of mycology is their usefulness in medicine (antibiotics and metabolites), animal nutrition (edible mushrooms), mutuialistic association in different plant tissues (leads to stress tolerance and prevent insect herbivory) and association with roots of tree species (mycorrhizas to provide desired nutrients to plants from soil) (Fig. 2). Further developments in mycology improved our knowledge on their importance towards favourable food or feed fermentation (e.g. *Rhizopus oligosporus*) and value-added fermented products (e.g. wine, spirit and beer) (Venduk and Veljović, 2021). More specific discoveries in mycology revealed their bioactive metabolites and pharmaceuticals useful to control plant diseases (e.g. pest control) and to treat human lifestyle diseases (e.g. cancer and neurodegeneration). A recent publication compiled information on 50 ways of industrial applications of fungi (Hyde et al., 2019).

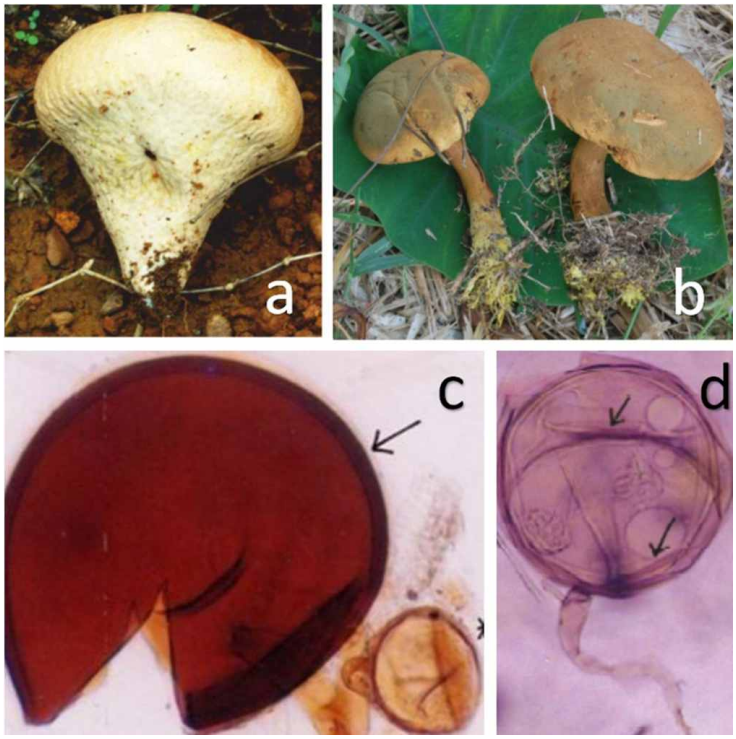

Fig. 2. Ectomycorrhizal fungal fruit bodies: *Lycoperdo nutriforme* (a) and *Phebopus marginatus* (b) (in *Acacia* and Burma bamboo of Yenepoya University Campus, respectively); Endomycorrhizal fungal spores: *Glomus dimorphicum* (c) and *Scutellospora pellucida* (d) (in Nethravathi mangrove trees, Mangalore).

Owing to extensive dependence on depleting fossil reserves, production of renewable products gained importance and fungi contribute towards sustainable global economy (Meyer et al., 2020). There are several mycological applications in emergent and advanced stage of development. Recent advances showed their usefulness in developing number of products such as building materials, packaging source, electronic appliances, leather-like products, nanopapers, biosurfactants and nanoparticles (Nawawi et al., 2020; Murali et al., 2019; Jones et al., 2020a). Besides, fungi are also known for its degradation of recalcitrant wastes in the ecosystem (e.g. plastics) and helpful towards sustainable waste management (Hyde et al., 2019).

Fungal biotechnology

Fungal biotechnology is in the transition stage to transform current petroleum-based unsustainable economy into a bio-based sustainable economy. Fungi are known for production of bioactive metabolites of pharmaceutical and agricultural importance, biofuels, enzymes and pigments useful in food, textile and leather industries. Fungal mycelia is a wonder material composed of chitin, chitosan, polyglucuronic acid (or cellulose), glucans, glycoproteins, and nanoproteins (Jouzani et al., 2020). Because of such biopolymers, fungal mycelia could be used to produce durable and biodegradable merchandise. Fungal mycelia has commercial interest in low-energy biofabrication and waste recycling. It has the capacity to bind the organic matter by hyphal microfilament network, which has application in low-cost packing materials as well as high-value composites for building materials (Jiang et al., 2016). Thus, the agrowastes could be transformed into industrially-valuable materials of commercial interest using fungi.

Fungal mycelia are also useful to produce shoe sole, fabrics or leather-like elastic materials, insulation devices, floatation materials, termite-

resistant materials, furniture, expanded polystyrene, foams, cork, thermoplastic, acoustic insulation and many more as substitute against petrochemical-based industrial products (Jones et al., 2020b). Fungal mycelium is useful in production of inexpensive ecofriendly composites to replace foam, plastic insulation, panels, floors and door cores. Owing to low density as well as low thermal conductivity, fungal mycelia possess high acoustic absorption as well as fire safety (burn but not catch fire). Fungal mycelia could also be used as transparent wearables, fungal fabrics (opaque or non-transparent), thin films, papers and electronic devices (e.g. resistors, flexible electronics and blends with metals).

Growth of fungal mycelium on agrowastes serves as potential materials for lamp shades, garden pots, attractive vases, ornaments and modern artistic materials (Manan et al., 2021). Mushroom spent material serves as non-toxic hand paints for interior design. Fungi are known to manufacture several biopolymers, which are of immense value in production of bioprotectants, bioemulsifiers, biosurfactants (hydrophobins) and electronic appliances. Fungal-derived compounds are useful as cosmeceuticals (skin-care products), prebiotics (exopolysaccharides as probiotic boosters), perfumes (replacement to plant or animal derived products), pigments (melanin from *Termitomyces* in skin-care), flavours and scents (mushrooms like truffles are known for these). Similarly, the fungal pigments serve as biodegradable paints on wood, ceramics, textiles, leather and artistic materials.

Mushroom mycelial-based strong and durable materials have the capacity to absorb sounds, seismic waves, retards flame expansion, serve as thermal insulators and could be broken into biorecyclable minerals. Many fungal companies using fungal mycelia to produce industrial products, fabrics, fashion design, architectural construction materials and artistic materials (Ghazvinian et al., 2019) (Table 1).

Table 1. Myco-companies involved in production of various fungal products.

Company	**Fungal products**	**Reference**
Ecovative Design (New York)	Packaging, insulation, foam buoys and rafts	https://en.wikipedia.org/wiki/Ecovative_Design
NEFFA (Netherlands)	Custom-made cloths	https://neffa.nl/
NexLoop (Brazil)	AquaWeb system to deliver desired water to plant roots (Used an ectomycorrhizal fungus *Suillus bovinus*)	https://biomimicry.org/solution/nexloop/
MycoWorks (California)	Sheets of urethanes, leathers, plastics and foams - used in fashion industry	https://en.wikipedia.org/wiki/MycoWorks
Trofe (New York)	Biodesign: Lamp shades and artistic materials	Trofe, New York

Biorefinery

Biorefinery is a factory that converts biomass into energy and other useful products. Natural green mini-biorefinery will be built by leafcutter ants (*Acromyrmex* and *Atta* spp.) using suitable leaf material along with mushrooms (e.g. *Leucoagaricus gongylophorus*) to get highly nutritious fungal biomass (Lange, 2014) (Fig. 3). Similarly, termites cultivate edible mushrooms (e.g. *Termitomyces*) in their garden to feed young ones with fermented high nutritious materials. There is ample scope to learn or simulate technical knowhow from these social insects to develop application oriented biorefinery.

Fig. 3. Leafcutter ants carrying leaves to build a biorefinery (a), part of completed biorefinery oozing protein- and sugar-rich nutrient material (b), spent biorefinery of leafcutter ants in a garden (c) and *Termitomyces fuliginosus* cultivated by the termites in a termite mound of Yenepoya University Campus (d) (a and b, source: 10.5598/imafungus.2014.05.02.10).

Fungal polysaccharides and enzymes

Innumerable number of fungi are known to produce various types of exopolysaccharides (EPS) in the laboratory cultures useful in medicine, food industries and cosmetics (Mahapara and Banerjee, 2013; Leong et al., 2021) (Table 2).

Table 2. Fungal polysaccharides, sources of production and applications.

Polysaccharide	**Fungus**	**Application**
Auricularin	*Auricularia auricula-judae*	Anticoagulant
Botryosphaeran	*Botryosphaeria rhodina*	Anti-cancer activity
Chitin	*Agaricus bisporus*	Cosmetics
Galactosaminoglucan	*Aspergillus fumigatus*	Anti-cancer activity
Glucan	*Saccharomyces cereviciae*	Drug target
Lentinan	*Lentinus edodes*	Immunomodulation
Pleuran	*Pleurotus ostreatus*	Immune booster
Pullulan	*Aureobasidium pullans*	Wound healing
Scleroglucan	*Sclerotium gluconicum*	Thickening agent

Many fungal enzymes have important applications, for example: amylases (clarifying agents), cellulases (as detergent additives), laccases (detoxification, dye reduction, biosensor, water treatment and bleaching), manganese peroxidase (textile, pulp and paper industries), proteases (wastewater treatment), proteinase (wool processing) and tyrosinase (removal of phenolic compounds in freshwaters). Enzymes of many fungi are also capable to degrade various types of synthetic plastics (Table 3).

Table 3. Fungal enzymes useful to degrade different kinds of plastics.

Enzyme	**Fungus**	**Nature of plastic**
Catalase and protease	*Aspergillus niger*	Polycaprolactone (PCL)
Esterase and urethane hydrolase	*Chaetomium globosum*	Polyurethane (PU)
Glucosidases	*Aspergillus flavus*	Polycaprolactone (PCL)
Glucosidases	*Talaromyces funiculosus*	Polyhydroxybuterate (PHB)
Laccase	*Bipolaris* sp.	Polyvinyl chloride (PVC)
Manganese peroxidase	*Phanerochaete chrysosporium*	Polyethylene (PE)
PHB-depolymerase	*Talaromyces pinophilus*	Polyhydroxybuterate (PHB)
Polyurethanase	*Curvularia senegalensis*	Polyurethane (PU)
Serine hydrolase	*Pestalotiopsis microspora*	Polyurethane (PU)

Outlook

Application of fungi beyond nutrition and health will be highly rewarding and serve several ecofriendly solutions to save the forests (for wood), animals (for leather, bones and tusk), degradation of recalcitrant materials (e.g. plastics) and bioremediation to remove toxic or xenobiotic constituents (in soil or water). Mycelia-based products are ecofriendly, renewable, resource efficient, economical, prevent deforestation and prevent animal poaching. Application of fungal mycelia or fungal products dependent on several basic and applied disciplines like mycology, microbiology, biochemistry, biotechnology, fermentation technology, chemistry, physics, engineering, nanoscience, environmental biology and arts. As mark of fungal newer applications, in the New York Museum of Modern art (MoMA), a 12 m high organic compostable tower with 10,000 bricks has been showcased.

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Observations on the Landslide Region in Kodagu (Karnataka)

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Natural disasters are the complex of detrimental events that occur completely beyond the human control and they are often indirectly made worse by human interventions (Alimohammadlou et al., 2013). Landslides are increasingly causing adverse impacts globally on the lives of people, economy and environment (Kirschbaum et al., 2015). These impacts are likely to escalate further as people continue to encroach and settle close to unstable gradients (Tegeje, 2017). Growth of population, land use pattern, urbanization, continuous infrastructure development and anthropogenic effects on climate change are the major factors increased the chances of landslides (Petley et al, 2007). Yalcin (2011) has discovered that the economic losses and casualties due to landslides are greater than generally recognized. Landslides are one of the natural hazards that affect about 15% of land area of India, including the geodynamically active domains in Himalayas (Sharda, 2004). Northern and Northeastern India as well as the stable domains of the Western Ghats and Nilgiri Hills of southern India witness recent frequent landslide triggered mainly by rainfall during southwest and northeast monsoons (Anabalagan et al., 2014). However there is inadequate research on landslides in India owing to lack of precise data. The present write up gives a glimpse of the extent of damage by the landslide in Kodagu and natural revegetation patterns in the landslide regions after two years nine months.

Kodagu

The district Kodagu is located on the eastern slopes of the Western Ghats. It has a geographical area of 4,102 km^2. Kodagu is bordered by Dakshina Kannada District to the northwest, Hassan District to the north, Mysore District to the east, Kasargod District of Kerala in west and Kannur District of Kerala to the southwest and Wayanad District of Kerala to the south. It is a hilly district with the lowest elevation 120 masl. The highest peak Tadiandamol, rises to 1,750 m followed by Pushpagiri the second highest peak (1,715 m). The main river in Kodagu is the Cauvery, which originates at Talakaveri located on the eastern side of the Western Ghats and with its tributaries drains the greater part of Kodagu.

Landslide Disaster

Kodagu is also called Scotland of Karnataka and it is one of the prominent nature tourist regions. Landslides in Kodagu were believed to be minor incidents during rainy season and never received much attention of the researchers as well as media. During June through July 2018, Kodagu District received up to 589 cm rainfall, which is about 22.5% of normal rainfall. In addition, during the first three weeks of August 2018, the district received a total rainfall of 168 cm and in a single day on August 17th the district received 30 cm rainfall causing landslides in more than 80 locations. Such devastation caused death of about 20 people, rendering up to 2,200 homeless and the Government estimated a total loss of about Rs.1,400 crores.

Kodagu although the smallest District in Karnataka state, it is blessed with gorgeous natural landscapes and pleasant climatic conditions attracts tourists from different parts of the world. Kodagu is also known for cultivation of several commercial crops such as coffee, pepper, cardamom, orange, rubber and others. It consists of three Taluks: Madikeri, Somwarpet and Virajpet. Although landslides of low magnitude occurd in all the three taluks during the monsoon period, the high lands of Madikeri and Somawarpet taluks were worst affected

compared to the incidences in Virajapet (Fig. 1). Scientific studies on landslides in Kodagu District are scanty and confined to only a few regions (Janardhana et al., 2016).Vegetation development on the landslide area is mixed grass, herbs, shrubs, climbers, orchids and small trees naturally vegetated in about three years duration. The species richness was lowest at the disturbed site and highest in undisturbed sites, while the species richness increased from the youngest to the oldest sites. Stand ordinations revealed that the site age was one of the most important factors influencing the species richness and abundance. Jodupala, Monnamgeri, Madapura, Udayagiri, Madikeri Town and Makkandur in Madikeri Taluk, while Iggodlu in Somawarpet Taluk are the severely affected areas due to landslide.

Fig. 1. Pattern of land slide and houses submerged in mud and silt
(Source: www.google.com)

Inventory

Landslide inventory revealed over 80 events of landslides have been recorded by the field studies (Vinutha, 2015) and majority of the incidences occurred in the areas covered with grantioid rocks and their weathering products. Landslides in the area are of various sizes from local surface slides to complex landslides involving an entire slope. From the historical data and the current situation, it was found that the majority of slides are triggered by the heavy rainfall in the preceding hours. Apart from the climatic conditions, other factors responsible for the triggering the landslides are the land use pattern and human activities (e.g. farm expansion and excavation in the slopes for widening the roads. Flageollet et al. (1999) are of the opinion that human action and land use are generally considered to increase chances of landslides, the real triggering factors being the rainfall or the seismic events.

Observations

Vegetation on a studied landslide recovered after two years and nine months by the natural restoration in the landslide area of Kodagu, which showed difference in vegetation pattern between the top, middle and bottom of the landslide. A shrub-herb community on a landslide after natural restoration formed, which consists of a total of 23 plant species. The species coverage, plant diversities and similarities were significantly different between the top, middle and bottom of the landslide, indicating the effects of changes in topography on revegetation (Fig. 2). The similarity species composition between undisturbed site and restored landslide revealed that natural restoration can promote the revegetation on landslide with native species.

Fig. 2. Naturally vegetated landslide area.

Durgin (1977) proposed four stages of classification of weathering products of granites: 1) Fresh rock; 2) Corestones; 3) Decomposed granitoid; 4) Fine-grained saprolite (Fig. 3). The estimate of the fresh granitic rock contains a maximum of 15% weathered material that forms in the joint system. The corestone stage ranges from 15 to 85% weathered rock enclosing

remnants of fresh rock. Decomposed granitoid consists of 85 to 100% weathered disintegrated rock that can be broken down into granules. Saprolite is a fine-grained residual rock that generally occur on the upper lateritic layer. All the four stages of the weathering products of granitic gneisses are seen and the rockslides on minor scale are noticed all along the road connecting Madikeri to Sullia in the Kodagu.

Decomposition of rocks increases the porosity and permeability of the rock. As a consequence to this, the shear strength and bulk density as well as the cohesion of the decomposed rock will be lost. Hence, during rainy days, the saturated decomposed rock offers no resistance and gets detached and the mass is brought down in the form of debris flow. This type of debris slides occur all over Kodagu. Although plantations has decreased the number of such incidences by stabilizing the slope, road widening, new road constructions and change in the land cover have contributed largely for the instability of slopes.

Fig. 3. Fresh rock (a), corestone (b), decomposed granite (c) and fine-grained saprolite (d).

Heavy rehabilitation measures are undertaken especially between Sampaje to Madikeri (Fig. 4). Whatever such measures taken to repair the damage, it will not be stable unless enforcing the revegetation with native plant species. Mitigation works carried out to reduce the damage in the Madikeri city and all along the highways include construction of retaining walls. Surface drainage control works in the form of U-ditches all along the road on either side, restricting development in landslide-prone areas, construction of retaining walls with weep holes and providing armored protection with concrete blocks are some of the mitigation measures undertaken (Fig. 4)

Impact of Deforestation

Kodagu has been witnessing a tourism boom for the last 10 years (Shivaraju and Anilkumar, 2015), which has attracted the tourists, thus new resorts and homestays were constructed along the landslide-affected areas (e.g. Tantipala, Mukkodlu, Hattihole, Megathalu, Yemmethalu, Hammiyala, Kaloor, Monnangeri and Jodupala). The landscape around these places, which encompasses moderate slope with structural hill ranges, have reduced the green cover owing to such commercial activities enhanced the

Fig. 4. Rehabilitation tasks in landslide region along the roadsides.

susceptibility of landslide. Earlier, the same slopes were covered with thick green cover, which ensured minimal soil erosion with minor landslides.

Heavy Rains and Tremors

Breaking the 87-year-old record (set in 1931), Kodagu received the highest ever rainfall during August 1931. Data for the first three weeks of August 2018, shows Kodagu received 168 cm of rainfall, which was the way above the mark of 156 cm of rainfall in 1931. The data from the Indian Meteorological Department (IMD), Bangalore, shows that 45% (or 77 cm) of the rain in August fell on just three consecutive days (August 15, 21 cm; August 16, 26 cm; August 17, 30 cm). Extreme rainfall during these three days coupled with several years of commercial exploitation of land led to severe landslides. Worst affected villages are Somwarpet and Madikeri taluks, while Tantipala, Mukkodlu, Hattihole, Megathalu, Yemmethalu, Hammiyala, Kaloor, Monnangeri and Jodupala recorded mild tremors in the month of July. Deforestation, intense rainfall and tremors destabilized the lands, which led to the observed landslides.

Harangi Dam and Water Tanks

The backwaters of the Dam Harangi, which has been constructed at a vulnerable confluence is also causing pressure in all the veins of perennial water flows at the nerve centres in the affected villages that are situated in the backwaters. Due to constant pressure, the nerve centres of water spring and the veins were punctured. This also is responsible for such massive landslides. Some reports denote that wherever there is a reservoir close by, tremors will be followed by landslides in the surrounding regions. Coffee estate owners in the affected villages had constructed massive ponds to store the rainwater for irrigation purposes. Due to heavy rains and massive water flow, the ponds were unable to withstand the pressure, which leads to massive collapse of slopes downwards.

Conclusion

According to World Resources Institute (WRI) of India, most of the landslides in Kodagu occurred due to slope failure along the roads as observed in landslide-prone areas. In addition, the landslides may have aggravated due to inadequate landslide prevention measures (e.g. retaining walls and drainage channels).Landslides in parts of Kodagu may be correlated to the weathering stage of the peninsular gneisses. The transition of fresh rock of peninsular gneiss to saprolitein the hilly terrains are normally microscopically sheeted due to unloading of stress. Although the region of landslides has naturally revegetated after about three years, massive attempts should be enforced to revegetate the affected areas with native tree species to avoid such devastation in future.

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The challenge of waste management in the COVID era

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Let the waste of the *'sick'* not contaminate the lives of *'the healthy'* – K. Park

In a country that was already grappling to manage biomedical waste (BMW) efficiently, the COVID-19 pandemic has brought to the forefront newer challenges in waste management in India. With the need to stay safe and protect oneself, the production and utilization of products such as gloves, masks, sanitizers, thermometers, tissue paper, cleaning products and others have reached challenging proportions.

Fig. 1.Waste management (Global Times, December16, 2020: https://www.unep.org/events/webinar/waste-management-during-covid-19-crisis-opportunity

The COVID related waste can be broadly categorized as:

1. Hospital/Health facility generated waste
2. COVID vaccine associated waste
3. Household COVID waste

COVID waste from each of these sources must be segregated effectively and managed efficiently.

Hospital/Health facility generated biomedical waste can be of the following types:

- Infectious waste (10-15%)
- Chemical waste
- Sharps waste
- Cytotoxic waste

Segregation of Biomedical waste

As a first step of managing BMW, it is essential to segregate it into various categories on colour coded bins (Ref. # 1).

Fig. 2. Segregation of biomedical waste, as per Central Pollution Control Board of India (CPCB) Guidelines for Common Bio-medical Waste Treatment Facilities, 2016 (https://www.sciencedirect.com/science/article/pii/S266601642030027X)

For efficient handling of COVID -19 wastes, the CPCB in March 2020 has issued guidelines for COVID-19 waste management which includes the following recommendations (Ref. # 2):

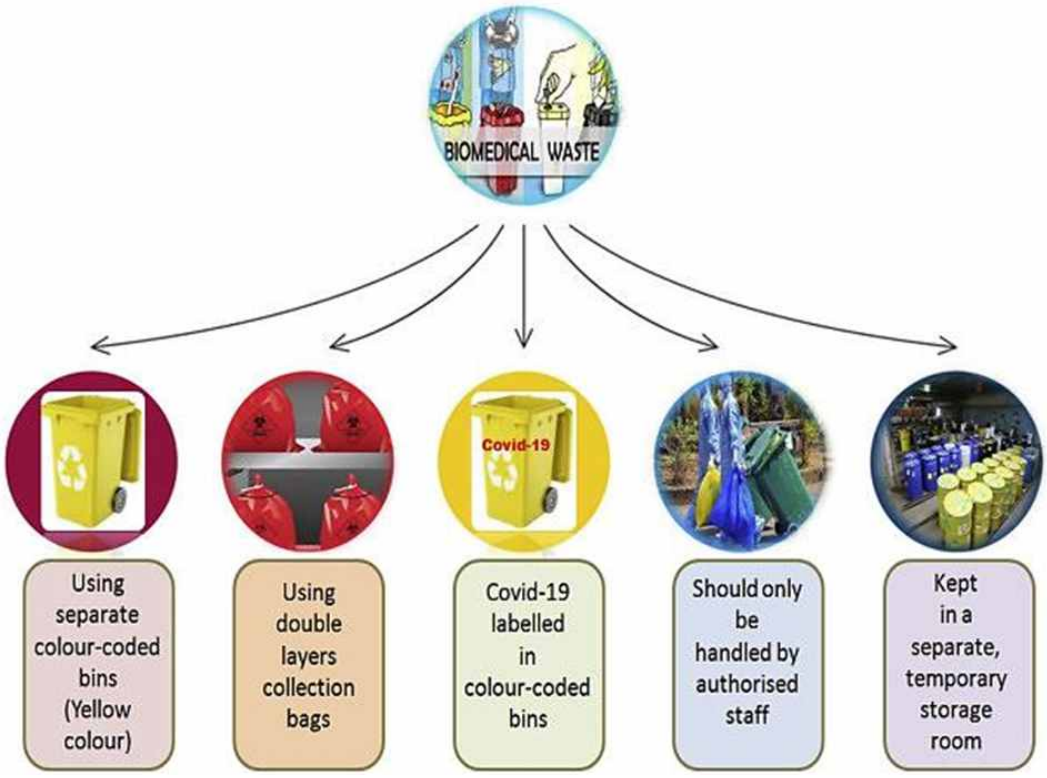

Fig. 3. Guidelines by the CPCB for the biomedical waste management (March 2020: https://www.sciencedirect.com/science/article/pii/S266601642030027X)

Treatment of Biomedical Waste

The segregated biomedical waste is appropriately treated based on the category of waste as shown in the figure 4 (Ref. # 1).

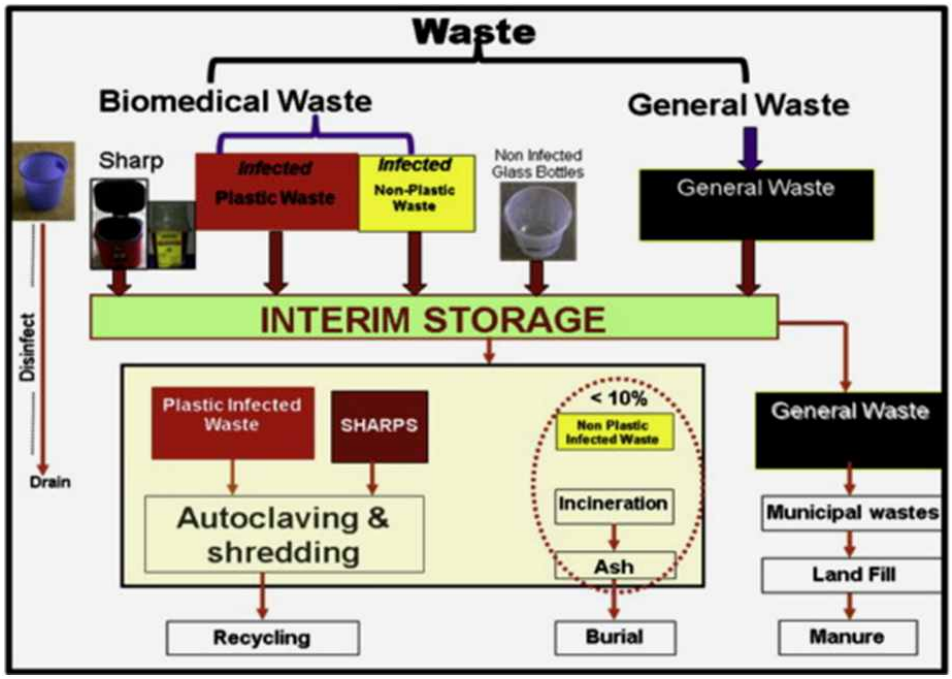

Fig. 4.Treatment of Biomedical waste, CPCB 2016
(https://cegh.net/article/S2213-3984(12)00008-5/fulltext)

COVID vaccine associated waste

The availability of effective vaccines against COVID has given a sense of a battle that we are about to win. However, tackling and recycling the waste generated by this herculean exercise of vaccinating 130 crore population needs to be taken up on a war footing.

Fig. 5. COVID vaccine associated waste management
(https://timesofindia.indiatimes.com/city/hyderabad/35000-health-staff-trained-in-biomedical-waste-disposal/articleshow/80239800.cms)

Management of COVID related waste generated in the households

With home isolation being the norm for majority of the COVID positive individuals we need an efficient way to tackle the waste generated during quarantine and care of COVID positive individuals at home, lest it becomes a source of infection to another person.

Types of household waste (Ref # 3)

In general household waste can be segregated into three categories as shown in figure 6:

- Wet waste
- Dry waste (recyclable)
- Reject/ Sanitary waste

Fig. 6. Segregation of Household waste as per Bruhat Bengaluru Mahanagara Palike (https://m.facebook.com/bbmpswm/photos)

Challenges of household COVID waste

- COVID -19 virus may survive for upto 72 hr on surfaces
- There may be asymptomatic individuals with infection
- Increase in biomedical waste in households during the pandemic
- Chances of mixing of infectious and general waste

Segregation and handling of household COVID-19 waste at source

As per the circular by the Commissionerate, Health and Family Welfare Services, and Government of Karnataka for the management of solid waste generated by COVID-19 positive persons in home care, we need to follow these instructions: (Ref. # 4).

1. The used face masks, gloves, tissues toiletries or swabs contaminated with blood / body fluids of COVID-19 patients including used syringes, medicines and others should be treated as biomedical waste and shall be sprayed/ soaked in 1% Sodium Hypochlorite and disposed in a separate closed bin with yellow bag.
2. The yellow bag shall be provided to home

care persons by local civic authorities and this shall be collected twice by local civic authorities.

3. Masks and gloves used by the care giver and family members shall be kept in a paper bag for a minimum of 72 hr prior to disposal of the same as general waste after cutting the same to prevent reuse.
4. Leftover food, empty juice bottles, disposable utensils tetra-packs, empty water bottles, packaging material, waste papers and plastic, floor cleaning dust and other items generated or used by family members and COVID-19 infected person at home care should be collected separately in bags and securely tied for handing over to waste collectors appointed by the local civic authorities. This waste shall not be mixed with the infective waste of the COVID positive person that shall go separately in a yellow bag.

Disposal of yellow bags

All urban local bodies and Gram Panchayaths shall ensure safe disposal if yellow bags by one of the following methods as per CPCB guidelines.

- Households shall hand over the yellow bags containing biomedical waste to authorized waste collectors at the door step. In turn the local civic authorities shall ensure safe disposal through Common Biomedical Waste Treatment Facilities (CBWTF)

Or

- Households shall deposit biomedical waste in yellow bags at designated deposition centers established by the local civic authorities. In turn the local civic authorities shall ensure safe disposal through CBWTF.

Or

- Households shall handover the biomedical waste to waste collector engaged by the Common Biomedical Waste Treatment Facility (CBWTF) at the door step.

Eco-friendly and rational use of PPE in the community

For day to day use in the community cloth masks will be an eco-friendly and economically sustainable option.

More effective fabrics for cloth masks (Ref. # 5)

- Tightly woven fabrics, such as cotton and cotton blends
- Breathable
- Two or three fabric layers

Innovative use of COVID related waste

Today's PPE kits could be tomorrow's roads, fuel etc. Scientists from The Council of Scientific and Industrial Research (CSIR) are pooling their expertise to convert discarded Personal Protective Equipment (PPE), and other plastic waste of the pandemic into fuel, bricks or pellets that can be moulded into automobile parts or used for road construction (Ref. # 6).

The COVID-19 disaster has created challenges in waste management. Unscientific ways of handling healthcare waste will pose public health concerns and significant impact on the environment. In developing countries where the waste management is not in accordance with international standards, careful handling and treatment are needed. The COVID-19 pandemic will be with us for more years multiplying the waste management challenges. Every country needs to implement the issued guidelines for infectious waste management and develop its own strategy for ensuring sustainable waste management.

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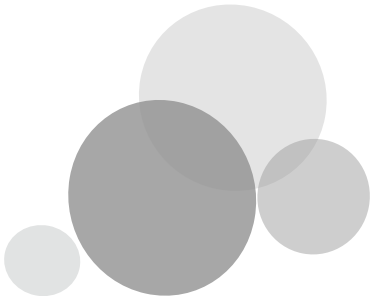

Blink

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Blink once, blink twice,
The colours in the sky before her,
They catch her eyes for the first time,
A kaleidoscope she makes of her world,
A paradise that flows within those eyes,
That can capture God's work in the light,
For she lived twenty years with night sky,
Felt the warmth of the sun caressing her skin,
She longed to watch the day the sun will break out of her dark skies,
She loved the silky, smooth moonlight her eyes imagined,
Longing for the day her eyes can catch at least a smidgen of God's creation,
A smidgen of that smile she always gave,
A smidgen of her mother's face she touched with love,
A smidgen of those beautiful eyes that never opened.

Blink once, blink twice,
The beautiful eyes that once saw the world,
Is now giving her the gift of a lifetime,
That beautiful eyes of theirs is surely leaving their kind soul behind in the world,
With her.

Blink once, blink twice,
Tears that come out of her beautiful eyes,
As the sunlight strikes it's corners,
Her insides light up in an incandescent glow,
She falls to her knees and prays,
Prays, praises,
That beautiful soul who gave their beautiful eyes to her forever,
This gift of vision only a blind girl would treasure,
This treasure she'll keep with her forever,
For she can finally see her beautiful eyes in the mirror.

And she whispers,
'Thank you'
Blinking once, blinking twice,
Her eyes can really see now

From the Perspective of the Blind

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They say eyes are the windows to the soul,
That one glance is enough to tell you all the secrets they hold.
The twin lenses we all possess help us see the world,
They capture images and store it to memory, invoking powerful emotions.
Emotions that makes our heart swell with joy,
Or shatter into a billion little pieces.

They say look too deeply into someone's eyes; and you will fall in love,
That eyes manage to have their own language.
A language of curious glances and furious glares,
Of bewildered blinking and confident gazing.
The intricate beauty of eye contact can leave us all in awe,
Bringing a deeper connection, binding soul to soul.

They say that eyes represent a kaleidoscope of colours,
I say that everything about eyes are exaggerated.
But what else would I say,
For I am one of those born without the gift of sight.
I wake up to an eternal darkness, the only thing I have ever seen,
And never has a single colour reached me, let alone a rainbow.

And then I enter the operation theatre, and minutes and hours and days later,
A faint light dawns, growing brighter by the minute.
And i see as described, a kaleidoscope of colours,
I feel the yearning to look into others eyes.
To pick out every shade and hue in the things around me,
And finally be able to experience the world in all of its glory.

But most of all I enjoy looking into my own eyes in the mirror,
For it is as they say, the eyes are windows to the soul.
And for the first time ever, I can gaze upon my hopeful soul,
I look deeply into my own eyes, and it is as they say.
For the first time ever, I fall in love with myself,
With my eyes, like a phoenix from the ashes, I am reborn.

Natures Rage

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Pollution, pollution every where
Humans are decreasing every day.

Awareness, afforestation all they say
They kill it for timber even from bay.

No man ever imagined the disaster he caused
Killing the plants and animals to get payed.

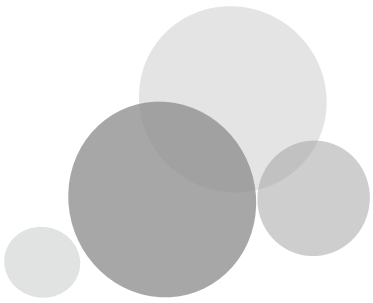
No man ever satisfies with what he has
Today for sake of nurture, tomorrow to become king.

Fire started to burn forest as natures rage started to soar
The greenery which pleased us is no more.

The nature that used to be a friend of man
Now turned to become wild beast to kill the man.

Scorching sun that cannot be tolerated
All this happened because of destruction we caused.

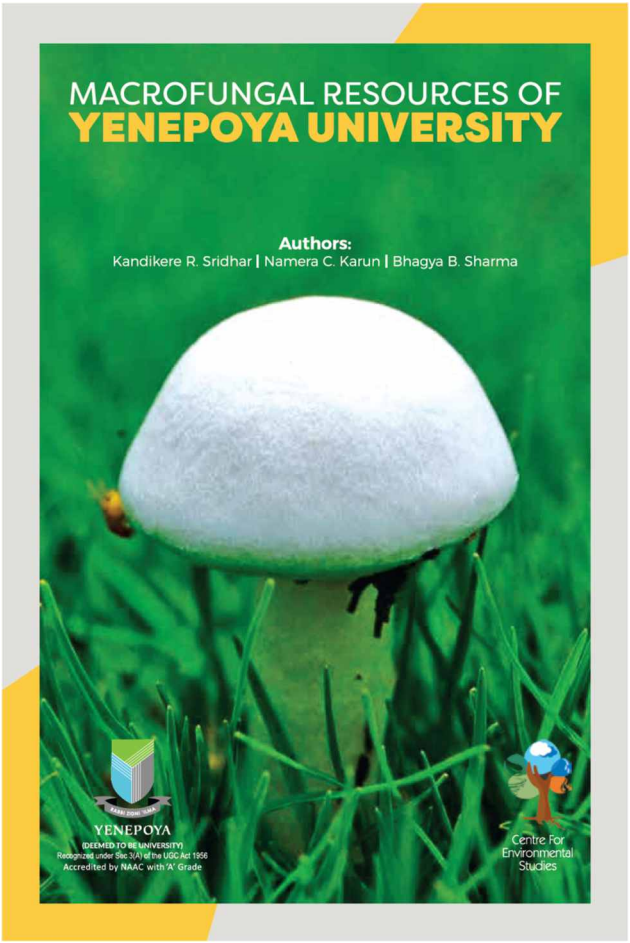
We should try to plant greenery every day
Reducing the pollution to increase harmony in the day.



Book News

Macrofungal Resources of Yenepoya University. By Kandikere R. Sridhar, Namera C. Karun and Bhagya B. Sharma. 2018. Yenepoya Printers and Publishers, Mangalore, India. pp. 95, 80 figs. ISBN 978-81-934857-2-9. Price Rs.250.

Our environment is endowed with a variety of life sustaining systems and become integral part of human life. A wide variety of macroscopic and microscopic bioresources play significant role in environment and human health. Southwestern India owing to its geographic location under the influence of the Western Ghats and Arabian Sea, sustain interesting biota of high magnitude. They are the integral part of our life and provide support for sustainable overall environmental, human and livestock development. The educational institutions being important link connecting new generation with current tasks of overall human development, shoulder responsibilities to maintain their environment healthy and provide platform for future sustainable development. As a measure of life sustenance in and around Yenepoya University (e.g. plants, animals and microbiota), inventory of macrofungi during wet season was performed. This report embodies the technical aspects of the macrofungi occurring in the Yenepoya University Campus with hopes to provide baseline information for future sustainable developments.



The inventory was performed once in fortnight in different habitats of the campus during June through November 2016. The habitats surveyed include *Acacia* grove, *Areca* plantation, bamboo thicket, banana plantation, deadwood dump, horticulture, medicinal garden, playground lawn and around basketball court. Up to 40 species belonging to 31 genera were recovered. They were thoroughly examined for identity (macroscopic and microscopic) and representative specimen was preserved. The substratum on which macrofungi were recovered include soil, decaying leaves, decaying palm debris, decaying twig, decaying bark, decaying log, decaying stub, humus and dead insect. The macrofungi recovered consists of 11 edible (*Agaricus* sp., *Amylosporus campbellii, Auricularia auricula-judae, Coprinus disseminatus, Dacryopinax spathularia, Lentinus dicholamellatus, Lentinus squarrosulus, Lycoperdon nutriforme, Phlebopus marginatus, Termitomyces fuliginosus, Volvariella* sp.), eight medicinal (*Amauroderma conjunctum, Daldinia concentrica, Ganoderma applanatum, Lentinus dicholamellatus, Lenzites betulina, Pycnoporus*

cinnabarinus, Schizophyllum commune and *Xylaria longipes*) and one ectomycorrhizal (*Phlebopus marginatus*).

At the outset, the habitats (natural and artificially maintained) consist of interesting macrofungi and many of them are edible, medicinal and one species is ectomycorrhizal (in bamboo thickets). There is wide scope to establish congenial environment for macrofungal sustenance on the campus for degradation of plant-generated waste materials (e.g. leaf litter, lawn shreds, twigs and dead woody material). The organic matter derived from gardens, restaurants and kitchens also valuable in supporting macrofungi which needs appropriate processing. There is ample scope for sustainable management and recycling of such organic wastes (e.g. compost, vermicompost, mushroom cultivation and biogas production). Yenepoya University Campus will be a model in sustenance of plants, animals and macrofungi owing to its landscape, environmental and aesthetic concern. As a first step, this 'coffee table book' on macrofungi of the campus makes a landmark in environmental concern, stimulate all around to respect environment and maintain sustainability for human habitation.

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1. Lindley ST, Estimation of …….. data. *Ecol Appl.*, 2003; 13: 806-813.
2. Martin H, The Archean grey ……..of continental crust. In *Archaean Crustal Evolution* (Ed. Condie, KC), Amsterdam: Elsevier; 1994, pp. 205-259.
3. Rao KN, Vaidyanadhan R, Geomorphic …….. and its evolution. In Proceedings of the National Symposium on Morphology and Evolution of Landforms, Department of Geology, Delhi University, New Delhi, 1978.
4. The URL of web reference should be given with date of access.

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