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EDITORIAL

CRISPR Plant Genome Editing: Towards Global Food Security

The advent of the CRISPR/Cas9 genetic scissors has revolutionized the precise genetic engineering of food crops with high-yielding, high-quality, climate-resilient and eco-friendly agriculture that can help achieve the United Nations global food security goal.

THE 2020 Nobel Prize in Chemistry was awarded to Emmanuelle Charpentier of Max Planck Unit for the Science of Pathogens, and Jennifer Doudna of University of California, Berkeley, for discovering the CRISPR/Cas9 genetic scissors that have revolutionized genome editing. CRISPR is an acronym for Clustered Regularly Interspaced Short Palindromic Repeat, referring to the unique organization of short, partially palindromic repeated DNA sequences which are part of the immune systems of bacteria and other microorganisms. CRISPR-Cas loci on the bacterial genome consist of a CRISPR array, which is up to several hundred direct, often palindromic, repeats (35–45 bases) separated by unique spacer sequences (30–40 bases). Adjacent to the CRISPR array, one or more operons having a cluster of Cas (CRISPR-associated) genes encoding the effector enzymes of this system. The immune response provided by the CRISPR-Cas system includes three stages, viz. adaptation, pre-CRISPR RNA (crRNA) expression/processing, and interference. CRISPR-Cas systems has two classes (1 and 2), six types (I to VI) and several subtypes, with multi-Cas protein effector complexes in Class 1 systems (Type I, III, and IV) and single effector protein in Class 2 systems (Type II, V, and VI). Of these, type II CRISPR-Cas9 system of *Streptococcus pyogene*s (SpCas9) is one of the best characterized and most commonly used.

The advent of this genome editing technology has revolutionized several fields of biology including diagnosis and treatment of human diseases, solving key problems in organ xenotransplantation, gene therapy, and precise genetic engineering of important crops. Zero hunger is one of the sustainable development goals (SDGs) set by the United Nations in 2015 to achieve global food security by 2030. Genome editing is critical for high-yielding, high-quality, climate-resilient and eco-friendly agriculture, and efficient genome editing tools like CRISPR-Cas9 can help achieve this goal. Recent advances in CRISPR-Cas systems, such as base editing and prime editing, have further improved its use by enhancing its precision power with fewer or no off-target effects.

There are already different success stories regarding CRISPR-based crop improvement. These include biotic and abiotic stress tolerance, reduction in heavy metal accumulation, improvement in photosynthesis, rice grain quality improvement, improved submergence survival, improved root architecture etc. For example, DELLA proteins limit plant growth and thus, editing DELLA proteins generated vigorous and short-stature rice plants. Virus resistance can also be achieved in crops by CRISPR-Cas system by directly targeting the viral genomes.

Despite these advantages, ethical issues on the commercial release of CRISPR-Cas edited plants are also there. But, creating mutations without incorporating foreign DNA reduce the ethical issues. This along with the versatile nature of CRISPR-Cas system expands their scope of application in crop improvement. Thus, CRISPR-Cas technology has revolutionized agriculture and can bring a new green revolution to achieve global food security.

Ashutosh Mukherjee
Assistant Professor & Editor
World Habitat Day, October 4, 2021

A National Webinar on Ethnobotany

THE department, in collaboration with the IQAC of the college, successfully organized a National Webinar entitled "Ethnobotanical Study of Traditional Knowledge: The Key to Better Future" on August 8, 2020. The resource person was Prof. Abhaya Prasad Das, Adjunct Professor, Dept. of Botany, Rajiv Gandhi University, Itanagar, Arunachal Pradesh. In his talk, Prof. Das shared his vast experience in and profound insights on the ethnobotanical wealth of India in general, and the Eastern Himalayas in particular.
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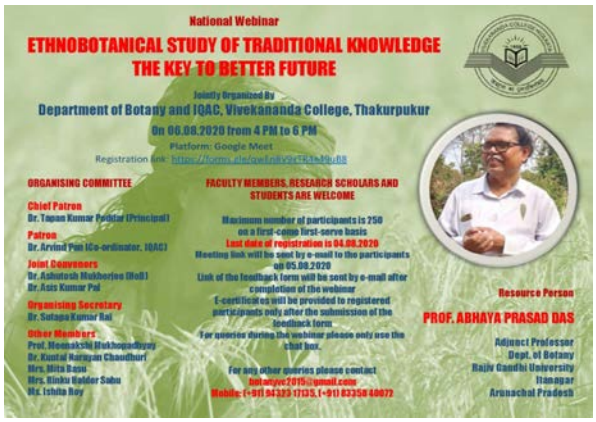
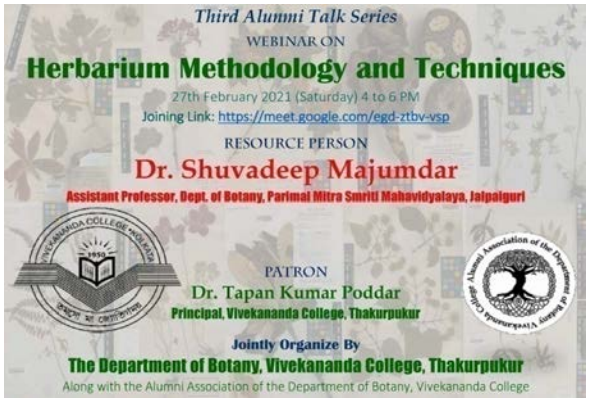


Virtual Talks by Our Alumni



THE department and its Alumni Association invites eminent alumni to their Alma Mater to share their academic achievements and inspire our students. The lockdown had deprived students of field studies. Thus, a webinar was organized on *Herbarium Methodology and Techniques* on February 21, 2021. The resource person was Dr. Shuvadeep Majumdar, Assistant Professor, Dept. of Botany, Parimal Mitra Smriti Mahavidyalaya, an alumnus (batch of 2004-07). On the occasion the 314th birth anniversary of Carolus Linnaeus, a webinar on *Algal Phylogeny* was organized on May 23, 2021. The resource person was Smt. Sreemanti Banerjee, Ph.D. student at the Phycology Laboratory, Dept. of Botany, University of Calcutta, an alumna of this department.
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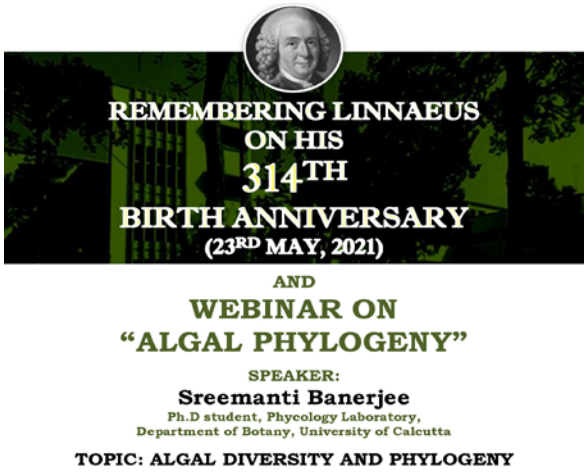
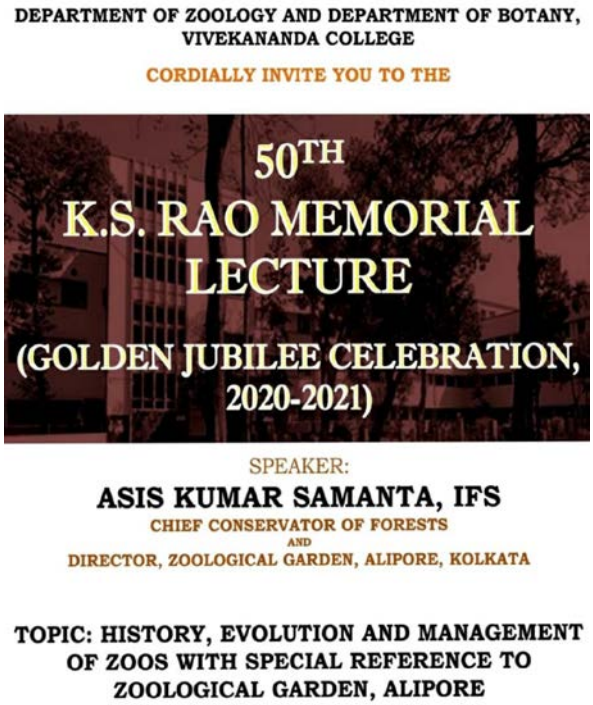


Golden Jubilee: The 50th KS Rao Memorial Lecture



NOVEMBER 29, 2020, was a poignant yet red lettered day in the history of the department of Biological Sciences of this college. Unfortunately, half a century ago, KS Rao, a promising undergraduate student had passed away in an accident while collecting sea urchins near the beach during the course of a field study in far-away Kanyakumari, Tamil Nadu. The loss of any life is heartbreaking, but the untimely loss of a young person is tragic because it is also the demise of myriad unfulfilled dreams. However, his teachers, batch mates and all the stakeholders of the present departments of Botany and Zoology have kept his memory alive by inviting prominent scientists to deliver lectures to enrich us. This has remained an unbroken tradition for the last five decades. The 50th KS Rao Memorial Lecture (Golden Jubilee celebration) was jointly organized with the department of Zoology on January 9, 2021, using the in the virtual platform. The resource person was Sri Asis Kumar Samanta, IFS, Chief Conservator of Forests and Director, Zoological Garden, Alipore, Kolkata. He delivered the lecture entitled "History, Evolution and Management of Zoos with special reference to Zoological Garden, Alipore".

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Beating the Lockdown Blues

THE COVID-19 pandemic had a far-reaching bearing not only on our bodies but also on their minds. As teaching and learning gradually adapted itself to the virtual space, a handful of innovative measures during the lockdown period tried to draw them into the real world. World Music Day was observed on July 21, 2020, with the compilation of a video of vocal and instrumental performances by the students, teachers and alumni, entitled the "Garden of Melodies." On Independence Day, 2020, another video was similarly compiled that featured songs, poetry, dance and art. A documentary short film competition entitled "Plant Short Stories" was organized among the departmental students for the theme "Lockdown and the Plant World around Us". These were screened as part of the celebrations of World Environment Day, 2020. Adjudicated by Prof. Abhaya Prasad Das, Adjunct Professor, Dept. of Botany, Rajiv Gandhi University, Arunachal Pradesh, the winners were: Anamika Gazi (1st position), Jesika Upadhyay (2nd position), Sahasrabdi Aich and Sirin Aslam (3rd position).

--*Eds*

SHUTTERBUGS

NATURE AROUND US

Trapeze Artist
Animesh Manna
Botany Hons. (Outgoing)

Bright Eyes
Nistha Hazari
Botany Hons. (Sem 5)

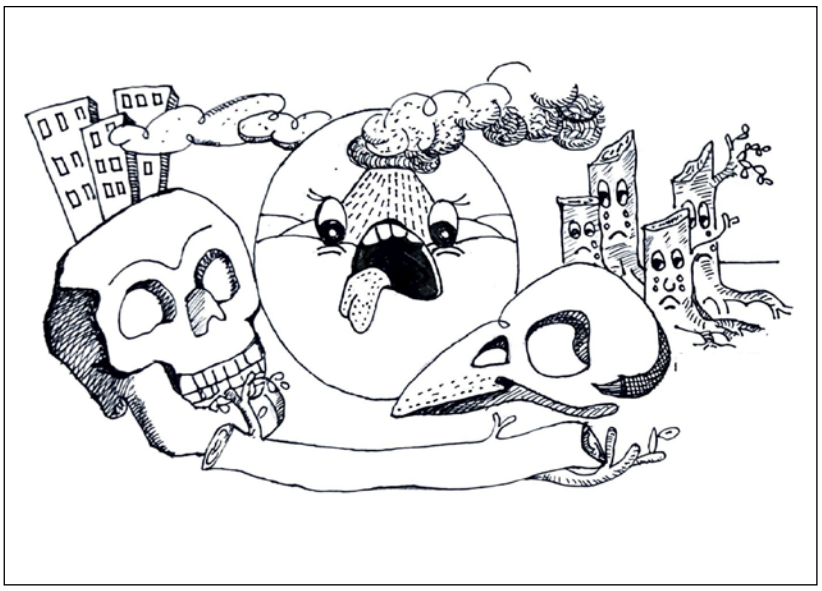
Foraging Jewel Bugs
Nilesh Halder
Botany Hons. (Sem 3)

Flaming Lily
Parthapratim Kar
Botany Hons. (Sem 3)

Water Lilies
Asis Kumar Pal
Assistant Professor

The Fallen Flowers
Kuntal Narayan Chaudhuri
Assistant Professor

BIO-TOONS



Global Warming:

A Global Warning

Saikat Deb
(Sem. III)

REFLECTION

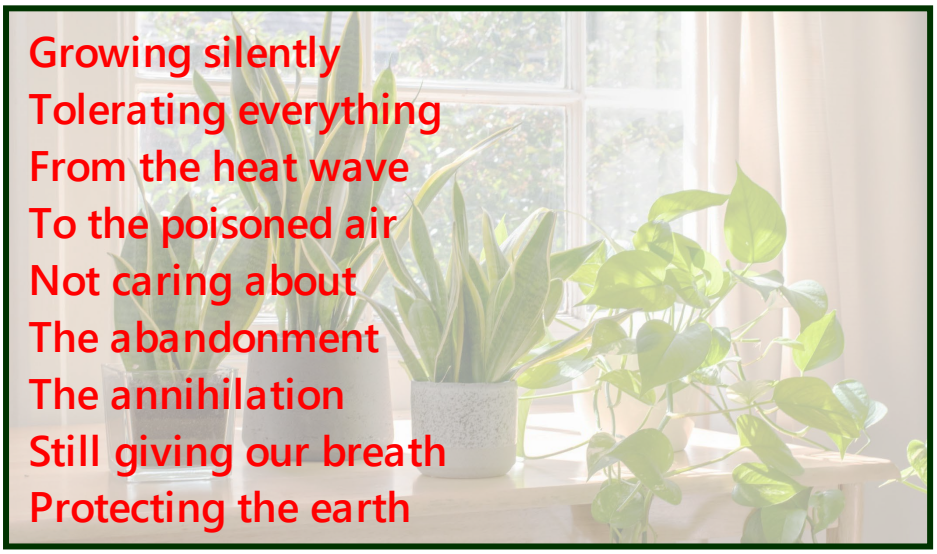
The Real Neelkanthas

Sutapa Kumar (Rai)
Associate Professor

LORD Shiva or Mahadeva (Lord of the Lords) is worshipped as Neelkantha (One with the Blue Throat) as he drank the deadly poison created by Samudra Manthana (Churning of the Ocean) and accumulated it in His throat (*kantha*)—which turned blue (*neel*)—to save the world. Strangely humans do not realize that real life Neelkanthas are plants that hyper-accumulate a wide array of environmental toxins in their body to save their fellow beings. There are plants that can even degrade these poisonous pollutants into harmless products. Even the most humble grasses and weeds can accomplish this noble task.

Not only trees outside homes curb pollution, but even houseplants are a great way to counter indoor pollution. Harmful volatile organic compounds like benzene, formaldehyde, trichloroethylene, toluene, xylene etc. are released from furnishings, cleaning and disinfecting agents, paints, cosmetics and aerosols. Plants like *Aloe vera*, *Dracaena* spp., snake plant, spider plant, money plant, cactuses and others are at our rescue as they absorb these toxins and provide improved air quality indoors. Moreover, in recent times, humans have become slaves in a world that is owned by technology and mere gadgets run their lives. But little do they realize that these friendly devices are slowly killing them at their back. Once again, the indoor plants are their saviour by absorbing the electromagnetic radiation from these beloved gadgets. They work by detoxifying the air,. boost the immune system and increase metabolism. They take all the carbon dioxide present in the room and convert it into fresh oxygen that helps humans breathe better. These anti-radiation indoor plants are really a boon to the human race. Keeping these plants, also help one to be more energized, lower stress levels, and reduce the frequency of headaches that are often linked to radiation. These real Neelkanthas create toxin-free, radiation-free homes to give families the pureness of breathing so that they live a healthy life.

All this remediation the plants do selflessly for others, not expecting anything in return. Unfortunately, human beings are only capable of giving them a death penalty for this altruistic self-sacrificing attitude. The self-centred human race can only slay them and wipe them out from their own cosy habitats in order to meet their need and greed. Not being able to survive even for a few seconds without the help from the plant world, and depending on them for their every need, it really is surprising how humans even dares to destroy these silent good doers.



PERSONALITY

Nikolai Vavilov (1887-1943): Visionary Botanist who Dreamt of Feeding the World

Kuntal Narayan Chaudhuri
Assistant Professor

Vavilov pioneered studies in using and saving plant genetic resources for food security. This globetrotting plant breeder's global seed bank holds an impressive germplasm collection that had helped forge his seminal ideas on the world's historic centres of plant domestication that he succinctly termed 'gene centres.' These centres of diversity of cultivated plants are now called 'Vavilov centres' in his honour.

NICKOLAI Vavilov was born in Moscow, Russia, on November 25, 1887, to Aleksandra and Ivan Ilich Vavilov. In 1908, studying genetics at the Petrovskaya Agronomic Institute, Moscow, he got influenced by Mendel's theory of heredity. After graduating in 1911, he worked at the Bureau for Applied Botany, Leningrad, before travelling abroad from 1913 to 1914. In London, his mentor was William Bateson, co-founder of genetics. He also met Reginald Punnett in England and Ernst Haeckel in Germany. He returned to Moscow and in 1917completed his thesis.

Vavilov was one of the first geneticists in Russia. In 1917, he became professor of genetics at the Department of Agriculture, University of Saratov. But he soon re-joined the Bureau as director from 1924 to 1940, reorganizing it into the All Union Institute of Applied Botany. He obsession of improving food crop breeds to end famines in Russia and the world was propelled by memories of crop failures that forced his family to the city. This endeavour made him the "most widely travelled biologist of our day". He was literally chasing genes during 115 expeditions to 64 countries across the globe to collect "seeds" of local varieties of crops and their wild relatives. Many would disappear soon. His formidable collection of seeds, fruits and rhizomes at the institute formed the first global seedbank. Earlier, in 1917, his hypothesis (now called "Vavilovian mimicry") explains how weeds become crops by adapting to survive control practices of prehistoric farmers. Later, in 1926, his theory on the historic centres of plant domestication immortalized him. His *Origin and Geography of Cultivated Plants*, was elaborated later (1927-40) with 13 geographical regions as centres of crops diversity or "gene centres" organized into seven basic centres.

Vavilov, the Leonardo Da Vinci of the plant world, excelled in myriad fields. Unfortunately, he fell prey to political intrigue by opposing the non-Mendelian pseudoscience of his more influential junior Trofim Lysenko. In 1940, after his nemesis replaced him as the director, he was arrested, sentenced to death (1941), but commuted to life imprisonment (1942). Meanwhile, during the Siege of Leningrad (1941-44), his fellow botanists hiding in a secret vault of his seedbank saved the world's lost seeds by starving themselves to death, rather than consuming them. On January 26, 1943, the man whose mission was to feed the world, himself died of starvation in Siberia. His reputation was publicly restored in the 1960s. In 1968, renamed as the Vavilov Institute, his legacy lives on as the world's largest collection of plant genetic resources in the form of meticulously catalogued seeds from all over the earth.

DO YOU KNOW?

Eucalyptus deglupta: The Rainbow Gum Tree

Manjira Yadav
Botany Honours (Sem. V)

THE rainbow gum tree, *Eucalyptus deglupta* (Myrtaceae), also known Mindanao gum or rainbow eucalyptus, is tree species native to Indonesia, Papua New Guinea and the Philippines. Incredibly, as the tree sheds its bark, it looks like a colour pencil being sharpened. As the rainbow eucalyptus sheds, it first reveals a bright green inner bark. Over time, this ages into different hues of blue, purple, orange and maroon that appear as colourful striations as that the tree doesn't shed all at once. Slowly, over time, different layers fall off, while other exposed areas have already begun ageing. This process creates a spectacular visual, resembling a multi-coloured crayon scratch drawing, covered with black crayon that is then scraped away to reveal the multiple colours underneath.

On Plant Blindness

Soumyadeep Banerjee
Botany Honours (Sem. III)

Plants fuel life on Earth by tapping solar energy to produce food and oxygen, yet most of us tend to appreciate animals more than plants? The botanists J. Wandersee and E. Schussler coined the term "plant blindness" as a form of cognitive inability to notice plants in one's environment, leading to the inability to recognise the importance of plants in the biosphere and in human affairs. Although it is assumed that a range of cultural, social and educational biases may contribute to this, however it is the human visual information processing system that is the basic factor behind plant blindness. Our brain can't process everything we see, and it usually focuses on movements, colours and patterns, but static objects often blend with the surroundings. Thus, animal movements around us, that are often threatening, are observed, while plants in to the background gain our attention only when they are in bloom. Efforts to overcome plant blindness include popular articles, books, projects, campaigns, etc. But, at the end of the day, one question is still there "have we really been able to overcome this plant blindness?"

Trametes versicolor: The Anti-Cancer Mushroom

Asis Kumar Pal
Assistant Professor

THE turkey tail, *Trametes versicolor* (L.) Lloyd, (also known as *Coriolus versicolor* and *Polyporus versicolor*) is a well-known and common species of polypore mushroom that is found throughout the world. The mycelial and fruit body extracts of this fungus is used to treat primarily gastric and colorectal cancer. A substance called polysaccharide-K (PSK or krestin) has been extracted from the turkey tail which finds its use as an adjunct drug for the treatment of cancer in Japan. Studies on PSK are going on regarding its efficacy in cancer treatment by modulating the immune system. Although not yet approved by the FDA (of the United States), this novel drug has been placed under 'new drugs' category as per section 201(P) of the Federal Food, Drug and Cosmetic Act.

HERBAL HEALER

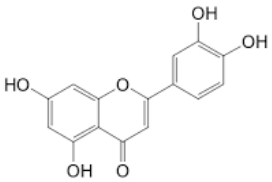
Begonia malabarica: The Mythical *Sanjeevani*?

Sayantan Mondal
Botany Honours (Outgoing)

MALABAR begonia, *Begonia malabarica* Lam. of the family Begoniaceae, is endemic to India (Southern Hills) and Sri Lanka. It is an sub-succulent herb (up to 60 cm); stem is reddish-pink and glabrous; leaves are alternate, ovate, hispid, with unequal base; flowers are yellow (male) and pink (female), borne on axillary cymes, and appear from August to April. The plant is propagated by seeds and grows in the wild in evergreen and semi-evergreen forests. It is called *sankha sanjeevi* or Narayana *sanjeevi* in Tamil for the leaves resemble the conch shell (*sankha*) associated with Vishnu (Narayana).

In Peninsular India, *B. malabarica* leaves are wild edibles (tamarind substitute) only one-of-its-kind with five different flavours: starting with sour, and followed by bitter, sweet, pungent and astringent. These are also used as medicine in Ayurveda, Siddha, and folk medicine of the local tribes, for treating myriad aliments. Due to its amazing curing abilities, *B. malabarica* is one of the potential candidates for *sanjeevani*—the mythic herb with the power to beat situations when death is almost certain. These leaves are used in the Ayurveda-Siddha as a *kaya-kalpa* species for reversing the ageing process and detoxification of the body. The Kanikkars of Agasthiarmalai Hills, Tamil Nadu, orally take the fresh leaf juice to relieve stomach-ache, along with salt to treat giddiness, and leaf paste is topically applied on sores. The Paliyans of Kodaikanal Hills, Tamil Nadu, consume boiled leaves for stomach and lung ailments. The leaves are also used to treat heart diseases, lung issues, skin infections, anaemia, rheumatism, and even blood cancer. The traditionally preparations of the leaves have body cooling, blood purifying, hypo-glycemic, anti-bacterial, anri-fungal, anti-oxidant and anti-cancerous properties.

B. malabarica leaves have key nutrients and therapeutic agents in the form of secondary metabolites, *viz*. luteolin (see fig. below), quercetin and β-sitosterol. Leaves also contain flavonoids, alkaloids, phenols, saponins and tannins.



The anti-oxidant effect of *B. malabarica* is the most investigated mechanism of action of this traditional medicinal plant. Its active principles, such as luteolin, are known to prevent chronic diseases by protecting body cells from oxidative stress by their scavenging the free radicals in the form of reactive oxygen species.

Malabar begonia propagation from seeds is particularly challenging because of their dormancy and rapid loss of their viability. In addition, propagation from seeds often leads in a high degree of variability among the progeny. Although not yet threatened, this medicinal plant species with commercial potential needs to be cost-effectively clonally propagated to meet its rising demand in global trade. A rapid and efficient protocol for the large-scale micro-propagation of this valuable medicinal herb is possible by auxiliary shoot proliferation and organogenesis.

Mucormycosis: Tackling this Emerging Global Threat

Shreyansi Das
Botany Honours (Sem. V)

THE second COVID-19 wave had affected India severely. An emerging threat in the form of mucormycosis, colloquially known as black fungus, is caused by the filamentous fungi belonging to the order Mucorales (Zygomycetes), as species of *Rhizopus* and *Mucor*. This opportunistic infection can affect immunocompromised patients. A standard component of the COVID-19 treatment is administration of high doses of corticosteroids to damp down the immune system's overreaction to the infection. Although these steroids save lives, but they also make a patient more vulnerable to fungal attacks. Thus, coupled with diabetes, was the culprit behind an increased rate of mucormycosis. The sporangiospores (see fig.) enter the body through inhalation, ingestion, or other means to cause the infection. The symptoms include fever, headache, abdominal pain, eye swelling, short breath, etc. Treatment includes surgical debridement and use of anti-fungal drugs like amphotericin B to slow or halt the spread of the fungus. However, early diagnosis is challenging, and delayed treatment affects the outcome. Recently, Dr. Ashraf Ibrahim and his team from the Lundquist Institute, California, USA, reported in the journal *Nature Microbiology* that a toxin named mucoricin plays a key role in the virulence of this disease. Antibody mediated inhibition and RNA interference inhibited its effects in mice. Therefore, targeting mucoricin for the diagnosis and treatment could be a possible solution in the near future.

Roridomyces phyllostachydis: A Light-emitting Mushroom

Ayan Deb Goswami
Botany Honours (Sem. V)

THE fungus *Roridomyces phyllostachydis* (Mycenaceae) is a species of bioluminescent mushroom from Northeast India. Recently published in the journal *Phytotaxa* (2020), these "electric mushrooms" were discovered by a team of scientists from India and China on dead bamboo (*Phyllostachys mannii* after which the species is named) near a forest steam in Mawlynnong, East Khasi Hills, Megahalaya. It was later found in and KrangShuri, West Jaintia Hills of the state. The mushroom's stipe only displays the eerie green luminescence in the dark due to the activity of the oxidative enzyme called luciferase. This may be a mechanism for protection from frugivorous animals. Locals use bamboo sticks emitting the green glow of the fungus on them as natural torches to travel through the darkness of the forest at night.