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Theme

Sustainable Use of the Biological  
Wealth of Sri Lanka

Institute of Biology, Sri Lanka

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Dr. S A C N Perera  
Editor, IOB

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Mail            The Institute of Biology, Sri Lanka  
                  'Vidya Mandiraya'  
                  120/10, Wijerama Road,  
                  Colombo 07.

Web            [www.iobsl.org](http://www.iobsl.org)

Cover design: Mr. Mudith Ekanayake  
                  Department of Plant Sciences  
                  University of Colombo

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## About the Institute of Biology, Sri Lanka

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The Institute of Biology is a leading professional body of biologists in Sri Lanka. Its current membership is over 500. The institute was formulated in a small way by a group of Sri Lankan biologists led by late Prof. B. A. Abeywickrama (Emeritus Professor of Botany University of Colombo) in 1981. It became an incorporated organization by the Act of Parliament No 22 in 1984.

### **The objectives of the institute are:**

1. To promote and advance the science of biology and its applications in Sri Lanka.
2. To advise the government, and give counsel to public corporations, local bodies and other institutions on all matters connected with the application of biology in the progress and development of the country.
3. To promote acquisition, dissemination and interchange of biological knowledge by providing a forum for the presentation of original communications and discussions and maintaining libraries which publish matters of interest to the profession of biology.
4. To promote education in biology at all levels.
5. To promote, encourage and foster original research in biology.
6. To ensure the maintenance of high standards in the professional activities and the general conduct of its members.
7. To establish liaison with other scientific organizations.
8. To establish and enhance the status of the profession of biology in Sri Lanka.

### **Membership**

The institute has around 500 members, working in industry, research, education and healthcare. The institute also awards Fellowships and Charter of Biology status for members. There are seven categories of membership and members are encouraged to transfer to other grades in due course. Eligibility for each category depends upon a combination of professional experience and academic qualifications. Fellows are entitled to use the abbreviated designation F.I.Biol (Sri Lanka) while the Chartered Members are eligible to use C.I. Biol (Sri Lanka), Members M.I.Biol (Sri Lanka), Associate Members, A.I.Biol (Sri Lanka) and Licentiates L. I. Biol (Sri Lanka).

The designation 'Chartered Biologist' endorses the high standards expected of biologists and is for international recognition as a hallmark of professional competence and ethical conduct.

### **Activities**

The Institute organizes workshops/seminars on current topics in biology on a regular basis. It also plays an important role in biology education to a wider spectrum of participants ranging from those in the industry, those seeking self-employment, school children and general public. Details of events are posted on the IOB website. The information provided on the web also keeps teachers informed on current events in the field of biology. The Biology Olympiad Competition organized solely by the Institute of Biology is a hallmark event in the country which provides opportunities to students in the country to become champions in biology both locally and internationally. The annual session provides a forum for both senior and junior biologists to present their research findings for a complex audience of scientists, policy makers and implementers. The annual sessions continue for the 38<sup>th</sup> time this year.

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# **Sustainable use of the biological wealth of Sri Lanka: under-explored plant resources**

**Presidential Address by**

**Pradeepika Shaminie Saputhanthri**

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"The most wonderful mystery of life may well be the means by which it created so much diversity from so little physical matter. The biosphere, all organisms combined, makes up only about one part in ten billion of the earth's mass. It is sparsely distributed through a kilometre-thick layer of soil, water and air stretched over a half billion square kilometres of surface. If the world were the size of an ordinary desktop globe and its surface were viewed edgewise an arm's length away, no trace of the biosphere could be seen with the naked eye. Yet life has divided into millions of species, the fundamental units, each playing a unique role in relation to the whole." *Edward O Wilson, (1992)*

## **Our biological wealth:**

Biological wealth in simple terms is the natural species of living things that are responsible for the structure and maintenance of all ecosystems. Human life and economic activity, in turn, are sustained by the ecosystem capital with goods and services. Sri Lanka is a nation blessed with an immense biological wealth, reflected in its rich biological diversity. It is well known that Sri Lanka, along with the Western Ghats, has been identified as one of 34 'biodiversity hotspots' of the world. A biodiversity hotspot is a biogeographic region with significant levels of biodiversity that is threatened with destruction. To qualify as a biodiversity hotspot, "a region must contain at least 1,500 species of vascular plants (>0.5% of the world's total) as endemics, and it has to have lost at least 70% of its original habitat."

In economic terms, as per the country classifications by the World Bank, we are a "developing- or a lower middle-income country of 21.4 million people with per capita GDP in 2017 of \$4,065. The economy is transitioning from a predominantly rural-based economy towards a more urbanized economy oriented around manufacturing and services". For a developing country like Sri Lanka, it is a great challenge to balance both ecological and economic development targets. Thus biodiversity in Sri Lanka is under several threats, the major ones being habitat loss, human population growth, pollution, invasive alien species, and overharvesting of natural resources. Poor land use planning, weak legislation, lack of proper management policies etc have aggravated the threats.

We depend on biodiversity for all aspects of life and value natural species for agriculture, medicines they provide, recreational, aesthetic, scientific and cultural purposes, and thus utilization of our biological wealth is essential. However, it has to be done in a manner that will 'not deprive the quality of life of future generations' (use sustainably).

Considering the biological wealth of the island in terms of plants, 3771 flowering plant species, 314 ferns & fern allies, 561 mosses and 227 liverworts have been recorded. It has been documented that endemic plant species diversity of Sri Lanka comprises 927 or 28 % of flowering plants, of which 60 % are found in the lowland wet zone and 34% in the montane zone ecosystems of the island. Among the ferns, 59 species are endemic to Sri Lanka. Of the island's moss flora, 11% are endemic. Recent revisions on the island's liverworts have not been made and its endemic component is yet to be compiled. Similarly, there is little information on the endemic species among fungi, algae and lichens.

For biologists in the country there are still many underexplored areas related to the Sri Lankan flora, which warrant further investigations for better awareness on potential benefits, for conservation and for sustainable utilization. This address focuses on two such under-explored plant resources in the country: 'lower plants' and 'plants in the extreme'.

### **Lower plants:**

Although being essential components of our natural ecosystems, 'lower plants' (algae, bryophytes, ferns and fern allies), particularly, the bryophytes, have received only a little attention other than for taxonomic purposes. Biological sources including plants, microbes, lichens etc. produce a range of structurally diverse compounds known as secondary metabolites (=natural products, phytochemicals). Some of these natural products have beneficial uses for the mankind and can serve as the basis for the production of pharmaceuticals, agrochemicals, cosmetics, food flavours, colouring agents etc. Currently, biological compounds from lower plants are being explored in the world for their bioactive potency, particularly as pharmaceutically important chemicals. Although only a few have been developed for medicinal use, many compounds with antibiotic, antitumor, antioxidant, phyto- or cytotoxic and other bioactive properties have been isolated from bryophytes. Bryophytes have gained attention in recent times as having anticancer properties. Anti-leukemic activity has been shown by several compounds from some liverworts. Reports on bioactive properties or any sort of biochemical analyses on bryophytes are scarce in Sri Lanka. This gap in scientific evidence supporting significance of these non-vascular lower plants, which are at present apparently overlooked by the research community of the country. Two reasons for this may be the lack of many bryologists in the country, and difficulty in identification of bryophyte species without proper training or expertise.

Bryophytes and bryology have many other potential applications. In some parts of the world they have been used in traditional medicines. They are now increasingly being used in horticulture, pollution monitoring etc. Bryophytes (and lichens), being poikilohydric (maintain a moisture equilibrium with their environment, and have no control over dehydration), are often used as bioindicators of air quality.

Bryophytes perform a significant function in ecological balance on earth. Habitat destruction and degradation, air pollution, over exploitation etc. are enhancing the rate of extinction of bryophytes due to their fragile nature. Ex situ conservation is one approach in

conservation of bryophytes which are under threatened status. In vitro culture techniques are used for ex situ conservation of lower plants in some countries. This would be a novel approach to Sri Lanka.

### **Plants in the extreme:**

Tectonic and climatic factors over the Earth's history have generated territories that exhibit harsh environmental conditions that are hostile for many living organisms. However, some have adapted to survive under extreme environmental conditions, for example high salt concentrations (halophytes) and water deficit (xerophytes). Yet, we know very little about how those survival traits have evolved and function in such 'extremophytes'- plants in the extreme.

In Sri Lanka, there is a group of unique geological sites named as 'Serpentines' which have soils naturally rich in heavy metals. When ultramafic (high-iron and magnesium) rocks and minerals formed from olivine and pyroxene rich magma in the Earth's mantle and oceanic crust are exposed at the surface of the earth due to tectonic movement, these may become 'serpentinized' – altered in contact with water, and weather to give a variety of soils known collectively as ultramafic soils or 'serpentine' and such soils are often enriched in Mg, Fe and sometimes with Ni, Cr and Co. Serpentine outcrops have long been subjected to mining for the extraction of heavy metals Ni and Cr as well as minerals such as asbestos. The serpentine soils are deficient in plant-essential nutrients, and often also in organic matter, cation exchange capacity, and water availability. These characteristic features of provide a harsh edaphic environment against which only a few species of plants have adapted morphologically and physiologically to colonize and for survival. Due to the harsh conditions ruling serpentine habitats, plants growing on serpentine and their associated biota (rhizosphere bacteria, mycorrhizae, pollinators, seed dispersers, pathogens, herbivores etc.) show unique adaptations or biotic associations. Some serpentine plants bear the unique physiological uptake mechanism of hyperaccumulation, in which they may accumulate to concentrations >1000 µg metal per g dry plant tissue. Recent breakthroughs at the global level have given first insights into the molecular basis underlying the complex extreme model trait of metal hyperaccumulation and associated metal hypertolerance. Heavy metal contamination of soils is an increasing environmental problem worldwide. Hyperaccumulator plants can be used to remove heavy metals by sequestering, stabilizing or biochemically transforming them. This technology, phytoremediation, is relatively cost-effective and environment-friendly.

Geological studies in Sri Lanka have shown at least five serpentine outcrops at Ussangoda, Uda-Walawe (Indikolapelessa and Ginigalpelessa), Yodhagannawa (in the Wasgomuwa National Park) and Rupaha. Recent studies have reported identification of nickel hyperaccumulator plants, especially from the Ussangoda serpentinite. Also, there are reports on bioactivities of some serpentine flora. World-wide, serpentine flora has been treated as a model system for understanding mechanisms of adaptation, ecotypic differentiation, and the linkage between natural selection and speciation. They also provide a model for botanical studies on plant physiology and ecology, and for applications for habitat conservation and

restoration. Many serpentine plants in the world are used as indicator plants in geo-botanical exploration of mineral deposits. Hyperaccumulators have been successfully used to revegetate degraded (due to mining etc.) serpentine substrates, but their most common and effective application is in heavy metal phytoremediation of polluted non-serpentine soils. In Sri Lanka too we have the unique 'biological wealth' of serpentine flora (also fauna, and microbes). However, awareness on the significance of these sites along with the species they harbor has to be enhanced in order to conserve and sustainably use these natural resources.

In 1798, the English cleric and scholar Thomas Malthus wrote in his book *An Essay on the Principle of Population*:

“Famine seems to be the last, the most dreadful resource of nature. The power of population is so superior to the power of the earth to produce subsistence for man, that premature death must in some shape or other visit the human race. The vices of mankind are active and able ministers of depopulation. They are the precursors in the great army of destruction, and often finish the dreadful work themselves. But should they fail in this war of extermination, sickly seasons, epidemics, pestilence, and plague advance in terrific array, and sweep off their thousands and tens of thousands. Should success be still incomplete, gigantic inevitable famine stalks in the rear, and with one mighty blow levels the population with the food of the world”.

Due to the advances in science and dedicated scientists, the world, however, did not encounter a Malthusian Catastrophe as predicted.

Likewise, it is our responsibility to find means to prevent further damage to our biological wealth and to move in the direction of sustainability.

## FELICITATION OF

**MR. LESLIE C. A. DE S. WIJESINGHE**

**THE CITATION**

**Presented by**

**Dr. Magdon Jayasuriya**

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*"We must find time to stop and thank the people who make a difference in our lives" – John F. Kennedy*

Today, I am very happy to have been invited to present this appreciation to Mr Leslie Wijesinghe. It was some 49 years ago when I had my first contact with him in teacher-student relationship at the University of Colombo. He was then the Assistant Conservator of Forests and delivered a course on Forestry and Forest Ecology for the Botany Special batch. Since then, I had many occasions to interact with him as an employee, member of several Committees and Working Groups that he chaired and I am fortunate to have later succeeded some of those eminent positions he has held. I will elaborate these occasions at appropriate places during this presentation.

### **Education**

Mr Leslie Wijesinghe had his entire school education at St Peter's College, except for one year when he schooled at Kingswood College (during the 2nd World War). Many years later, in 1988, he was honoured by his Alma Mater in recognition of his "outstanding services to science".

He entered the then University of Ceylon in 1951. Later he was awarded an Exhibition on the results of the First Science Examination, and graduated with honours in Botany in 1955. His academic qualifications are BSc Hons (Cey.), B A Hons Forestry (Oxon.) and M A (Oxon.).

### **Career**

He was appointed Assistant Conservator of Forests in 1956 and was awarded a Colombo Plan Scholarship to Oxford University for studies in Forest Science, and he graduated with honours in 1958. In Oxford, besides studying Forest Science, he carried out research on the shrinkage properties of wood and his paper on the subject was published in the British journal Forestry.

At the Forest Department, he has held the positions of **Assistant Conservator of Forests** (Working Plans), **Divisional Forest Officer** (Research and Development), **Principal of the Ceylon Forest College** and **Divisional Forest Officer** (Upcountry Division). In 1972, he assumed the position of **Senior Assistant Conservator of Forests** in charge of the island-wide forestation programme (set at 14,000 acres afforestation and reforestation and 2000 acres enrichment planting). The targets were exceeded every year during the period he served in this capacity.

While in the Forest Department, Mr Wijesinghe excelled in carrying out some applied research relating to the forestation activities.

**Sinharaja crusade:** In my view, one of the most exemplary services that he has contributed to nature conservation in Sri Lanka was the saving of Sinharaja in late 1970s. During late 1960s through 1970s, for short-term economic gains, the Government had been advised to log timber from Sinharaja to feed a Plywood Factory, described by nature scientists as a “folly and an act of absurdity” that caused severe damage to this large tract of virgin rainforest in Sri Lanka. Due to intense protests by environmental scientists, such as Late Prof. B. A. Abeywickrama, late Mr. Telo Hoffman of the Wildlife and Nature Protection Society, and others, the Government appointed a high level committee for advice on this issue. Mr Wijesinghe was appointed as the Secretary of this Committee which had to crusade against parties such as the Timber Corporation and the Plywood Corporation to achieve a tenable solution to the problem that led to a step-wise regulation of timber extraction and finally to a complete halt in 1977.

In 1972, Mr Wijesinghe wanted to broaden the scope of his scientific work and he applied for the post of Deputy Secretary General of the National Science Council. He was selected for the post and during the period **1977-1990**, he functioned as **Deputy Secretary General of the National Science Council** and then **Additional Director General** and **member of the governing board of the Natural Resources, Energy and Science Authority (NARESA)**.

He carried out surveys on household fuel-wood use in Sri Lanka and operational experience with biogas plants in Sri Lanka. The papers based on these studies were published in reputed international journals. The paper on biofuel, published in the British Journal of Biomass, earned the accolade from one reviewer, “This is certainly one of the most thoroughly investigated that I have come across”. Another paper on biofuel was published in 1988 titled “Biomass fuel and its utilization in Sri Lanka” in RREIC International Journal (10, 1: 67-80), published by Asian Institute of Technology in Bangkok. The paper on biogas was published in the journal of Natural Resources Forum published by the United Nations.

Another instance is when he coordinated the Salvinia control programme and played a key role in bringing together the key stakeholders and organizing the multi-disciplinary effort that led to the effective control of this widespread plant pest. This work involved in introduction of a bio-control agent *Cyrtobagus salviniae*.

Mr. Wijesinghe retired from the government service in 1991 and during **1991-1992**, he served as a UNDP Consultant to the Ministry of Environment and Parliamentary Affairs and in 1992 as an IUCN Consultant in the same Ministry. In **1993**, he assumed the position of **the Sri Lanka Country Representative of IUCN – The World Conservation Union** and he held this position till **1998**. It was during this period, I had the opportunity of being a Consultant of the National Conservation Review Project (1991-1996). This project was jointly conducted by the IUCN and World Conservation Monitoring Centre (WCMC) for the Forest Department. Therefore, this time Mr. Wijesinghe became my employer (1993-1995).

After his tenure at the IUCN, he was honoured with positions in several committees and consultancies in the Ministry of Environment and National Science Foundation. From **1994-2000**, he served as the **Chairman of the National Experts' Committee on Biodiversity** of the Ministry of Environment. Prof. Sarath Kotagama succeeded him as the Chairman till 2011 and then I took over the chairmanship till now. Therefore, Prof. Kotagama and I can be known as professional descendants of Mr. Wijesinghe.

From **1997-2005**, he served as the Chairman of the National Committee of UNESCO Man and Biosphere (MAB) Programme. Prof. Nimal Gunatilleke succeeded him during 2005-2011 and then I was appointed to the position in 2011. Therefore, Prof. Gunatilleke and I are again become professional descendants of Mr Wijesinghe.

From **2004-2010**, he was attached, for varying periods, to the **Ministry of Environment** as the **Lead Consultant** for undertaking, in collaboration with other consultants, subject matter experts, government agencies and Departments, etc., preparatory work aimed at nominating selected properties in **Peak Wilderness, Horton Plains, and Knuckles range** for inscription as a World Heritage under the UNESCO **World Heritage** Convention. Mr Wijesinghe, with other consultants, prepared the nomination dossier for the Central Highlands of Sri Lanka. The nomination was accepted by UNESCO and The Central Highlands of Sri Lanka was declared a **Natural World Heritage**.

### **Membership of Learned Bodies**

- Member, Sri Lanka Association for the Advancement of Science (SLAAS)
- President Section B (Agriculture and Forestry), SLAAS, 1969
- Fellow, Institute of Biology, Sri Lanka
- President, Institute of Biology, Sri Lanka, 1989-1990
- Fellow, National Academy of Sciences, Sri Lanka
- Vice President, National Academy of Sciences: 1998, 1999
- President, National Academy of Sciences: 2000, 2001

### **Membership in Professional Societies, Associations, Committees, Expert panels, Commissions, Delegations and Editorial Boards**

Over thirty positions have been held by Mr Wijesinghe; a few of the notable contributions being: He initiated work and provided technical guidance for the preparation of the Red List of Threatened Species in Sri Lanka.

He developed the structure for, and guided the preparation of the National Biodiversity Action Plan, using material collated by individual consultants.



As a National Environmental Consultant to the Ministry of Environment and Forestry (in 2001 and 2003), he prepared the National Environmental Action Plan (Caring for the Environment 2003-2007 – Path to Sustainable Development), and subsequently assisted the Ministry during the initial implementation phase in 2003.

### **Teaching - Universities**

Mr. Wijesinghe functioned as a visiting lecturer in forest ecology in the honours degree course in botany at the University of Colombo (1969, 1970). As a student I benefitted from his lectures / demonstrations on forestry and forest ecology and this was my first encounter with Mr Wijesinghe, 49 years ago.

### **Awards & Scholarships**

- Awarded a University Exhibition on the results of the First Science examination in 1952.
- Colombo Plan scholar, University of Oxford, 1956-1958.
- FAO Fellow studying forest harvesting techniques in Western Europe, 1966-1967.
- Selected by US government to participate in an International Visitors' Programme in the USA, 1983.
- Received the NARESA Merit Award for outstanding research in the field of biofuel energy.
- Awarded Certificate of Honour by St Peters College for outstanding contributions to science, 1988.

### **Publications** (in national and international refereed journals - feature articles excluded.)

28 Research and review papers are listed in Mr Wijesinghe's CV and they were mainly in the fields of Forestry, Timber technology, Logging technology, biomass and fuel wood usage. In addition, many important National Status Reports have been prepared by him. Here, I wish to highlight a few publications

### **Natural Resources of Sri Lanka – Conditions and threats. NSF.1991**

Mr Leslie Wijesinghe was a member of the Editorial Committee, chaired by Prof. B A Abeywickrama. He also contributed two chapters for the publication.

**Natural Resources of Sri Lanka – Conditions and Trends. NSF, 2000.** Mr Leslie Wijesinghe was a member of the Editorial Board, chaired by Prof. P.G. Cooray. Further, Mr. Wijesinghe contributed two chapters on Forestry and Biodiversity

**Natural Resources of Sri Lanka – Conditions, trends and Prospects. NSF. 2017.** Mr. Wijesinghe served as a member of the Editorial Board, chaired by Prof. M.J.S.Wijeyaratne. Prof. Wijeyaratne, Dr. N.P.Wijeyananda and I function as the Editors of this edition. Therefore, now I have the privilege of being a literary descendant of Mr. Wijesinghe.

### **FAMILY**

Mr. Wijesinghe married Yvonne Fernando, also an honours graduate in Botany in 1959. They have three children. The son Rohan is an accountant residing in Australia; daughter Achala is a banker and is now in New Zealand; the third is Mayuri.

Here, therefore, the Institute of Biology and we colleagues **“have found time to stop and thank an exemplary and illustrious individual – Mr Leslie Wijesinghe – who has made a difference in our lives”** (in the words of President John F. Kennedy).

Thank you.

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# **ABSTRACTS OF PAPERS**

**Parallel session 01 (Fauna & Environment)**

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## Comparison of the thermal sensitivities of two native anuran species

H.A.D. Pramodya<sup>1</sup>, H. Jayaweera<sup>2</sup> and Mayuri R. Wijesinghe<sup>1</sup>

<sup>1</sup>Department of Zoology and Environment Sciences, University of Colombo.

<sup>2</sup>Department of Physics, University of Colombo.

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The present study assessed the variation in thermal sensitivity in two native anuran species, the Asian Common Toad (*Duttaphrynus melanostictus*) and the Skipper frog (*Euphlyctis cyanophlyctis*). Due to the disparity in thermal behavior of terrestrial and aquatic media we hypothesized that the thermal sensitivity of the primarily terrestrial toad (*D. melanostictus*) and the fully aquatic frog (*E. cyanophlyctis*) would be different. This hypothesis was tested using animals from three bioclimatic zones of Sri Lanka (Matara, Colombo and NuwaraEliya) which were empirically exposed to six temperatures (between 12 and 38 °C). Test temperatures were maintained using a water bath and cold room. Four performance parameters (Jump Distance, Jump Force, Contact time and Righting Time) were measured and the data were used to construct Thermal Performance Curves (TPCs) to generate values for three indicators (niche breadth- NB, thermal optima - TO, and optimal performance - OP). Interspecific comparisons showed that, with the exception of the Jump force, for the other three parameters (Jump distance, Righting time and Contact time), there were marked disparities in thermal sensitivity between the two study species: NB of the toad was much significantly wider ( $P < 0.05$ ) compared with that of the frog; TO of the frog was lower than that of the toad, although not significantly ( $p > 0.05$ ); OP was significantly higher ( $P < 0.05$ ) in the frog than in the toad. These findings suggest that in an aquatic environment it is beneficial for aquatic species to perform over a narrow thermal range as water experiences lower thermal variation. For the terrestrial species in contrast, it would be advantageous to perform over a broad thermal range, even at the expense of reduced performance, since terrestrial habitats are exposed to a wider range of ambient temperatures. In comparison to *D. melanostictus*, the thermal optima of *E. cyanophlyctis* were below the average ambient temperature in each climatic zone, indicating that a small increment in ambient temperature may adversely affect this species. Such information on thermal performance would be useful to predict the vulnerability of amphibian species to climate change.

**Preliminary investigation of serum creatinine (SCr) and  $\beta$ 2-microglobulin in farming and fishing communities in the dry zone, Sri Lanka: Implications on Chronic Kidney Disease of unknown etiology (CKDu)**

W.A.K.G.Thakshila<sup>1</sup>, E.M.D.V Ekanayake, E. P. S. Chandana, P. Mangala C. S De Silva\*

Department of Zoology, Faculty of Science, University of Ruhuna, Matara, Sri Lanka.  
([chathura@zoo.ruh.ac.lk](mailto:chathura@zoo.ruh.ac.lk))

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Renal biomarkers are essential tools to recognize early and end stage chronic kidney diseases. Serum creatinine (SCr) is the most widely used marker, although new biomarkers are being used in detecting renal functions. Urinary  $\beta$ 2-microglobulin ( $\beta$ 2M) is one such novel biomarker which is considered as a popular end stage renal biomarker. Histopathological studies revealed that tubular damage is common patients suffering from Chronic Kidney Disease of unknown etiology (CKDu), which is more prevalent among dry zone agricultural communities in Sri Lanka (SL). Therefore, we conducted a study to detect urinary  $\beta$ 2M expression along with serum creatinine in a Paddy farming community in Wasgamuwa, sugarcane farming community in Pelwatta in comparison to a fishing community in Mannar in the dry zone. Early morning first void urine samples (n = 40) for each location were used for the  $\beta$ 2M analysis. Urinary  $\beta$ 2M were analyzed by using ELISA. The highest SCr (Mean, 1.16  $\pm$  0.18 mg/dL) was recorded from Mannar fishing community followed by Wasgamuwa and Pelwatta. However, 18% of Wasgamuwa community reported SCr > 1.4 mg/dl whereas Mannar community reported only 7.5%. This was also supported by elevated  $\beta$ 2M in Wasgamuwa community (0.65  $\pm$  0.44  $\mu$ g/mL) with compared to Mannar fishing community (0.54  $\pm$  0.09  $\mu$ g/mL). Elevated  $\beta$ 2M in Wasgamuwa (7.89% cases) and Mannar (7.5% cases) was higher than the  $\beta$ 2M reference level (0.3  $\mu$ g/mL) in adults. The lowest mean values for both SCr (0.95  $\pm$  0.16 mg/dL) and  $\beta$ 2M (0.04  $\pm$  0.01  $\mu$ g/mL) were recorded from Pelwatta farming community. It can be concluded that declining renal functions was evident in both Wasgamuwa and Mannar communities indicating risk of CKD/CKDu with compared to the Pelwatta farming community. However longitudinal cohort studies are required for further clarification of the kidney function among these communities.

**Acknowledgement:** Funding through RU/PG-R/16/04 is acknowledged.

**Growth performances and survival of Siamese fighting fish, *Betta splendens* (Regan 1910) under three formulated feeds with different sources of animal protein**

M.D.R.Madduma and M. Hettiarachchi

Department of Zoology & Environmental management, Faculty of Science, University of Kelaniya.

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Sri Lankan farmers complain about the non-availability of a suitable formulated feed for Siamese fighting fish, *Betta splendens*. Different quantities of fish meal is mixed for their diet while the use of fish meal in aquaculture is expected to reduce. A basal feed (BF) was formulated using fish meal as the animal protein source to have a crude protein content of 31-32%. Experimental feed 1 and 2 (EF 01 and EF 02) were prepared replacing 50% of fish meal in the basal feed with caridean shrimp meal and chicken blood meal respectively. Three groups of six weeks old male Siamese fighting fish of same variety were stocked in aquaria (n=10), fed separately for nine weeks with the three feeds having four replicates for each feed. With the beginning of aggressive behavior, each fish (in all three groups) was transferred to a jam bottle. Growth parameters were recorded at weekly intervals (analyzed by ANOVA and Tukey's test using Minitab 14) while recording daily mortality for nine weeks. Survival of the fish was recorded to be 100% in both experimental feeds. Mean standard body length, mean total body length, mean body weight, mean specific growth rate and mean average daily growth of both groups (fed with EF 01 and EF 02) were significantly higher ( $P < 0.05$ ) compared to the fish fed with the basal feed. When the fish were reared in aquaria, there was no significant difference between the condition factor recorded for groups fed with BF and EF 01 ( $P > 0.05$ ) which were significantly higher than that of the fish fed with the EF 02 ( $P < 0.05$ ). The results showed that 50% of the fish meal in the basal feed can be successfully replaced with caridean shrimp meal in a feed formulated for the early part of the growing phase of fighting fish (before each fish is transferred to a separate jam bottle due to aggressive behavior).

### **Limnological characterization of *Anopheles stephensi* breeding sites in Mannar and Jaffna**

Arthiyan Sivasingham<sup>1\*</sup>, Kokila Sivabalakrishnan<sup>1</sup>, Tibutius T. P. Jayadas<sup>1</sup>, Kalingarajah Karvannan<sup>1</sup>, Sharanga Santhirasegaram<sup>1</sup>, Meena Senthilnathanan<sup>2</sup>, Umasuthan Srivigneswaran<sup>3</sup>, Sinnathamby N. Surendran<sup>1</sup>

<sup>1</sup>Department of Zoology, <sup>2</sup>Department of Chemistry, University of Jaffna, Jaffna,

<sup>3</sup> Central Environmental Authority, Northern Provincial Office, Kilinochchi.

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Recently detected *Anopheles stephensi*, the major malaria vector in many tropical countries, is viewed as a challenge in the Mannar island off Northwestern coast of Sri Lanka to retain the malaria free status of the country. The potential vector species has spread to Northern Jaffna peninsula and larval breeding sites have been found in the Jaffna town area. Larval breeding characterization is essential to implement appropriate control measures as this vector mainly breeds in domestic wells. Therefore, this study was designed with the objective of characterizing the breeding environments. Field visits were carried out between June – October, 2017 in a rural and an urban environment in Mannar Island and Jaffna respectively. Larval survey was carried out using standard dipper methods inspecting domestic wells and water storage tanks. Collected larvae were brought to the laboratory and reared. The resultant adults were identified morphologically. Water samples were analyzed for various chemical parameters such as water temperature, phosphate content, fluoride, dissolved oxygen, pH, electroconductivity, salinity, nitrate and total hardness using standard APHA methods and commercially available probes. A total of 27 and 25 potential breeding sites were sampled from Mannar Island and Jaffna municipal area respectively and 04 and 19 sites were found with *A. stephensi* larvae respectively from Mannar and Jaffna. Ten physico-chemical water quality parameters influencing larval development were analyzed for the water samples and the Pearson correlation was established for each parameter with the larval density. Five positive and five negative Pearson correlations were obtained but, none of them were neither very strong nor very weak. The study reveals that the newly invaded *A. stephensi* can exploit a wide range of breeding habitats.

**Acknowledgement:** National Science Foundation of Sri Lanka (RPHS/2016/D2) and University of Jaffna (URG/2016/D/01).

**EGFR mutations in lung adenocarcinoma: development of an economical method for the detection of SNPs at exon 20 and exon 21**

Asitha Nuwan Premaratne<sup>1</sup>, N. Jayekumaran<sup>2</sup>, Inoka C. Perera<sup>1</sup>

<sup>1</sup>Department of Zoology and Environment Science, University of Colombo

<sup>2</sup>National Institute of Cancer, Maharagama.

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Lung cancer is a leading cause of cancer deaths worldwide and lung adenocarcinoma is the most frequent type recorded. Epidermal growth factor (EGFR) gene mutations are important in lung adenocarcinoma tumorigenesis. Exon 19 short in-frame deletion and L858R single nucleotide polymorphism (SNP) in Exon 21, represents 90% of all EGFR mutations. But, the SNP mutation (T790M) in Exon 20 plays a critical role in Tyrosine kinase inhibitor (TKI) drug resistance. Thus, early genotyping and routine diagnosis of EGFR mutations are important for lung adenocarcinoma chemotherapy. Existing diagnostic methods are not cost effective and therefore unaffordable to be carried out as a routine diagnostic practices in a developing country like Sri Lanka. To overcome this barrier, a Tetra Primer ARMS-PCR method was developed to be used as an evaluation method to check mutation status of Exon 20 and 21. Here, two different primer pairs are used, one is region specific and another one with allele specific binding which works together and result different banding patterns relevant to each genotype. DNA was extracted from Formalin-fixed paraffin-embedded tissue blocks using the common phenol chloroform method. Tetra Primer ARMS-PCR was optimized using patient samples previously sequenced for Exon 20 and 21 regions. For Exon 20, All 4 samples were homozygous for the T790M wild type allele. For Exon 21, all together 5 samples were checked, three of them were heterozygous for the L858R mutant allele and other two were homozygous for the L858R wild type allele. Tetra Primer ARMS-PCR results were completely aligned with the sequence data which obtained for Exon 20 and 21 mutation status. Thus, this method holds a huge potential to be used as an economical diagnostic tool for EGFR Exon 20 and 21 mutation detection.

**Impact of temperature increase attributed to climate change on survival, growth, morphometrics, and development of *Polypedates cruciger* (common hourglass tree frog)**

W.A.M.T Weerathunga and R.P.G.K. Rajapaksa\*

Department of Zoology and Environmental Management, Faculty of Science,  
University of Kelaniya.

[\\*gayani@kln.ac.lk](mailto:gayani@kln.ac.lk)

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Rise of atmospheric temperature is a principal factor associated with climate change. Predicted temperature elevations corresponding to two extremes of climate change as of IPCC-AR5, are RCP2.6 (E32), the most eco-friendly scenario, and RCP8.5 (E34), scenario leading to the highest warming. Since all living systems have a favorable temperature range for optimum functioning, temperature increase significantly influences organismal physiology. Amphibians are extremely vulnerable for temperature changes. The objective of this study was to determine the physiological responses of *Polypedates cruciger* to climate change based on continuous exposure to elevated temperature from early-larval to adult stage. Treatments included two elevated water treatments of  $32\pm 0.5^{\circ}\text{C}$  (E32) and  $34\pm 0.5^{\circ}\text{C}$  (E34), and a control treatment at ambient temperature of  $28\pm 0.5^{\circ}\text{C}$  (TA). Tadpoles were raised from egg clutches and fifteen were assigned to each treatment tank which was triplicated. Survival, mortality and development upto Gosner stages 30 and 42 were observed daily. Morphometrics (total length, snout-vent length, tail length, body width) were measured weekly. Cumulative mortality was 100% in E34 at 11th week, before metamorphosis. In E32, cumulative mortality reached 48% at metamorphosis at 18th week. However, none of the metamorphosed individuals in E32 survived for more than 24 hours. No mortalities were recorded in TA where tadpoles metamorphosed after 11 weeks. Increment of total body and snout-vent lengths were lower in E32 and E34, than in TA, from the 4th week onwards. When nearing metamorphosis, rates of increase of all morphometrics in E34 and E32 decreased and the morphometrics were significantly lower compared to TA. Tadpoles of E32 took the longest times for metamorphosis. Results show that even the most eco-friendly scenario of RCP2.6 (E32) can affect the physiology of *Polypedates cruciger*. In conclusion, the growth, survival and metamorphosis of *Polypedates cruciger* is significantly affected by predicted temperature increases attributed to future climate change.



## Effects of five medicinal plant products on survival and progeny development of cowpea bruchid, *Callosobruchus maculatus* (Fab.) infesting cowpea seeds in storage

S.M.J.C.K.Jayasundara<sup>1</sup> and G.A.S.M. Ganehiarachchi<sup>1\*</sup>

Department of Zoology and Environmental Management, Faculty of Science,  
University of Kelaniya  
[\\*mangala@kln.ac.lk](mailto:mangala@kln.ac.lk)

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*Callosobruchus maculatus* is a serious pest in stored cowpea seeds (*Vigna unguiculata* (L.)) in Sri Lanka. Plant powders of five medicinal plants were evaluated for their effectiveness in protecting cowpea seeds from *Callosobruchus maculatus* (F.) (Family: Bruchidae) during storage. The plants evaluated included *Pandanus amaryllifolius*, *Murraya koenigii*, *Vitex negundo*, *Pavetta indica* and *Croton aromaticus*. The powders of the above plant leaves were applied separately at the rates of 0.0 (control), 2g and 5.0g/20g of cowpea seeds providing direct contact with the adult beetle to assess contact toxicity. Results of contact toxicity assay of powders showed that *C. aromaticus* was more effective against the adult *C. maculatus* causing 96.19% ( $F_{5, 18} = 24.05$ ,  $P=0.00$ ) highest mortality and 18.21% ( $F_{5, 18} = 92.01$ ,  $P=0.00$ ) minimum progeny development within 4 days of application at rate 5g/20g of cowpea seeds. Results of the contact toxicity assay of combination of powders showed that both mixture of *P. indica*, *V. negundo*, *C. aromaticus* and the mixture of *V. negundo* and *C. aromaticus* were more effective against the adult *C. maculatus* causing 100% and 90.56% ( $F_{4, 15} = 45.50$ ,  $P = 0.00$ ) mortality respectively. The minimum percentage progeny development 19.35% ( $F_{4, 15} = 20.16$ ,  $P=0.00$ ) was observed in the samples treated with mixture of *P. indica*, *V. negundo* and *C. aromaticus* powders. The powders were applied at rates 2g and 5.0g/20g of cowpea seeds in plastic containers to assess fumigant toxicity of their volatiles. The results of fumigant assay showed that *C. aromaticus* had the highest insecticidal activity causing 60.16% ( $F_{5, 18}=12.72$ ,  $P=0.00$ ) the highest mortality and 40.41% ( $F_{5, 18}=79.81$ ,  $P=0.00$ ) minimum percentage progeny development within four days of application at the rate 5g/20g of cowpea seeds. This study showed that all the tested plants products were toxic to cowpea bruchid and can serve as grain protectants against *C. maculatus*.

## **Investigation of heavy metals in the maturation pond of Biyagama export processing zone**

**P. Bandara**<sup>1</sup>, KM Nalin De Silva<sup>2</sup>, D. Gunathillake<sup>3</sup>, D.D. Wickramasinghe<sup>1</sup>

<sup>1</sup>Department of Zoology and Environment Sciences, University of Colombo.

<sup>2</sup>Department of Chemistry, University of Colombo.

<sup>3</sup>National Water Supply and Drainage Board, Rathmalana.

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Heavy metal pollution has been a serious concern globally due to their potential health and environmental impacts. Even with the increasing industrialization in Sri Lanka in the recent past, systematic studies on heavy metal pollution is sparse. The current study was carried out to investigate the concentrations of selected heavy metals in the waste water treatment facility in the Biyagama Export Processing Zone (BEPZ) where more than 57 industries are located. No desludging was done in the final maturation pond since its inception three decades ago and as a result no studies have been carried out to assess the heavy metals in waste water in this pond, which contributes to increased risk of contamination. Sludge and water samples (20 each) were collected from the maturation pond and analyzed for heavy metals (total as well as EDTA extractable and water extractable fractions were investigated in sludge) using Atomic Absorption Spectrophotometry. Six heavy metals were present in the sludge (Mean  $\pm$  SD mg/kg: Ni- 137  $\pm$  59, Cu- 189  $\pm$  81, Pb- 17  $\pm$  5, Cd- 1.5  $\pm$  0.2, Cr- 199  $\pm$  76, As- 18  $\pm$  4) and in water (all values were less than 0.1 ppm). Since Sri Lanka does not have regulations for sludge, European Union Directive 86/278/EEC was used as the standards. None of the samples exceeded the standards, but the Arsenic concentration in the sludge was high. It was found that the chance of pollution of ground water table from leaching of heavy metals is low. Nevertheless, the risk of contamination of the Kelani river, which is situated in close proximity cannot be ignored since the area is vulnerable for floods and the presence of a small water way channeling waste water towards the river. The results of this study highlight the urgent need of the safe management of sludge and developing regulations for sludge management.

**SDS PAGE electrophoresis-based profiling of *Echiscarinatus* venom from Sri Lanka**

M. G. B Gunasena<sup>1</sup>, A. Gnanathanan<sup>2</sup> and P. V. Udagama<sup>1</sup>

<sup>1</sup>Department of Zoology & Environment Sciences, Faculty of Science, University of Colombo, Colombo 03.

<sup>2</sup>Department of Clinical Medicine, Faculty of Medicine, University of Colombo, Colombo 08.

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Sri Lanka being a tropical, developing island nation, suffers heavy economic and medical impacts due to snakebite envenomation. Sri Lanka records a high prevalence of snake envenomation as well as one of the highest incidence rates of venomous snake bites in the world. *Echis carinatus* is one among the six species of land snakes in Sri Lanka that are considered to be highly venomous. It inhabits the arid coastal areas of the peneplain in the dry zone. The geographical distribution includes the districts of Jaffna, Mullaitivu, Mannar of Northern province, the Eastern province, and parts of the Southern province such as Yala. Venoms of *Echis* species exert lethal, hemorrhagic, coagulant effects leading to renal injury. This study aimed to analyze the venom profile of the Sri Lankan saw scaled viper which was hitherto unexplored. Pooled venom sample from two Saw scaled vipers was subjected to 15% SDS-PAGE under reducing conditions. Separated proteins were fixed and stained with Coomassie Brilliant Blue G-250. The protein bands were analyzed using the ImageJ software version 1.51.k. The venom protein profile included 24 proteins, ranging in relative molecular weight from 10.5 to 148.7 kDa and in relative abundance ranging from 0.2 to 20%. Based on the relative molecular weights, the probable identity of these proteins was established using previous literature. Accordingly, these included Serine protease, L- amino acid oxidase, Phosphomonoesterase, P -IV class Snake venom metalloproteinases (SVMP), Phosphodiesterase, NAD-nucleosidase, 5' Nucleotidase, Factor X activator, P -III class SVMP, P -II class SVMP, Prothrombin activator, P -II class SVMP, Thrombin like enzyme, P -I class SVMP, Phospholipase A2, non-enzymatic toxin proteins and peptides. The three most abundant proteins were estimated to be of approximate molecular weights of 85.44, 12.03 and 24.24 kDa and may correspond to Factor X activator protein, non-enzymatic toxin protein or peptide and PI Snake venom metalloproteinases respectively.

**Acknowledgement:** Financial assistance by the University of Colombo.

## Shape variation in relation to predation and other habitat features in selected guppy (*Poecilia reticulata*) populations of Sri Lanka – a preliminary study

R.G.D.R. Jayawikrama<sup>1,3</sup>, K.B.S. Gunawickrama<sup>2</sup>, B. Diaz-Pauli<sup>3</sup>, Mikko Heino<sup>3</sup>

<sup>1</sup>Department of Marine benthic, Akerblå AS, Norway.

<sup>2</sup>Department of Zoology, University of Ruhuna, Sri Lanka.

<sup>3</sup>Department of Biology, University of Bergen, Norway.

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Phenotypic variation in fish occurs due to factors including habitat features, predatory pressure and life history features. Present preliminary study aimed to elucidate inter-population shape variations of guppies (*Poecilia reticulata*) using geometric morphometrics (GM). Length distribution and body-shape morphology of three selected populations differing in habitats and apparently experiencing different degrees of predation pressure were selected (P1: Kaluthara ditch, P2: Kurunegala ditch, P3: Welimada- stream/Uma Oya). Ten landmarks on individual images of mature male guppy (n=180) were digitized and landmark coordinate configurations were applied for size correction. The allometry-free shape variables of fish were used for comparative GM shape analyses. The study revealed that inter-population differences exist in size (SL) of guppies among the locations (p<0.05). Both Mahalanobis and Procrustes distances of P3 were significantly different (p<0.05) from those of P1 and P2. Guppies under high predation (P3) showed longer and more streamlined (fusiform) body shape (canonical variate CV1 57%) which is adaptive for swimming with a smaller head region reducing the drag. The adaptive shape also includes a longer caudal peduncle, probably an adaptation for sudden and unsteady swimming to escape from predators. Observed adaptation of high predation guppies (P3) potentially represents local environmental adaptations to a considerably high current velocity too. The results also support that body shape has a link to foraging ecology of fish. The guppies of P3 showed relatively sub-terminal mouth, suggesting that pelagic feeding habit may be more adaptive there. In contrast, the other two populations (P1 & P2), which live at shallow polluted drainage canals in high abundance showed upturned mouth. This may be an adaptation for the aquatic respiration at the air-water interface that meet oxygen demand under hypoxic condition. The study concludes that guppies show adaptive shape variation that can be attributed to habitat conditions and ecological trade-offs.

## Selected serum cytokines as potential biomarkers of Colorectal cancer

O.Peiris<sup>1</sup>, S. Seneviratne<sup>2</sup>, C. Fernando<sup>3</sup> and P. Udagama<sup>1\*</sup>

<sup>1</sup>Department of Zoology and Environmental Sciences, Faculty of Science, University of Colombo, Sri-Lanka.

<sup>2</sup>Department of Surgery, Faculty of Medicine, University of Colombo, Sri-Lanka.

<sup>3</sup>Curtin University, Perth, Australia.

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Tumor associated inflammation is a central feature of colorectal cancer (CRC). Although early diagnosis significantly improves patient survival, CRC remains asymptomatic until advanced stages. Colonoscopy, the current gold standard of CRC diagnosis, limits patient participation in screening programmes due to its relative invasiveness and cost. Therefore, we investigated the potential alternative use of selected serum inflammatory cytokines as immune biomarkers for CRC diagnosis. In this case control study, serum TNF- $\alpha$ , IFN- $\gamma$ , IL-1 $\beta$  and IL-10 levels of CRC patients (N= 27) were compared with age and gender matched oral and oropharyngeal cancer (OOPC) patients (N=28) as disease controls and normal, healthy controls (N= 28). Blood was collected for serum following voluntary informed consent from the participants. The serum cytokine levels were assayed using specific sandwich ELISAs. Compared to the two control groups, a significant increase of TNF- $\alpha$  and a significant decrease of IL-10 levels were evident in the CRC cohort. IFN- $\gamma$  level of CRC patients though significantly higher than that of normal controls (P<0.05) was not distinct from the OOPC group (P>0.05). A significant elevation of TNF- $\alpha$  and a significant depletion of IL-1 $\beta$  and IL-10 was observed in the test population (CRC patients) when compared with the OOPC patients. The explicit Th1 biased immune response detected in the CRC group was significantly higher than that of the OOPC group. Receiver operating characteristic (ROC) curve analysis showed that TNF- $\alpha$  had the strongest potential diagnostic utility as a biomarker in distinguishing CRC patients from normal healthy individuals, while IL-10 emerged as the most potent cytokine among the panel indistinguishing between CRC patients from the disease controls. The diagnostic accuracy of the four analytes validated by ROC curve analysis showed TNF- $\alpha$ , IFN- $\gamma$  and IL-10 as a strong biomarker panel in CRC diagnosis (Accuracy > 95%, sensitivity > 85% and specificity > 80%).

**Acknowledgement:** The Vice Chancellor of the University of Colombo, Sri Lanka is acknowledged for providing funds for this interdisciplinary undergraduate research project.

## Is Catalase KatE activity a survival mechanism of *Leptospira interrogans*?

N.P. Barupala<sup>1</sup>, N. Fernando<sup>2</sup>, S.M. Hadunnettia<sup>2</sup> and S. Premawansa<sup>1</sup>

<sup>1</sup>Department of Zoology & Environment Sciences, Faculty of Science, University of Colombo, Colombo 03.

<sup>2</sup>Institute of Biochemistry, Molecular Biology & Biotechnology, University of Colombo, Colombo 03.

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Leptospirosis is a zoonosis caused by pathogenic spirochete belonging to genus *Leptospira*. Pathogenesis of *Leptospira* is poorly understood and cellular immune responses play a major role in the pathogenesis of Leptospirosis. This study was designed to assess the survival mechanisms of pathogenic *L. interrogans* in comparison to saprophytic *L. biflexa* against intracellular killing by neutrophils *in vitro*. Survival mechanisms were assessed by subjecting HL-60 derived neutrophils to *in vitro* stimulation of *L. interrogans* serovar Pyrogenes and *L. biflexa* serovar Patoc. Intracellular superoxide and H<sub>2</sub>O<sub>2</sub> production in neutrophils interacted with *Leptospira* assessed by NBT assay in the range of MOI 0.5-10. Catalase KatE activity of *Leptospira* and catalase activity of neutrophils interacted with *Leptospira* was determined by visual approach by Triton X-100. *Leptospira* viability was assessed with Trypan blue exclusion method and BacTiter Glo kit respectively. Hydrogen peroxide level produced by *L. biflexa* stimulated by neutrophils showed no significant difference compared to that of *L. interrogans* (p=0.471). *L. interrogans* showed significant increase of superoxide production compared to the *L. biflexa* stimulated neutrophils (p<0.001). Catalase KatE of *L. interrogans* showed significant increase in 0.5 MOI (p=0.010) and 1 MOI (p=0.002) when compared to *L. biflexa*. *L. interrogans* stimulated neutrophils showed a significantly higher level of catalase activity compared to *L. biflexa* (p<0.05). *Leptospira* viability was similar for both strains after interacting with neutrophils. The ability of *Leptospira* to survive in higher superoxide levels suggests high tolerance of pathogenic *Leptospira*. Same levels of hydrogen peroxide in both strains indicate an extensive detoxification mechanism regulated by catalase activity of both neutrophils and *Leptospira* suggesting pathogenic *Leptospira* may induce neutrophils to trigger more catalase activity which may be used as an advantage. In conclusion, pathogenic *L. interrogans* catalase KatE may act as a survival mechanism to oxidative stress generated by neutrophils.

### **Evidence of different isolates of *Pratylenchus loosi* in Sri Lanka based on morphometric characterization**

P. G. D. S. Amarasena<sup>1\*</sup>, K. M. Mohotti<sup>1</sup>, D. M. De Costa<sup>2</sup> and A. K. Prematunga<sup>1</sup>

<sup>1</sup>Entomology and Nematology Division, Tea Research Institute of Sri Lanka, Talawakelle 22100.

<sup>2</sup>Department of Agricultural Biology, University of Peradeniya, Peradeniya.

\**depthiamarasena@yahoo.com*

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The root lesion nematode, *Pratylenchus loosi* is considered as the most economically important pest in tea plantations owing to its widespread nature in all regions in Sri Lanka. The damage symptoms varied among the different regions. The present study compared the morphometrics of different populations of *P. loosi*, PL 1 (Cicilton, Balangoda), PL 2 (Delmar Estate, Halgranoya), PL 3 (Hapugastenna, Ratnapura) PL 4 (Mahadowa, Passara), PL 5 (Nawalapitiya) and PL 6 (Richiland, Deniyaya) to determine any evidence of presence of distinct biotypes or strains. The study compared morphometrical characters of the six *P. loosi* populations collected from different locations in Sri Lanka aiming at differentiating a) among each other and b) to assess the intraspecific variability of some of these characters. The specimens closely conformed to the previously described *P. loosi* populations through morphometric characters. The female morphometrics of *P. loosi* populations measured represented intra-specific variability and clustered in four groups in Principal Component Analysis. PL 4 and PL 2 populations were clustered in separate groups compared to other populations. PL 1 and PL 5 were clustered in one group while PL 3 and PL 6 were found in a separate group. Thus, it is evident that there were distinct biological pathotypes / strains within the six *P. loosi* populations tested. Accordingly, PL 1 and PL 5 populations were closely related. The two populations PL 3 and PL 6 were clustered in one group indicated a close relationship between them while PL 2 and PL 4 populations categorized in two separate groups proved to be morphometrically different from other four populations. The different damage symptoms caused by the six Sri Lankan *P. loosi* populations were clustered into four groups based on morphometric characterization.

**Unlike *Dillenia suffruticosa* (Griff. ex Hook.f. & Thomson) Martelli, daytime changes in flower colour of *Melastomata malabathricum* (L.) Smith maintain bee visitation throughout the day**

K.M.G.M.R. Kariyawasam<sup>1</sup>, S.M.W. Ranwala <sup>2</sup>, W.B. Yapa<sup>1</sup>

<sup>1</sup>Department of Zoology and Environment Sciences, University of Colombo, Sri Lanka.

<sup>2</sup>Department of Plant Sciences, University of Colombo, Sri Lanka.

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Rewards of flowers provide niches for pollinators and in this regard flower colour is vital for diurnal pollinators. Flowers that appear similarly coloured to human may appear very differently to bee pollinators providing clues about the age of flowers and the availability of food rewards. In this study, we hypothesized that the two plants may behave differently in attracting bees for their co-existence. We investigated i) whether same bees visit flowers of the two species ii) how the inner and outer parts of the petals colour of *Melastomata malabathricum* (MM) and *Dillenia suffruticosa* (DS) changes during day time to attract bees iii) what other rewards that MM and DS offer to bees. Insect visitors for both flowers (n=12) were observed between 08:00 hr and 16:00 hr in 2 h time intervals for 30 minutes at the Seethawaka Wet Zone Botanical Garden. Bee pollinators were sampled and identified using standard procedures. The colour of petals of both flowers was measured in each time interval using a spectrometer (USB 650 OCEAN OPTIC SPECTROPHOTEMETER) and analyzed using MATLAB R2016a (9.0.0.341360). Other floral features were also examined. Among the 14 species of bee pollinators observed, 7 (50%) were shared between both species while some others were exclusive. DS had 3 exclusive bee species while MM had 4. The peaks of reflection spectrum of DS and MM was different (340 nm and 540 nm for DS, and 430 nm and 650 nm for MM). The reflection spectrum of MM indicated that colour intensity in the UV region of inner and outermost parts of petals change within daytime while this was not shown by DS. However, Bee visitation for MM was 52% between 8:00 hr to 10:00 hr while DS attracted bee pollinators throughout the day time. This showed that changing of the reflectance spectrum of inner and outer parts of the MM flower was not successful in attracting bees throughout the day. The invasive alien DS therefore would have offered more rewards to attract bees all day through pollen availability (16025 pollen grains/flower) and large flower display. It could be concluded that the changes in reflection spectrum of inner and outermost parts of the flower is a strategy to maintain insect visitations to the flower, but may fail to do so in some instances, especially if there are flowering species with more floral rewards present in the neighborhood.



## **Assessment of capture efficiency of different sampling techniques in sampling dry cave fauna in Sri Lanka**

A.L.A.N.N. Perera, C.D. Dangalle and W.B. Yapa

Department of Zoology and Environment Sciences, University of Colombo, Sri Lanka.

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Caves are unique ecosystems that provide habitats for rare and unique vertebrates, invertebrates as well as micro fauna. Although several studies have described cave dwelling vertebrates, macro-invertebrate fauna of the caves in Sri Lanka have been rarely studied. As the resultant species composition and abundance depend on the method adopted in surveying any ecosystem, it is imperative to select a suitable method in sampling a novel, unknown habitat. Therefore in the present study we sampled, "Wavul-Galge" (6040'-6045'N: 81000'-81005'E), a large dry cave located in Nikapitiya, Wellawaya, for invertebrate fauna using a combination of survey techniques. Our sampling techniques included hand picking, pitfall trapping, visual encounter survey, light traps and soil sieving. Collected invertebrate fauna were identified using standard taxonomic keys and counted to estimate abundance. Capture efficiency for each sampling technique was calculated by estimating the number of individuals and families collected for a sampling effort. During the study period from May to October, 2017, 30 species representing 27 families in 11 orders belonging to two phyla were recorded. Highest capture efficiency was recorded from light traps proving it as a time saving and effective sampling technique especially in qualitative studies. Pitfall traps were also an effective method and hand picking based on visual encountering was the most appropriate method for recording crevice-dwelling species. Although pitfall traps are the most abundantly used method for sampling ground dwelling invertebrates elsewhere, it tends to over collect specimens in caves. Instead our study showed soil sieving to be more effective in sampling ground dwelling invertebrates in cave environment. Based on the effectiveness and limitations of different methods used, we suggest that a combination of methods should be used in sampling cave fauna. However, specific techniques can be used to sample specific taxa according to the objectives of the study.

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# **ABSTRACTS OF PAPERS**

**Parallel session 02 (Microbes & Biochemical)**

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***In vitro* antifungal activity of *Cymbopogon citratus* (lemongrass) and *Syzygium aromaticum* (clove) oils on the Stem-end rot pathogen -*Lasiodiplodia theobromae* from mango**

G. C. M. Ekanayake<sup>1</sup>, T. D. Kodituwakku<sup>1</sup>, K. P. Abeywickrama<sup>1</sup>

<sup>1</sup>Department of Botany, University of Kelaniya, Kelaniya, Sri Lanka.

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Stem-end rot (SER) disease causes considerable losses to mango fruits throughout the supply chain. The aim of this research was to evaluate the antifungal potential of lemongrass and clove oils against *Lasiodiplodia theobromae* which is a frequent SER causative agent of mango fruits (cv. Karutha Colomban). Under *In vitro* conditions, lemongrass and clove oils (100% pure) achieved a minimum inhibitory concentration (MIC) of 0.40 µL/mL over the test pathogen in the liquid bioassay. Further, clove oil displayed a fungicidal effect at minimum lethal concentration (MLC) of 1.00 µL/mL over the test pathogen in liquid phase. Notably, high % mycelial inhibition values were achieved against *L. theobromae*, 95.95 ± 2.01% and 94.83±5.22% with lemongrass and clove oils, respectively at a concentration of 0.40 µL/mL. During the fumigation bioassay (*In vitro*) both test oils displayed an inhibition at minimum concentrations (MIC) of 9.0 µL/plate and 2.0 µL/plate concentrations against the pathogen, respectively. Further, clove oil displayed a fungicidal effect at minimum lethal concentration (MLC) of 20 µL/plate in vapor phase. Meanwhile, both oils showed a highest % Inhibition of radial mycelial growth (%IRMG) of 100.00 ± 0.0 % at concentrations of 2.0 µL/plate and 9.0 µL/plate, respectively against *Lasiodiplodia*. Both negative (distilled water) and positive control 2 (ethanol) did not control the growth of test pathogen whereas carbendazim, (positive control 1) controlled the test pathogen. A significant difference (P < 0.05) with respect to mycelial inhibition was noted when control/ethanol were compared with carbendazim treatment or test oils. Clove and lemongrass could be exploited as ecofriendly antifungal agents for the development of an ecofriendly treatment strategy to manage *Lasiodiplodia* – the most frequently encountered fungal pathogen of Stem-end rot disease in mango cv. “Karutha Colomban”.

**Acknowledgement:** The financial support provided by the University of Kelaniya is greatly appreciated.

**Preliminary physiological characterization and genetic diversity assessment of the Rhizobial populations inhabiting *Gliricidia sepium* in selected locations of Ampara district, Sri Lanka**

P.W.I. Nawanjana<sup>1</sup>, Sanath Rajapakse<sup>1\*</sup>

<sup>1</sup>Department of Molecular Biology and Biotechnology, Faculty of Science, University of Peradeniya, Peradeniya 20400, Sri Lanka.

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*Gliricidia sepium* is a widespread multipurpose legume plant in Sri Lanka which is found to be effective in nitrogen fixation and host to many rhizobial strains. However, very few studies have been carried out to identify and characterize the rhizobial populations inhabiting *G. sepium* in Sri Lanka. The main objective of this study was to isolate and identify the stress tolerant *Rhizobium* sp. in *G. sepium* as a preliminary approach to use those strains to cross-inoculate legume crops as an alternative method to reduce the nitrogen fertilizer usage. Root nodules of *G. sepium* were collected from seven locations (Deegavapiya, Karativu, Uhana, Paragahakele, Keviliyamadu, Padiiyathalawa and Ampara) in Ampara district which belongs to the dry zone in Sri Lanka. Five *Rhizobium* isolates from each site were screened for the tolerance for different pH, temperature, salinity and drought conditions. All strains were grown under a wide range (5.0-10.0 pH, 0.1%-3.0% Salinity, 25°C-45°C temperature, 0.1%-0.4% PEG) of physiological conditions. High acidity affected the survival of all strains resulting a poor growth at pH 3.0 and pH 4.0. Rhizobial strains isolated from Karativu, a site closer to the coast showed a high tolerance for all salinity levels as they are adapted to the high salt stress experienced in their natural habitat. The growth response to drought conditions and temperature was variable. However, 14 isolates showed a high tolerance for more than two extreme physiological conditions individually. When extreme conditions were combined, only 12 isolates survived. Genetic diversity of these 14 isolates assessed using ERIC 1R and ERIC 2R primers revealed that they are genetically diverse as they belong to 10 clusters at 69 % similarity level. These 14 stress tolerant Rhizobial isolates may have potential to be used to cross-inoculate crop legumes to test their effectiveness and to identify possible cross-inoculation groups.

**Partial purification and characterization of chitinases from pitcher fluid  
of *Nepenthes distillatoria***

R.W.K.M. Senevirathna<sup>1</sup>, V.N. Seneviratne<sup>2</sup>, Sanath Rajapakse\*<sup>1</sup>

<sup>1</sup>Department of Molecular Biology and Biotechnology, Faculty of Science, University of Peradeniya,  
Peradeniya 20400, Sri Lanka.

<sup>2</sup>Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya 20400, Sri Lanka.

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*Nepenthes distillatoria* (Bandura) of family *Nepenthaceae* is a carnivorous pitcher plant endemic to Sri Lanka. *Nepenthes* secretes hydrolytic enzymes to digest trapped organisms but no studies have been conducted on chitinases in pitcher fluid of *N. distillatoria*. Thus, this study was conducted to partially purify chitinases in *N. distillatoria* to characterize chitinases. We aimed at testing the suitability of dispersible, soluble and inexpensive colloidal Chitin Azure as a substrate for chitinase. Further, we targeted in optimizing the assay procedure for the maximum chitinase activity and determining the thermal stability of chitinase. Accordingly, fluid from both opened (OP) and closed (CP) pitchers was collected from *Hakurugala* forest in Sri Lanka. The assay procedure was carried out for crude OP and CP samples to determine their optimum pH (from pH 1.0-10.0), optimum incubation time (time intervals from 10min to 60min) and optimum temperature (room temperature, 37°C and 50°C). An ion exchange chromatography was carried out at pH 7.0 to check the binding ability of chitinase to the DEAE cellulose column and to identify different types of chitinases. Finally, thermal stability of both OP and CP was determined within 4°C to 90°C. The optimum pH, temperature and incubation time for the enzymatic activity were pH 5.0, room temperature and 30 min respectively. Chitinase activity was observed in both OP and CP and there was no any significant difference between the two samples ( $P < 0.05$ ). The chitinase activity gradually decreased when the temperature was increased. Chitinases were successfully bound to the DEAE cellulose column. Three chitinase activity peaks were obtained indicating the presence of more than one type of chitinase within the pitcher juice. Since chitinases have a broad range of applications, the knowledge acquired by this study can be used in further investigations about the structure and other biological activities of chitinases in *Nepenthes*.

## Antifeedant activities of endophytic fungi of *Cyperus iria* collected from Matale District on *Plutella xylostella* (Diamond Back Moth) larvae

J.M.N.M. Jayasundara<sup>1</sup>, P.B. Ratnaweera<sup>1\*</sup>, K.M.D.W.P. Nishantha<sup>2</sup> and E.D. de Silva<sup>3</sup>

<sup>1</sup>Department of Science and Technology, Uva Wellassa University, Badulla.

<sup>2</sup>Horticultural Crop Research and Development Institute, Gannoruwa.

<sup>3</sup>Institute of Biochemistry, Molecular Biology and Biotechnology, University of Colombo, Colombo 03.

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*Plutella xylostella* is a highly destructive cabbage pest responsible for huge economic losses worldwide. Novel bio-friendly alternatives are crucial to replace existing synthetic pesticides to minimize human health impacts while reducing the development of pesticide resistant pest strains. Though sedges are known reservoirs of endophytic fungi their antifeedant activities have not been so far investigated. This study reports the antifeedant activities of the endophytic fungi of the sedge *Cyperus iria* collected from Matale district, which is within a comprehensive investigation on endophytic fungi of *C. iria* plant from different geographic locations in Sri Lanka. Endophytic fungi were isolated from healthy plants of *C. iria* collected from Weragama, Matale District and were identified using molecular techniques. The ethyl acetate extracts of their laboratory cultures grown on five different culture media were obtained close to sporulation and the extracts were subjected to no choice leaf disc bioassay against the 2<sup>nd</sup> instar larvae of *P. xylostella*. Assays were conducted in triplicate at 200 µg/cm<sup>2</sup> concentration using 3 cm diameter cabbage leaf discs with 10 larval instars. Commercially available neem 20%, was used as the positive control while methanol (10 µL/leaf disc) was used as the negative control. Consumed areas were obtained using Image J software and feeding deterrent indexes were calculated. Data were statistically analyzed using Minitab 17. A total of 25 endophytic fungi, 16 from aerial parts and nine from roots were isolated. Among them 17 extracts highly affected feeding deterrence of *P. xylostella* [feeding deterrent indexes (FDI's) >60%], while seven extracts showed medium deterrence (30% ≤ FDI ≤ 60%) with one extract showing low deterrence (FDI <30%). *Trichoderma reesei* extract showed the highest feeding deterrence with 99.7% FDI while 24 fungal crude extracts showed a significant antifeedant activity ( $p < 0.05$ , ANOVA and Turkey's HSD) compared to the negative control and 23 extracts showed activities similar to the positive control. The current study revealed the endophytic fungi of *C. iria* show promising feeding deterrent effects against *P. xylostella* larvae.

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## Comparative GC-MS identification of value added coconut oil

D.L.S.M. Jayaratne, W.A.D.D. Wasalamuni, T.D.C.M.K. Wijayasiriwardena\*

Herbal Technology Section, Industrial Technology Institute, 503/A, Halbarawa Gardens, Thaladena, Malabe.

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Coconut oil has more than 90% saturated fatty acids but due to high stickiness consumer acceptance becomes poor. Hence, stickiness reduction will ensure consumer acceptance as a cosmetic product. Coconut oil produced using sekku (expeller pressed), sludge oil, virgin coconut oil made by fermentation method and the king coconut oil were used for stickiness reduction. Such value added coconut oil samples were subjected to GC-MS analysis after derivatization. Nine compounds were identified from each sample. Medium chain triglyceride (MCT) such as capric acid, caproic acid, caprylic acid and lauric acid were detected in all samples. Capric acid in all the samples was between ( $5.0 \pm 0.01\%$  to  $7.5 \pm 0.01\%$ ). Long chain fatty acids like myristic acid ( $20 \pm 0.1\%$  to  $23 \pm 0.2\%$ ), palmitic acid ( $9 \pm 0.5\%$  to  $12 \pm 0.5\%$ ), stearic acid ( $3 \pm 0.02\%$  to  $5 \pm 0.01\%$ ), oleic acid ( $5 \pm 0.05\%$  to  $6 \pm 0.05\%$ ) and linoleic acid ( $1 \pm 0.002\%$ - $2 \pm 0.005\%$ ) were detected. Linoleic acid was not detected in sludge oil and king coconut oil. The fatty acid composition of differently processed value added coconut oil samples did not show marked differences. However, caprylic acid ( $8.63 \pm 0.05\%$ ) was detected in virgin coconut oil prepared by fermentation method that acts as an excellent emollient in skin cosmetics and as an anti fungal agent. Therefore, medium chain triglycerides appear to have potential cosmetic properties that need to be investigated further.

**Acknowledgement:** ITI/ TG 16/119 Value addition to coconut oil

## Cyto-genotoxicity and quality of sediments in Dandugan Oya, Sri Lanka

L.G.Y.J.G. Wadasinghe and W.M.D.N. Wijeyaratne\*

Department of Zoology and Environmental Management, University of Kelaniya, Kelaniya, Sri Lanka.

\*dimuthu.wijeyartne@kln.ac.lk

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Sediments are very important in maintaining aquatic ecosystem health. Dandugan Oya is a stream located in the Western province of Sri Lanka. Dandugan oya receives industrial waste from multiple sources. It also serves as a raw water source for public water supply in some suburban areas in the Gampaha District. This study was conducted with the objective of assessing sediment quality and cyto-genotoxic effects of sediments in Dandugan oya. Shallow sediments (5 replicates) were collected from six sites (A: Urban site; B and D: Industrial sites; C: water intake for public water supply; E: Agricultural site; F: Reference site) at two month intervals from May to November 2017 and sediment quality was analysed using standard analytical methods. Cyto-genotoxicity of the sediment elutriates were assessed using *Allium cepa* bioassay. Spatial variation of sediment quality and toxicity indices were analysed by ANOVA followed by Tukey's pairwise comparison using MINITAB 14 software. Significant spatial variations of sediment quality parameters and nuclear abnormalities were observed. Site B recorded significantly lower sand (37%) and significantly higher silt contents (44%) while site D showed a significantly higher clay content (40.6%). Significantly lower sediment pH (4.71) and sediment conductivity (25.29  $\mu\text{S}/\text{cm}$ ) were recorded from reference site and highest total organic matter (2.32 %) content was recorded at urban site. Mean nuclear abnormalities ranged from 13‰ to 44‰ with significantly higher abnormalities in sites B (42‰) and D (44‰). Occurrence of nuclear buds and condensed nuclei in the interphase cells of the *Allium cepa* root tips exposed to sediment elutriates from industrial sites (15‰ and 18‰) were significantly higher (7 to 9 fold) compared to reference site. Further, Site B showed the highest condensed nuclei formation (61‰). However, occurrence of binuclei showed no significant spatial variations. The Mitotic index of the *Allium cepa* root tip cells ranged from 2.9% to 7.4% with significantly higher values in sites A and B. The results of the present study indicated the occurrence of potential cyto-genotoxic contaminants in the sediments of Dandugan Oya. Therefore, further investigations on the identification of the active forms of these contaminants are recommended in order to maintain the health of the ecosystem.



## Isolation and identification of probiotic yeast from goat milk

S.A.C.L. Ranatunga<sup>1</sup>, D.U. Rajawardana<sup>2</sup>, H.A.D.Ruwandeeepika<sup>1</sup>

<sup>1</sup>Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka.

<sup>2</sup>Industrial Technology Institute, Colombo 07, Sri Lanka.

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Yeasts belong to a large and heterogeneous group of microorganisms that are playing a significant role in food industry as well as in the medical field. Due to nonpathogenic nature of probiotic yeast it is gaining promising popularity in medical and pharmaceutical fields as bio therapeutic agents and has been used to treat a variety of human gastrointestinal disorders. Hence, this study was designed to isolate and identify probiotic yeast from goat milk. Fresh Nineteen goat milk samples were collected from different farms located in Nawagamuwa, Homagama, Kaluthara, Negombo and thirteen dairy products samples were purchased at retail outlets in Colombo district. Then yeast was isolated by pour and spread plate techniques using yeast peptone dextrose agar (YPDA) and characterized using conventional methods; urease test, catalase test, sugar fermentation test, carbon and nitrogen accumulation tests, 50% glucose tolerance test and single cell protein (SCP) production test. Subsequently probiotic potential of isolates were assessed by investigating their tolerance to temperature, pH, NaCl, phenol and bile. In total thirty five yeast isolates were obtained out of which six from goats' milk (GMY 013, GMY 014, GMY 044, GMY 045, GMY 068, and GMY 070) were proved to possess strong probiotic potential. Selected isolates survived well under harsh gastrointestinal conditions provided (pH < 2, up to 1% bile, up to 6.5%, NaCl and up to 0.6% phenol). The selected six isolates were able to produce SCPs and did not produce clear zones around colonies ( $\gamma$ -haemolytic) on human blood agar plates and hence, could be considered as safe for human consumption. Therefore, this study paves a way for future investigations on probiotic yeasts isolated from goats' milk in food and pharmaceutical industries.

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## **Evaluation of dye decolorization capability of laccase producing fungi**

M. M. P. Shashikala<sup>1</sup>, P. Wijesinghe<sup>2</sup> and R. N. Attanayake<sup>1</sup>

<sup>1</sup>Department of Botany, University of Kelaniya, Sri Lanka.

<sup>2</sup>Department of Botany, University of Peradeniya, Sri Lanka.

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Fungi are eukaryotic organisms that have the ability to produce different types of enzymes in order to access nutrients. Laccase is an oxidoreductase that is capable of lignin degradation and recently it has gained scientific interest due to tremendous potential in various biotechnological applications. Objectives of this study were to determine laccase producing abilities of white rot hardwood associated fungi of dry and intermediate zone forests in Sri Lanka, and to determine whether these species can degrade industrial dyes. It was hypothesized that the fungal species associated with hardwoods of the dry zone forests are strong laccase producers and are capable of degrading synthetic industrial dyes. A total of 23 fungal isolates were obtained for qualitative and quantitative analysis of laccase production. Qualitative test was based on the color change on guaiacol amended PDA and the quantitative analysis was based on the absorbance measurements at 450 nm. Based on these assays, 12 isolates were selected as potential laccase producers. They were then tested on textile dye decolorization capacity. Three replicates of each laccase producer was inoculated separately into a selective medium containing bromophenol blue dye and incubated at room temperature for three weeks. Color change from blue to yellow was visually observed. Dye decolorization efficiency was determined by measuring the absorbance values at 590 nm. Five isolates out of 12 showed more than 70% of triphenyl methane dye decolonization ability within 21 days of incubation. Statistical analysis was carried out to determine the correlation between laccase production and dye decolorization capability. According to the Pearson's correlation analysis, there was a positive and significant correlation ( $R= 0.64$ ,  $P= 0.023$ ) between the dye decolorization and laccase production. Based on the results it is clear that these fungal isolates can be further studied to be used in industrial dye degradation.

## **Etiology and thiophanate methyl resistance of a *Fusarium* spp. causing wilt of beans in Badulla district, Sri Lanka**

M. D. I. H. Seneviratne, R.N. Attanayake

Department of Botany, University of Kelaniya, Sri Lanka.

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In Sri Lanka yellowing in beans has been reported in Bandarawela and the disease outbreak has reached a level where farmers started abandoning bean cultivation. Out of twenty-five fields inspected, no disease free field was found. Therefore, the objectives of this study were 1) to investigate the disease incidence in selected commercial bean fields of Bandarawela 2) to identify the pathogen to the species level and 3) to determine whether fungicide resistant isolates have appeared in Sri Lankan common bean fields. Twenty-five commercial bean fields in Welimada and Bandarawela were inspected and disease incidence varied from 60 to 75%. Sixty-three bean plants showing the symptoms were collected randomly from all the inspected fields. Pure cultures of 40 isolates were obtained. All 40 isolates were tentatively identified as *Fusarium oxysporum* using morphological features. Since ITS region was less informative for species conformation, Foc\_EF1 and Foc\_EF2 specific primers were used to amplify Translation Elongation Factor (TEF) 1- $\alpha$  region of three randomly selected isolates. DNA sequences were highly similar (99%) to *F. oxysporum* isolates available in the GenBank (KJ776746.1, JF740777.1). Koch's postulates were completed on three bean cultivars (Capri, Black Capri, and Brown Capri) under greenhouse conditions. All 40 isolates were assayed for Fungicide, thiophanate methyl at 5.0  $\mu\text{g/ml}$  discriminatory concentration to determine the sensitivity among isolates. Based on the results, it was also found that the sensitivity of the pathogen population is highly diverse to the fungicide inferring high genetic variation and potential resistant isolates were identified. Though observed variations could be due to their genetic and other physiological factors, high genetic variation in a pathogen population infers its high adaptability to various control measures.

## **Spatial distribution of corticolous lichens with respect to ambient air quality in Kegalle urban council area**

M.D.N.R. Dayananda, M.D.M.D.W.M.M.K. Yatawara\*

Department of Zoology and Environmental Management,  
University of Kelaniya, Sri Lanka  
mmkyat@kln.ac.lk\*

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The present study attempted to assess and correlate the spatial distribution of corticolous lichens in the estimation of atmospheric SO<sub>2</sub> and NO<sub>2</sub> levels in Kegalle urban council area. Nine sampling locations with 162 mango (*Mangifera indica*) and coconut (*Cocos nucifera* L.) trees were selected as the lichen host trees for the study. The corticolous lichens found on the selected trees were recorded by using 400 cm<sup>2</sup> scaled transparent quadrat. The lichens were identified using taxonomic keys. Ambient SO<sub>2</sub> and NO<sub>2</sub> levels were determined using “Ogawa” passive air samplers and the index of atmospheric purity (IAP) was calculated using lichen diversity data at each site. The environmental parameters related to lichen colonization were measured using standard methods. Results indicated a considerable spatial variation of lichen diversity within different disturbed habitats in selected urban, semi-urban and rural areas. Genus *Pyxine* was predominant in almost all urban sites while *Graphis* sp., *Chrysothecia* sp., *Pertusaria* sp. were abundant in comparatively pristine rural sites. Nevertheless, genus *Chrysothecia* was the dominant lichen species followed by the genus *Pyxine* in semi-urban sites. A significant increase was observed in canopy cover of the selected tree types from urban to rural and a positive correlation ( $p < 0.05$ ) was observed between lichen diversity and percentage canopy cover of *M. indica*. Results further revealed that ambient SO<sub>2</sub> and NO<sub>2</sub> varied from 9.32 µg/m<sup>3</sup> to 29.15 µg/m<sup>3</sup> and from 0.062 µg/m<sup>3</sup> to 1.024 µg/m<sup>3</sup> respectively from rural to urban and a negative correlation was found to exist between the lichen diversity expressed as IAP and SO<sub>2</sub> and NO<sub>2</sub> concentrations in the study site. These results conclude that the spatial distribution of corticolous lichens can be used to evaluate ambient air quality within human influenced tropical environments.

**Comparative analysis of solvent-free microwave extraction and hydro distillation of essential oil from leaves of *Cinnamomum zeylanicum* Blume**

R.A.G.N. Ranatunga, H.D.S.M. Perera, V.S. Bandara and R. Samarasekara\*

<sup>1</sup>Herbal Technology Section, Industrial Technology Institute, Colombo 07, Sri Lanka.

\*radhika@iti.lk

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*Cinnamomum zeylanicum* Blume (Lauraceae), locally known as “Kurundu” is a Cinnamon cultivar endemic to Sri Lanka. Solvent Free Microwave Extraction (SFME) is a green extraction technique used to extract essential oils from medicinal plants. The aim of this study was to extract the essential oil from the leaves of *C. zeylanicum* using SFME technique and to characterize the *C. zeylanicum* oil using Gas Chromatography (GC) and Gas Chromatography-Mass Spectrometry (GC-MS) to compare the oil profiles obtained from SFME and hydro distillation (HD) techniques. The fresh leaves of *C. zeylanicum* was subjected to SFME (Microwave power: 700 W for 10 min. followed by 500 W for 50 min.) and HD to extract the essential oil. The essential oils were analyzed using GC and GC-MS. The extraction time for SFME was found to be less (1.0 h) in comparison to that of HD method (6.0 h) to obtain comparable yield of oil from both methods (SFME: 0.55% and HD: 0.65%). The GC-MS analysis enabled the identification of 36 compounds from essential oil of leaves of *C. zeylanicum* extracted using both techniques. Eugenol was detected as the major compound in the oil obtained from both extraction techniques and the relative abundance of eugenol was found to be comparable (HD: 91.35 ± 0.79%, SFME: 87.25 ± 0.33%). In the leaf oils obtained from both extraction methods, phenylpropanoids (Trans-cinnamaldehyde, Eugenol, Eugenyl acetate, Benzyl Benzoate) were found to be the most abundant group of compounds followed by monoterpenes ( $\alpha$ -Pinene, Camphene,  $\beta$ -Pinene, 2-Thujene,  $\alpha$ -Terpinene, D-Limonene,  $\beta$ -Phellandrene,  $\beta$ -Ocimene, o-Cymene,  $\beta$ -Linalool) and sesquiterpenes ( $\beta$ -Caryophyllene, Caryophyllene oxide). Taken together, these results indicated that SFME is an efficient method to extract the essential oil from the leaves of *C. zeylanicum* over conventional HD technique.

***In vitro* pro-inflammatory enzyme inhibitory activities of *Artocarpus altilis***G.D. Liyanaarachchi<sup>1</sup>, R. Samarasekera<sup>1\*</sup>, K.R.R. Mahanama<sup>2</sup>, K.D.P. Hemalal<sup>3</sup><sup>1</sup>Industrial Technology Institute, Colombo 7.<sup>2</sup>Department of Chemistry University of Colombo Colombo, 3.<sup>3</sup>Rocky Mountain Soap, Co.201-106, Bow Meadows Crescent, Canmore.

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Pro-inflammatory enzymes including arachidonate 5-lipoxygenase (A5-LOX), xanthine oxidase (XO) and hyaluronidase (HYL) produce inflammatory mediators and free radicals, which can provoke several inflammatory diseases including bronchial asthma, allergic rhinitis, cardiovascular diseases, rheumatoid arthritis and cancer. The inhibitors of these enzymes have therefore gained a high therapeutic potential in the treatment of inflammatory mediated diseases. Medicinal plants still remain as potent sources of new enzyme inhibitors. *Artocarpus altilis*, locally known as breadfruit (Moraceae), has been used in traditional folk medicine against many diseases including liver cirrhosis, hypertension and diabetes. Hence this study is aimed at evaluating A5-LOX, XO and HYL inhibitory activities of ethanol extract of *A. altilis* barks and mature leaves. Ethanol extracts of air-dried and powdered bark, leaves and fruits of *A. altilis* were evaluated *in vitro* for A5-LOX, XO and HYL inhibitory activities following standard protocols. Ethanol extract of *A. altilis* leaves showed good A5-LOX inhibitory activity having IC<sub>50</sub> value of 3.70±0.66 µg/mL with comparison to that of bark extract (126.62±2.09 µg/mL) but less than the activity of positive control baicalein (IC<sub>50</sub> 1.76 ± 0.15). *Artocarpus altilis* bark and leaves extracts exhibited low XO inhibitory activity (3.38±0.64% and 5.46±0.58% at 500 µg/mL, respectively) in comparison to the positive control allopurinol (99.87±1.44% at 500 µg/mL). Bark extracts exhibited good HYL inhibitory activity having 68.59% inhibition at 500 µg/mL with comparison to tanic acid (90.25% at 500 µg/mL). The present study may provide impetus to search for novel anti-inflammatory compounds from *A. altilis* which deserves further investigations and supports the traditional claims of this plant.

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## Biocontrol potential of endophytic fungi associated with weedy and wild rice species in Sri Lanka

Y De Silva and K.G.S.U. Ariyawansa\*

Department of Plant Sciences, University of Colombo.

[\\*sameera@pts.cmb.ac.lk](mailto:sameera@pts.cmb.ac.lk)

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Plant fungal endophytes are known to influence the ecology and fitness of host plants while enhancing their resistance against biotic and abiotic stress conditions. Fungal endophytes, amidst their other uses in agriculture, are considered as potential biocontrol agents to mitigate pests and diseases of crop plants. In view of this, this study was aimed at isolating fungal endophytes from weedy and wild rice species in Sri Lanka and investigating their antifungal activity against the fungal rice pathogen *Rhizoctonia solani*. In addition, an attempt was made during this study to optimize a transformation technique to fluorescently label fungi with the long term aim of using the optimized technique to label fungal endophytes to study their compatibility and colonization patterns in different host plants. A total of 22 weedy (*Oryza sativa* f. *spontanea*) and wild rice (comprising of *O. granulate*, *O. rufipogon*, *O. rhizomartis*, *O. nivara* and *O. echingeri*) samples were collected from the Batalegoda Rice Research Institute and Gannoruwa Plant Genetic Resource Center respectively. Putative fungal endophyte isolation using standard procedure yielded 77 and 205 morphologically distinct isolates from the weedy and wild rice species respectively. Dual culture assay of 50 isolates (from the total of 282) revealed the ability of 5 isolates to inhibit the radial colony growth of *R. solani* on 1% PDA at room temperature by 80 to 95% compared to the control (*R. solani* alone). Ethyl acetate crude extracts of the two most promising isolates (according to dual culture assay), B.W.E.R.L 0005 and G.W.I.G.L 0001, tested using the well diffusion method demonstrated significant ( $P < 0.05$ ) inhibition of radial colony growth of *R. solani* at 50  $\mu$ L of fungal extract (20 mg/mL) per well compared to the negative control (50  $\mu$ L of DMSO), while inhibition of *R. solani* by the extract of isolate B.W.E.R.L 0005 was comparable with the positive control (20 mg/mL hygromycin). ITS sequences of B.W.E.R.L 0005 and G.W.I.G.L 0001 showed 99 and 98% identity with ITS sequences of *Xylaria feejeensis* (KY951907.1) and *Trichoderma harzianum* (KC561083.1) respectively. Polyethylene glycol (PEG) mediated transformation of *Fusarium* protoplast with pYH2a (harbor a hygromycin resistant *hph* gene and a histone H2A gene fused to yellow fluorescence protein gene) and pPN1688 (harbor hygromycin resistant *hph* gene) plasmids separately resulted in hygromycin resistant transformants on selective media and hyphae with fluorescently labelled globular structures (presumed to be nuclei) when observed under fluorescent microscope, confirming the successful transformation of *Fusarium* protoplasts and expression of histone H2A gene fused to yellow fluorescence protein. Thus, the study yielded a number of rice fungal endophytes antagonistic to *R. solani* *in vitro* and a PEG mediated transformation technique to fluorescently label endophytic fungi in future.

## **An outbreak of rotting disease on *Dendrobium* in Sri Lanka**

W.G.H. Jayalath and R.N. Attanayake

Department of Botany, University of Kelaniya.

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Floriculture is an emerging industry in Sri Lanka with 0.13% contribution to the total exports in 2016. Among the main floricultural products, orchids have a very high demand and have dominated in the floriculture industry. Recently, severe *Dendrobium* floral bud drop was reported from several commercial net houses in the Gampaha district. It was often observed that both flower buds as well as leaves were infected. The aims of the study were to determine the disease incidence of both the diseases of selected fields and to determine whether the pathogen causing *Dendrobium* leaf rot could also cause the floral bud drop. Three commercial *Dendrobium* fields with disease history in Gampaha district were inspected. Leaf rot and bud drop incidences were estimated. Bud drop incidence was about 80-90% and leaf rot was found to be around 50% in the field inspected. Previously we found that floral buds were occupied with a larval stage of *Contarinia maculipennis*. The current study was conducted on the grounds that characteristic pungent odour of bacterial rot was detected from both types of tissues. Bacteria from infected leaves and buds were separately isolated and pure cultures were obtained. On the basis of colony morphology two isolates were selected from rotted leaves and one from floral bud. Gram negative, rod shaped bacterial cells and several biochemical tests confirmed all three isolates as *Erwinia* sp. Koch's postulates were completed. Briefly, three bacterial strains isolated from leaves were inoculated on to detached young *Dendrobium* leaves as well as to floral buds and vice versa. All the isolates confirmed their pathogenicity on both leaves and floral buds of *Dendrobium* and caused similar symptoms and pathogens were re-isolated supporting the idea that the strains infecting leaves could also infect the flower buds.



## Morphological and molecular characterization of cyanobacteria in Maha Oya hot springs in Sri Lanka

D. G. S. N. Samarasinghe<sup>1</sup>, R. P. Wanigatunge<sup>1</sup>, H. M. Herath<sup>1</sup>, D. N. Magana-Arachchi<sup>2</sup>

<sup>1</sup>Department of Botany, University of Kelaniya, Kelaniya.

<sup>2</sup>Molecular Microbiology and Human Disease Unit, National Institute of Fundamental Studies, Kandy.

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Cyanobacteria are morphologically, physiologically and genetically diverse group of organisms inhabiting almost all the environments from aquatic to terrestrial habitats and some of them are potential toxins producers. In Sri Lanka few studies have been conducted for identifying thermophilic cyanobacteria based on morphology and 16S rDNA sequences. The present study was conducted to isolate and identify thermophilic cyanobacteria in Maha Oya hot springs based on morphology and 16S rDNA gene and to identify the presence of potential microcystin producers by microcystin synthetase (*mcy*) gene amplification. Water and mat samples were collected from the seven wells of Maha Oya hot springs which showed water temperatures ranging from 42 to 59.8 °C and pH ranging from 6.89-7.63. Water and mat samples were inoculated into cyano specific BG11 and BG11<sub>0</sub> media. Morphological identification of both uncultured and cultured cyanobacteria revealed the presence of eight different cyanobacterial genera. The most abundant genus was *Oscillatoria*. Additionally *Calothrix*, *Synechococcus*, *Gloeocapsa*, *Gloeotheca*, *Cylindrospermopsis*, *Lyngbya* and *Pseudanabaena* were observed. Amplification of cyanobacterial 16S rDNA (~450 bp) and segments of *mcyA* (~230 bp) and *mcyE* (~300 bp and ~400 bp) genes by PCR indicate the presence of cyanobacteria and potential toxin producers in mats. Findings of the present study confirmed the presence of rich cyanobacterial diversity and potential microcystin producers in Maha Oya hot springs. The isolation of these cyanobacterial strains will be useful for future research on thermostable enzymes and other heat stable bioactive compounds.

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# **ABSTRACTS OF PAPERS**

**Parallel session 03 (Flora & Environment)**

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**A comparative analysis of the total phenolic and flavonoid contents and some antioxidant activities of *Centella asiatica* (Centella), *Coccinia grandis* (Ivy Gourd) and *Costus speciosus* (Crepe Ginger) in Sri Lanka**

Y. A. Jayasinghe and S. Dias\*

School of Science, Business Management School, Colombo 06, Sri Lanka.

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Antioxidants are natural or synthetic substances which combat the cell damage occurring due to oxidative stress usually caused by oxygen free radicals. Natural antioxidants can serve as human friendly nutraceuticals to neutralize oxidative stress. The current study aimed at determining the total phenolic and flavonoid contents and antioxidant activities of the leaves of *Centella asiatica* (Centella / 'Gotukola'), *Coccinia grandis* (Ivy gourd/ 'Kowakka') and *Costus speciosus* (Crepe Ginger/ 'Thebu') in Sri Lanka. The quantitative spectrophotometric analysis of the TPC (Total Phenolic Content), TFC (Total Flavonoid Content), TAC (Total Antioxidant Capacity), FRAP (Ferric Reducing Antioxidant Power), radical scavenging activity of ABTS (2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt) and of DPPH (1,1-Diphenyl-2-picrylhydrazyl) in 100% methanolic extracts of the leaves of Centella, Ivy gourd and Crepe Ginger were carried out. Results showed TFC as Crepe Ginger (514.00 ± 57.688 mg Rutin/ L) = Ivy gourd (514.00 ± mg Rutin/ L) > Centella (192.00 ± mg Rutin/ L), TPC as Ivy gourd (2310.58 ± 108.430 mg GAE/ L) > Centella (716.8 ± 487.935 mg GAE/ L) > Crepe Ginger (407.85 ± 51.749 mg GAE/ L), TAC as Crepe Ginger (184 ± 10.077 mg Ascorbic acid/ L) > Ivy gourd (99.2 ± 6.269 mg Ascorbic acid/ L) > Centella (33.4 ± 3.135 mg Ascorbic acid/ L), FRAP as Ivy gourd (217.0 ± 7.566 mg FeSO<sub>4</sub>/ L) > Crepe Ginger (89.2 ± 13.777 mg FeSO<sub>4</sub>/ L) > Centella (4.5 ± 3.990 mg FeSO<sub>4</sub>/ L), ABTS as Centella (83.71 ± 0.515%) > Ivy gourd (79.28 ± 0.872%) > Crepe Ginger (69 ± 1.449%) and DPPH as Centella (78.99 ± 4.155%) > Ivy gourd (61.56 ± 1.144%) > Crepe Ginger (44.78 ± 0.428%). Further, the flavonoids may have contributed to the antioxidant activity in Crepe Ginger, whereas the phenolics may have contributed to the antioxidant activity in Centella and Ivy gourd.

**Acknowledgement:** Financial assistance provided by BMS is acknowledged.

## **A preservative holding solution to enhance vase life and postharvest quality of *Rosa* hybrid var. 'Red Sky' (Red rose) cut flowers**

H. P. H. C. Premarathna and P. S. Saputhanthri

Department of Plant Sciences, Faculty of Science, University of Colombo, Colombo 00300.

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Cut flowers of roses generally have a relatively short vase life. Holding solution formulations with various combinations of germicides, ethylene inhibitors, carbohydrates, acidifiers etc have been developed and commercialized in many countries in order to extend the vase-life of many cut flowers. However, postharvest practices other than cold-storage are minimal in the local cut-flower industry. This study aimed to develop an effective holding solution to improve the vase life and postharvest quality of Rose cut flowers. For the study cut-flowers of red rose (*Rosa hybrid* var. 'Red Sky') at half open stage were obtained from a retailer. The effect of chemicals Table sugar, Citric acid, Bleaching powder, Silver nitrate, Aluminium sulphate and 6- benzyl adenine, in the holding solution, both individually at different concentrations, and under various combinations, on vase life and on postharvest quality of cut red roses were investigated. The flowers during treatments were kept at 24 °C and 2.58 klux florescence light. The solutions were renewed and flower stems were re-cut (removing 2 cm from the end) once in three days. The experiment was arranged in completely randomized design and each treatment was triplicated. Number of days for visible wilting symptoms, stem bending, petal colour change and pH of vase solution were determined. Results were analyzed by one way analysis of variance (ANOVA) using SPSS statistical software version 20.0. Out of forty chemical combinations tested the most effective one to extend the vase life while keeping the overall quality of the flowers was 6% table sugar, 200 ppm aluminium sulfate and 250 ppm citric acid, in water. It extended the vase life of cut flowers of *Rosa hybrid* var. 'Red Sky' up to  $9.33 \pm 1.33$  days compared to  $3.33 \pm 0.33$  days in the control (distilled water). Prepared solution of this combination can be kept for about one week at 4 °C and preparative cost of this holding solution is relatively low.

## Floristic diversity of Kikiliyamana mountain in Sri Lanka

S.M. Pawuluwage<sup>1</sup>, A.T.N. De Silva<sup>1</sup>, H.S Kathriarachchi<sup>1</sup> and A.M.A.S. Attanayake<sup>2</sup>

<sup>1</sup>Department of Plant Sciences, University of Colombo, Colombo 03.

<sup>2</sup>Royal Botanic Gardens, Peradeniya.

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Kikiliyamana mountain which is located in the central highlands of Sri Lanka extend over 4858.6 ha. Kikiliyamana is the sixth highest peak in Sri Lanka recording a height of 2240 m. The aim of this study was to perform a quantitative vegetation analysis in Kikiliyamana montane forest. Sampling was carried out using randomly assigned 10×10 m<sup>2</sup> plots for tree and understory layers to determine floristic diversity. Within each plot, girths at breast height (gbh) of all individual trees were measured to determine the tree layer (gbh ≥ 15 cm) and understory layer (gbh < 15 cm and height > 1 m). Four (1×1) m<sup>2</sup> sub plots were randomly demarcated in the same 10×10 m<sup>2</sup> plots to enumerate the ground layer (height < 1 m). Floristic richness of the tree, understory and ground, layers was determined separately by calculating the Relative Density (RD), Relative Frequency (RF), Relative Basal Area (RBA), Important Value Index (IVI) and diversity indices. Cluster analysis was used to identify plant communities. Sampling was performed in 50 plots revealing 186 plant species belonging to 117 genera and 69 families at Kikiliyamana. Among them 43% were endemic to Sri Lanka. The study revealed 78 threatened plant species including one Critically Endangered, Possibly Extinct (CR (PE)) (*Christisonia albida*) and two Critically Endangered (CR) (*Impatiens repens* and *Utricularia hirta*) plant species. Based on the IVI values tree layer was dominated by *Strobilanthes sexennis*, *Neolitsea fuscata* and *Acronychia pedunculata* species. *Rhodomirtus tomentosa*, *Actinodaphne ambigua* and *Hedyotis trimenii* recorded the highest IVI values in the understory layer. The ground layer was dominated by *Arundinaria debilis*, *Ageratina riparia* and *Symplocos cochinchinensis*. Orchidaceae, Rubiaceae, Lauraceae, and Myrtaceae, were the dominant plant families. Cluster analysis revealed two major floristic communities from the higher (>2000 m) and lower altitudes (<2000 m). Girth class distribution of the total sampled trees showed a J- shaped curve.

**Acknowledgement:** Financial assistance from the Royal Botanic Gardens, Peradeniya is acknowledged.

## **Vegetative and reproductive trait analysis to characterize pepper (*Piper nigrum* L.) accessions from four districts in Sri Lanka**

W. G. N. A. Wimalarathna, T. D. Silva

Department of Plant Sciences, Faculty of Science, University of Colombo, Colombo 03.

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Sri Lanka is considered to be home to a number of *P. nigrum* wild varieties harboring a large genetic variability within the genus. In a limited survey conducted in Galle, Matale, Kurunegala and Colombo Districts 30 accessions of *Piper* (*P. nigrum* both cultivated and wild) were collected. In addition three other species (*P. betle*, *P. longum* and *P. siriboa*) encountered in the study were included in the analysis. Germplasm characterization was carried out using the standard descriptors developed for black pepper. Quantitative traits were measured from thirty randomly selected mature leaves, twelve randomly selected lateral branches and fifteen mature spikes from each selected accession. Significant differences ( $p \leq 0.05$ ) were found among the accessions for nine quantitative traits studied (leaf width, leaf length, petiole length, lateral branch length, number of nodes per lateral branch, spike length, peduncle length, number of well developed fruits per spike and % fruit set with the largest variation observed for leaf and fruit characteristics. Qualitative vegetative trait analysis produced two principal components that explained 52.82% of the variation. Plant growth habit, leaf base shape, vein type and lateral branch habit were significantly loaded on the first component. Leaf hairiness and pubescence on stem showed no variation. Cluster 1 and 2 each included two wild *P. nigrum* accessions (KeS25 with KeS26 and Gs15 with Gs16). The third cluster included wild and cultivated *P. nigrum* accessions as well as *P. longum*, *P. siriboa* and *P. betle*. For qualitative reproductive traits also two main principal components were generated which explained 90.96% of the total variation. The characters that showed high loading were bract type, fruit taste and fruit shape. Spike fragrance had no variation. A new bract type that was not in the descriptive list was identified in accession named as GS 21, which was pouch like and deeply copular with a decurrent base.

## **Meteorological and Hydrological drought analysis in Attanagalu Oya basin**

Devanmini Halwatura

Department of Zoology and Environmental Sciences, Faculty of Science,  
University of Colombo, Colombo 03.

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Droughts are categorised into different classes as meteorological, hydrological, soil moisture, and socioeconomic, based on the affected system(s). They are known to cause ecological losses accompanying significant secondary and tertiary impacts than any other natural disaster. Understanding each drought type and their characteristics is useful to identify and manage affected ecosystems. For example, meteorological droughts are biophysically more meaningful and are more applicable for vegetation studies, while hydrological droughts are more applicable for drought assessments in aquatic ecosystems. Sri Lanka has been affected by droughts over consecutive years for the past decade and can be seen in almost all regions in various scales. Thus, it is timely important to identify the different characteristics of various drought types for proper drought risk assessment and management. The objective of this study was to analyse meteorological and hydrological droughts in Attanagalu Oya basin focusing on the similarities and differences of severities and durations. Attanagalu Oya basin is one of the smallest river catchments in Sri Lanka, and it is convenient for a preliminary analysis of drought in basin level. Calibrated and validated hydrological model HEC-HMS-3.0.1 was used to simulate the river flows and Standardised Precipitation Index (SPI) which is a widely accepted drought index, was used to estimate meteorological droughts using monthly average rainfall (1960-2009). The same drought index was used to estimate hydrological droughts and monthly averaged river flow was used instead of rainfall. Droughts were then categorised into different classes based on drought index values. The drought analysis indicated that the meteorological droughts are more prominent than the hydrological droughts in the basin. During the study period three extreme meteorological droughts and one extreme hydrological drought were recorded. Further, 18 and two severe meteorological and hydrological droughts were recorded respectively. Outcomes of this study show that different drought classes have variations in severities and durations which require unique risk assessments and management actions.

**Non-host status of forest tree species for *Pratylenchus loosi* and *Radopholus similis* affecting tea in low grown areas in Sri Lanka**

K. M. Mohotti\*, A. K. Prematunga and P. G. D. S. Amarasena

Tea Research Institute of Sri Lanka, Talawakelle 22100.

\*mohottik@yahoo.com

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The tea declines under low country scenario experienced at various magnitudes showed a variety of above ground and below ground stress symptoms as a result of a composite of many specific causes. The symptoms exhibit as deterioration, overall reduction of tree vigor, localized symptoms with healthy bushes adjacent to dead or dying, slow and slightly developing symptoms *etc.* The affected bushes may survive indefinitely but die within a year or two. Infestations by *Pratylenchus loosi* and *Radopholus similis* were seen associated as a primary attribute to such crop declines. The sources of infestation of *P. loosi* and *R. similis* in hitherto areas in the low country were questionable. However, the major possible source of nematode infestation could be the planting materials as the areas were reported to be free from any history of nematode infestations. In the case of *P. loosi*, since tea is the main host, it was important to investigate the host status of other plant / tree species in the surrounding forests of the infested tea fields. The rhizosphere soil and roots of thirty forest trees were sampled in Pitawathura, Wathurawa and Kalawana areas in the borders of Sinharaja forest during the year 2016. The results confirmed that none of the forest tree species harbour *P. loosi* and *R. similis* while other nemic fauna species such as spiral and free living nematode species were present. Hence, the possibilities of *Pratylenchus loosi* and *Radopholus similis* disseminating through forest borders and / or forest tree roots are excluded.



## **Adverse effects of induced high temperature stress and water stress on tissue cultured banana plants (AAA Cv Cavendish)**

K.I.C. Amarasinghe<sup>1</sup>, C.S De Silva<sup>2</sup> and L.K.R.R. Jayakody<sup>1</sup>

<sup>1</sup>Department of Botany, Open University of Sri Lanka, Nawala, Sri Lanka.

<sup>2</sup> Department of Agricultural and Plantation Engineering, Open University of Sri Lanka, Nawala, Sri Lanka.

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Climate change is a major problem faced by the world today. Due to the increase in global temperature and the decrease in rainfall, the vegetative and reproductive growth of the plants are heavily affected, consequently reducing the yield. Banana is a fruit that is highly consumed in the world. Banana ranks as the fourth most important food crop in the world with respect to production and has an economic significance both locally and internationally including the developing countries. *In vitro* propagated banana have been introduced to the farmers locally and found to be popular among them due to their beneficial characteristics. This study investigated the impact of simulated temperature stress and water stress reflecting global warming on growth and development of *in vitro* propagated banana cv Cavendish which has a high demand among consumers. This study was carried out at the Open University premises in Nawala, in a temperature-regulated poly tunnel where maximum temperature was maintained at 35 °C and in a plant house at the ambient temperature (29-30 °C). Two sets of pots were maintained under temperature stress. Each set consisted of six pots and in each pot, there was a single *in vitro* propagated one month-old banana plant. One set was watered to field water capacity and the other set to half field water capacity daily. The other two sets of plants, maintained in the plant house were also treated under the similar water regimes. The vegetative growth parameters, height of pseudo stem, number of leaves, leaf length and width and girth at the base were measured at the beginning and in four week intervals for forty weeks in two cycles. The plants were maintained in a completely randomized design and the results were analyzed, using SAS University software package. The results of ANOVA indicated that all the vegetative growth parameters measured have been adversely affected by the temperature stress and/or the water stress imposed ( $P < 0.0001$ ). As such, it can be concluded that the *in vitro* propagated banana cv Cavendish plants are unable to withstand the temperature stress and the water stress that would result due to climate change.

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## Study on Chalcone synthase and Chalcone isomerase partial coding sequences of selected *Dendrobium* cultivars

R. P. I. V. Somasiri, H. M. Herath, S. P. Senanayake

Department of Botany, University of Kelaniya, Kelaniya.

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Family Orchidaceae is one of the largest angiosperm families in the world. Orchid flower is long lasting, attractive and have a high demand in local and international markets. Sri Lanka is in need of producing quality floriculture products with novel floral qualities and findings of this preliminary study would support to develop novel *Dendrobium* cultivars by gene silencing. Objectives of the present study were to amplify coding sequences of two flavonoid pigments producing genes: Chalcone synthase (CHS) and Chalcone isomerase (CHI), from selected eight *Dendrobium* cultivars with high floricultural importance and compare the eight sequences of each coding region to identify gene silencing targets. Genomic DNA was extracted from fresh young leaves of *Dendrobiums* and segments of coding regions of CHS (121 bp, 235 bp) and CHI genes (186 bp) were amplified by PCR. Primers used in PCRs were determined by aligning CHS or CHI, DNA and cDNA sequences of *Dendrobium catenatum* available in NCBI. Sequences of PCR products were aligned with NCBI nucleotide databases to identify the *Dendrobium* cultivars used in the study. Furthermore all sequences of the cultivars studied were aligned with each other (blastn), separately for each coding region, to find sequence variations among cultivars. All amplified CHS coding sequences had 84-100% identities with *Dendrobium* hybrid Blue Sapphire CHS mRNA (KY399855.1) while all amplified CHI coding sequences had 93-96% identities with *Dendrobium* hybrid Sonia 'Earsakul' CHI1 mRNA (KC345012.1). In a multiple sequence alignment, CHS 121 bp, CHS 235 bp and CHI 186 bp coding sequences had 92-100%, 84-100% and 95% similarities to each other, respectively. The nucleotide differences in amplified regions could be used to differentiate individual cultivars. Regions similar among cultivars could be considered as suitable targets in future research to develop new *Dendrobium* cultivars by gene silencing.

**Acknowledgement:** This work was supported by the University of Kelaniya and the World Academy of Sciences (TWAS) research grants.

**Efficacy of powdered mature leaves of *Terminalia arjuna* in reducing the nitrate – N and total hardness of the domestic well water in Kondavil area, Jaffna Peninsula, Sri Lanka**

M. Shanthamareen and W.M.D.N. Wijeyaratne\*

Department of Zoology and Environmental Management, Faculty of Science, University of Kelaniya.

\*dimuthu.wijeyaratne@kln.ac.lk

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In Jaffna peninsula, groundwater is the primary water source for domestic agricultural and industrial purposes. However, increased water hardness and contamination by nitrates are two major water quality problems prevalent in this area. The present study was conducted with the aim of assessing the efficacy of powdered mature leaves of *Terminalia arjuna* (Kumbuk) to improve the water quality in terms of nitrate concentration and total hardness. Water samples with three replicates were collected from randomly selected 15 domestic wells located in the Kondavil area, Jaffna peninsula. The nitrate-N, and total hardness (TH) were measured using standard analytical methods. The water samples were filtered in a column filter using powdered mature leaves of *Terminalia arjuna* and these water quality parameters were measured in filtered water samples as well. The water quality parameters were compared with the standard water quality parameters for safe drinking water established by the Sri Lanka Standards Institution (SLSI). The variation of water quality parameters before and after filtration were compared by paired t test using MINITAB 14 software. The mean TH of the sampled wells ranged from 644.15 mg/L CaCO<sub>3</sub> and The mean nitrate N ranged from 12.07 mg/L. All the the wells exceeded the SLSI standard (250 mg/ L) for TH and 60 % of the wells exceeded the SLSI standard (11.3 mg/ L) for nitrate. After filtration through the powdered mature leaves of *Terminalia arjuna*, the TH and nitrate N were reduced significantly (Paired t test, p< 0.05). The mean TH and nitrate N of the filtered water were 635.8 mg/L CaCO<sub>3</sub> and 9.49 mg/L respectively. Percentage reduction of TH and nitrates after filtration were 1.3 % and 21.36% respectively. Therefore, results of the present study showed that *Terminalia arjuna* leaf powder can be used as an effective low cost household treatment method to improve the water quality in terms of TH and nitrate N.

**Propagation of *M. dioica* using *in vitro* embryo and cotyledon culture****D.S. Vanrooyen and T. D. Silva**

Department of Plant Sciences, Faculty of Science, University of Colombo.

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*Momordica dioica* is a dioecious, perennial climber belonging to family Curcubitaceae. Its common name is spine gourd and is locally known as “thumba karawila”. *M. dioica* is a popular vegetable grown in the dry zone low lands of Sri Lanka. It has a good market demand because of its high nutritional qualities and value in ayurvedic medicine. Due to the presence of good shelf life this has a high export potential also. *M. dioica* is usually propagated vegetatively using underground tuberous roots but the number of propagules is low. Propagation by vine cuttings can be done but the rate of success is poor due to difficulty in rooting and establishment of cuttings. It is capable of sexual reproduction and produces a large number of seeds. However, seeds have a long period of dormancy and the germination rate is poor. In the present study *in vitro* culture of embryos and cotyledons was examined as an alternative vegetative propagation method. For both embryo and cotyledon culture the Murashige and Skoog (MS) medium was used with growth regulators BA (16.2 mg/L), NAA (2.7 mg/L) and GA<sub>3</sub> (0.54 mg/L). Prior to embryo dissection surface sterilization of seeds was carried out with 0.1% (w/v) HgCl<sub>2</sub>. But it was not adequate for successful surface sterilization. In a second trial Sodium hyperchlorite (NaOCl), 70% alcohol and 0.1% (w/v) HgCl<sub>2</sub> was used. Out of 15 different treatments in which soaking duration and concentration of NaOCl were varied, successful sterilization of seeds was achieved following 10 min. treatment in 50% NaOCl for embryos and 20 min. treatment in 30% NaOCl for cotyledons. In culture, callus forming efficiency of embryos and cotyledons was 47% and 32% respectively and direct shoot formation efficiency was 64% from embryos. Shoots were produced from embryos 36 days after transfer to the shoot regeneration medium. According to the results obtained, *in vitro* embryo culture technique can be used for the propagation of *M. dioica*.

### **Impact of *Bamboosa vulgaris* plantations on soil properties under Sri Lankan eco-climatic setting**

W.A.R.T.W. Bandara\*, S.A.N.M. Senanayake, K.J.R. Madhubhashini, J.K.P. Jayawardana,  
K.A.D.D. Chandimali

Department of Zoology and Environmental Management, Faculty of science, University of Kelaniya.

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Bamboo is one of the fastest growing plants in the world. Because of its unique physical and biological characteristics, it is considered to be an economically important plant. It can be identified as an alternative to tropical timber. UNIDO, UNEP are to implement and promote bamboo as a commercial cultivation in Sri Lanka among the local communities. The community perception in the recent past against commercial cultivation have been challenged due to Sri Lankan common belief that bamboo has influenced negatively on soil conditions including soil moisture. Therefore, the objective of the current study was to evaluate the impacts of *B. vulgaris* plantations on water and soil quality. Parakaduwa, Aththanagalle and Alawwa from wet zone and Hambanthota from dry zone were selected as study sites. Soil samples were extracted from each site from two different locations where *Bamboosa vulgaris* naturally present and from an adjacent sampling site where *B.vulgaris* is not present. From each location soil samples were extracted at two depths surface and 15 cm down from the surface using soil bores and from each depth three replicate samples were taken. Altogether 12 samples from each study site and 48 samples from all four study sites were extracted. pH, Moisture content, Organic matter content, Porosity, Nitrogen content, Bulk density, Particle density of soil samples were analyzed and statistically analyzed by using ANOVA. In all the study sites where *B.vulgaris* is present moisture contents, organic matter contents, particle densities and porosity values, Nitrogen contents were significantly higher than in the sites where *B. vulgaris* was not present. On the other hand *B.vulgaris* not present study sites show higher bulk densities, temperature, conductivity and pH in all four study sites. Therefore, it can be concluded that certain physical and chemical properties such as pH, Moisture content, Organic matter content, Porosity, Nitrogen content, Bulk density, Particle density of soil where bamboos are naturally grown have been improved in the areas where *B. vulgaris* is naturally present.

**Plant DNA barcoding of *rbcl* gene for eight endemic plant species of *Dipterocarpaceae* family for authentication**

R.D.B. Lavensan<sup>1,2</sup>, N.P.S.K. Niroshana<sup>1,2</sup>, H.H.K. Achala<sup>1</sup>, W.W.P. Rodrigo<sup>1</sup>, W.T.G.S.L. Withana, A.A.M.A.S. Attanayake<sup>3</sup>, J.K.R.R Samaresekera<sup>1</sup>, A.M.M.H. Athapaththu<sup>1\*</sup>

<sup>1</sup>Biotechnology Unit, Industrial Technology Institute, Colombo 07, Sri Lanka.

<sup>2</sup> BMS, School of Science, Colombo 06, Sri Lanka.

<sup>3</sup>Royal Botanical Gardens, Peradeniya, Sri Lanka.

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In order to assist in conserving the endemic species, molecular technique, DNA barcoding is immensely used. The objective of this study was to amplify and sequence the *rbcl* gene, of eight, medicinally and industrially important endemic plant species belonging to *Dipterocarpaceae* family in Sri Lanka. Plant samples were collected from the Royal Botanical Gardens, Peradeniya, Sri Lanka and the DNA extraction was carried out using Cetyl Trimethyl Ammonium Bromide (CTAB) method and commercially available kit (GenElute™ Plant Genomic DNA Miniprep Kit). The master mix for PCR was prepared for a total volume of 15 µl using 1X of Go Taq® Green master mix, 0.2 mM *rbcl* forward and reverse primers each, 0.5 - 2 µl of DNA template. The amplification of *rbcl* gene was carried out using following conditions: 94 °C for 1 min, followed by 35 cycles at 94 °C for 30 sec, 62 °C for 30 sec, 72 °C for 1 min, and the final extension was performed out at 72 °C for 8 min. The PCR products were analyzed on a 0.8% Agarose gel and purified PCR products were sequenced and deposited in NCBI followed by Phylogenetic tree analysis using MEGA 5.2 software. The generated sequences were deposited in NCBI under the accession numbers of *Stemonoporus acuminatus* (KX828977.1), *Hopea jucunda* subsp. *modesta* (KX828979.1), *Shorea ovalifolia* (KX828980.1) and *Balanocarpus bravipitiolaris* (KX828981.1), *Shorea dravipitiolaris* (KX944295.1), *Doona nervosa* (KX828982.1), *Doona venulosa* (KX828978.1) and *Doona macrophylla* (KX944294.1). The phylogenetic tree demonstrates *Stemonoporus acuminatus* to be highly distant from *Doona venulosa* and *Doona macrophylla*. Furthermore, *Doona venulosa* and *Doona macrophylla* as well as *Hopea brevipetiolaris* and *Shorea brevipetiolaris* showed high similarity between their pairs respectively. The data in this study could be used to eliminate biopiracy and to authenticate the endemic species of *Dipterocarpaceae* family in Sri Lanka.

## Floristic investigation of the Wawekele Forest, Seethawakapura, Avissawella

Masha Nishadi Matharage and Sudheera M.W. Ranwala

Department of Plant Sciences, Faculty of Science, University of Colombo, Sri Lanka.

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Small forest patches in sub-urban areas play a key role in maintaining the health of the environment. The present study inventoried flora, assessed heterogeneity of the forest using floristic and soil parameters and identified the detrimental human interferences on the Wawekele forest of Seethawaka, Avissawella. All herbaceous seedlings (< 1 m height), treelets (> 1 m height and dbh < 10 cm) and trees (> 1 m height and dbh > 10 cm) were identified using fifteen 10 m × 10 m plots. Diameter at breast height (dbh) was measured for trees. Density of treelets were determined using 3 sub plots (2 m × 2 m) and forest density of herbaceous undergrowth was enumerated using 1 m × 1 m sub plots. The ecological importance was calculated by the Important Value Index of woody species. Diversity indices also employed for comparing the diversity across strata. Soil samples up to 15 cm depth obtained from 14 locations were analyzed for pH, Cation Exchange Capacity, Electrical conductivity, Percentages of Carbon, Nitrogen, and total Phosphorous and Potassium contents using standard analytical methods and subjected to cluster analyze using PAST Ecological Software to identify site differences. The flora of Wawekele comprised of a total of 79 angiosperm species belonging to 70 genera and 43 Families. Total of 54 tree species, seven shrub species, six herb species, nine climber species and two vine species and one creeper were recorded out of which 12 were endemic to Sri Lanka contributing to 16.3% endemism. Three invasive species and two critically endangered species, three endangered species, seven vulnerable species, 10 near threatened higher plant species were identified. In addition three fern species belonging to two families were also inventoried. The most ecologically dominant species of the forest was *Hevea brasiliensis* followed by *Horsfieldia iryaghedi*, *Chaetocarpus coriaceus*, *Artocarpus nobilis*, *Cyathocalys zeylanica*. Shannon Weiner, Simpson's and Margalef indices indicated that the richness of flora varied across understory > undergrowth > canopy and sub canopy. Shannon dominance measure supported above results and Shannon evenness measure indicated that the highest evenness represented by the undergrowth. Soils were grouped into five major clusters depending their chemical characteristics. Establishment of the signal towers on one side of the forest, nature trail, neighboring plantations of Rubber had impacted negatively on the forest. Changes in soil properties of soil and threat from invasive species such as *Clidemia hirta* and *Ochlandra stridula* indicate early signs of forest degradation. Therefore, necessary action should be taken to protect this valuable patch of Wawekele forest in Seethawakapura, Avissawella.

## Leaf functional characteristics vary among of weedy *Panicum L.* species

Dinuka Rukshan Witharana and Sudheera M.W. Ranwala

Department of Plant Sciences, faculty of Science, University of Colombo.

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In Sri Lanka, *Panicum maximum* (*Megathyrus maximus* varieties A and B), *Panicum repens* and *Panicum trichocladum* are considered as troublesome species of family Poaceae. *Panicum maximum* guinea A is listed as a priority invader while *P.trichocladum* is identified as a potential invader. We compared leaf functional traits that reflected their capacities in carbon assimilation. The grasses were raised in pots with a 4:4:1:1 growing mixture containing compost, top soil, sand, coir dust. Rhizome nodal cuttings obtained from plants previously acclimatized (30°C, 7% RH, open sunlight) in pots were arranged in a completely randomized design. Chlorophyll a and b (n=9), trichome and guard cell characteristics (n=15), stomatal conductance (n=9) and specific leaf area (n=3) of mature leaves of plants were measured in replication as indicated. Specific leaf area was measured after 10 weeks. Data were subjected to ANOVA and LSD using SPSS to compare species. *Panicum repens* had the lowest Chlorophyll a and b concentrations while *P. trichocladum* showed the highest Chl a/b ratio. The longest trichomes were observed in *P. maximum* guinea- A (117.40µm), shortest from *P.repens* (59.32 µm), no trichomes in *P. trichocladum* while *P. maximum* guinea- B had non-glandular trichomes. Trichome density was the highest in *P.repens*. Highest stomatal density was reported in *P.trichocladum* while the lowest was observed in *P.repens*. Guard cell length of *P.trichocladum*, *P. maximum* guinea-A and *P. maximum* guinea-B was 0.19 mm while in *P.repens* it was 0.15 mm. Potential Conductance Values varied *P. trichocladum* ( $8.8 \times 10^{-4}$ ) > *P.repens* ( $2.1 \times 10^{-4}$ ) > *P. maximum* guinea- A ( $6.7 \times 10^{-4}$ ) > *P. maximum* guinea-B ( $5.9 \times 10^{-4}$ ). *P. maximum* guinea-A species showed the highest stomatal conductance while *P.repens* showed the lowest. The specific leaf area varied *P. repens* (526.3 cm<sup>2</sup>/g) > *P.trichocladum* (378.4 cm<sup>2</sup>/g) *P. maximum* guinea-A (242.2 cm<sup>2</sup>/g) > *P. maximum* guinea-B (210.57cm<sup>2</sup>/g). Results showed that different foliar traits optimized carbon assimilation in *Panicum* species. The potential invader *P. trichocladum* exhibited signs of successful carbon assimilation and may become a noxious invader as *P. maximum* if its spread is not controlled at initial stages.



## **Use of bio char for the improvement of soil nutrient status of Calcic Red Yellow Latasol soil in Jaffna district of Sri Lanka for onion cultivation**

Theepa Rageendrathas<sup>1</sup> and C.S.De Silva<sup>2</sup>

<sup>1</sup>Regional Agricultural Research Station, Thirunelvely.

<sup>2</sup>Department of Agricultural and Plantation Engineering, The Open University of Sri Lanka, Nawala, Nugegoda.

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An experiment was conducted to find the response of *Allium cepa* (onion) for three types of biochar namely coconut char (CC), palmyrah char (PC), and paddy husk char (PHC) in combination with the Department of Agriculture, recommended fertilizer (DRF) and farmer-practice fertilizer (FPF). The field experiment was carried out in randomized complete block design at the Regional Agriculture Research Station, Application of biochar with fertilizer has improved onion yield and available nutrients (P and K) compared to fertilizer application alone. About 57% yield increase was observed in T3 (DRF+PHC) treatment. Similarly, about 14% and 51% increase was found in T6 (FPF + PC) and T7 (FPF + PHC) respectively. Palmyrah char has improved important soil properties followed by coconut char and paddy husk char when applied with DRF application. Paddy husk char has improved important soil nutrients compared to other two biochar. In T7 treatment (FPF + PHC), availability of P and K were increased by 25%, and 30% respectively. About 20% and 11% increase of available phosphorus and potassium were recorded in T6 treatment (FPF + PC). Soil pH in treatments related to FPF and increased soil pH in treatments related to DRF was recorded even in same charred biomass applied treatments. Therefore, PC has higher potential to improve soil properties and PHC has increased yield when apply with DRF and paddy husk char performs the best when applied with farmer-practiced fertilizer. However, coconut char and palm char has the potential to increase yield and improve soil properties with both DRF and FPF.

**Schedule of the Scientific Sessions**  
 38<sup>th</sup> Annual Sessions of the Institute of Biology, Sri Lanka  
 28<sup>th</sup> September, 2018 at the Hector Kobbekaduwa Agrarian Research & Training Institute (HARTI)  
 114, Wijerama Mawatha, Colombo 07.

**Parallel Session 01- Fauna & Environment**

| Time    | Abstract Number | Title   |
|---------|-----------------|---|
| 1.30 pm | 1-01            | Comparison of the thermal sensitivities of two native anuran species.<br><i>H.A.D. Pramodya, H. Jayaweera and Mayuri R. Wijesinghe</i>  |
| 1.45 pm | 1-02            | Preliminary investigation of serum creatinine (SCr) and $\beta$ 2-microglobulin in farming and fishing communities in the dry zone, Sri Lanka: Implications on Chronic Kidney Disease of unknown etiology (CKDu).<br><i>W.A.K.G.Thakshila, E.M.D.V Ekanayake, E. P. S. Chandana, P. Mangala C. S De Silva</i> |
| 2.00 pm | 1-03            | Growth performances and survival of Siamese fighting fish, <i>Betta splendens</i> (Regan 1910) under three formulated feeds with different sources of animal protein.<br><i>M.D.R.Madduma and M. Hettiarachchi</i>  |
| 2.15 pm | 1-04            | Limnological characterization of <i>Anopheles stephensi</i> breeding sites in Mannar and Jaffna.<br><i>Arthiyam Sivasingham, Kokila Sivabalakrishnan, Tibutius T. P. Jayadas, Kalingarajah Karvannan, Sharanga Santhirasegaram, Meena Senthilnathanan, Umasuthan Srivigneswaran, Sinnathamby N. Surendran</i> |
| 2.30 pm | 1-05            | EGFR mutations in lung adenocarcinoma: development of an economical method for the detection of SNPs at exon 20 and exon 21.<br><i>Asitha Nuwan Premaratne, N. Jayekumaran, Inoka C. Perera</i>   |
| 2.45 pm | 1-06            | Impact of temperature increase attributed to climate change on survival, growth, morphometrics, and development of <i>Polypedates cruciger</i> (common hourglass tree frog).<br><i>W.A.M.T Weerathunga and R.P.G.K. Rajapaksa</i>   |
| 3.00 pm | 1-07            | Effects of five medicinal plant products on survival and progeny development of cowpea Bruchid, <i>Callosobruchus maculatus</i> (Fab.) infesting cowpea seeds in storage.<br><i>S.M.J.C.K.Jayasundara and G.A.S.M. Ganehiarachchi</i>   |
| 3.15 pm | 1-08            | Investigation of heavy metals in the maturation pond of Biyagama export processing zone.<br><i>P. Bandara, KM Nalin De Silva, D. Gunathillake, D.D. Wickramasinghe</i>  |
| 3.30 pm | 1-09            | SDS PAGE electrophoresis-based profiling of <i>Echiscarinatus</i> venom from Sri Lanka.<br><i>M.G.B Gunasena, A. Gnanathanan and P. V. Udagama</i>  |
| 3.45 pm | 1-10            | Shape variation in relation to predation and other habitat features in selected guppy ( <i>Poecilia reticulata</i> ) populations of Sri Lanka – a preliminary study.<br><i>R.G.D.R. Jayawikrama, K.B.S. Gunawickrama, B. Diaz-Pauli, Mikko Heino</i>  |
| T       | E               | A   |

|         |      |   |
|---------|------|---|
| 4.00 pm | 1-11 | Selected serum cytokines as potential biomarkers of Colorectal cancer.<br><u>Q.Peiris, S. Seneviratne, C. Fernando and P. Udagama</u>   |
| 4.15 pm | 1-12 | Is Catalase KatE activity a survival mechanism of <i>Leptospira interrogans</i> ?<br><u>N.P. Barupala, N. Fernando, Shiroma M. Hadunnettia and Sunil Premawansa</u>   |
| 4.45 pm | 1-13 | Evidence of different isolates of <i>Pratylenchus loosi</i> in Sri Lanka based on morphometric characterization.<br><u>P. G. D. S. Amarasena, K. M. Mohotti, D. M. De Costa and A. K.Prematunga</u>   |
| 5.00 pm | 1-14 | Unlike <i>Dillenia suffruticosa</i> (Griff. ex Hook.f. & Thomson) Martelli, daytime changes in flower colour of <i>Melastomata malabathricum</i> (L.) Smith maintain bee visitation throughout the day.<br><u>K.M.G.M.R. Kariyawasam, S.M.W. Ranwala, W.B. Yapa</u> |
| 5.15 pm | 1-15 | Assessment of capture efficiency of different sampling techniques in sampling dry cave fauna in Sri Lanka.<br><u>A.L.A.N.N. Perera, C.D. Dangalle and Wipula B. Yapa</u>  |

## Parallel Session 02 – Microbes & Biochemical

| Time    | Abstract Number | Title   |
|---------|-----------------|---|
| 1.30 pm | 2-01            | <i>In vitro</i> antifungal activity of <i>Cymbopogon citratus</i> (lemongrass) and <i>Syzygium aromaticum</i> (clove) oils on the Stem-end rot pathogen - <i>Lasiodiplodia theobromae</i> from mango.<br><i>G. C. M. Ekanayake, T. D. Kodituwakku, K. P. Abeywickrama</i> |
| 1.45 pm | 2-02            | Preliminary physiological characterization and genetic diversity assessment of the Rhizobial populations inhabiting <i>Gliricidia sepium</i> in selected locations of Ampara district, Sri Lanka.<br><i>P.W.I. Nawanjana, Sanath Rajapakse</i>                            |
| 2.00 pm | 2-03            | Partial purification and characterization of chitinases from pitcher fluid of <i>Nepenthes distillatoria</i> .<br><i>R.W.K.M. Senevirathna, V.N. Seneviratne, Sanath Rajapakse</i>  |
| 2.15 pm | 2-04            | Antifeedant activities of endophytic fungi of <i>Cyperus iria</i> collected from Matale District on <i>Plutella xylostella</i> (Diamond Back Moth) larvae.<br><i>J.M.N.M. Jayasundara, P.B. Ratnaweera, K.M.D.W.P. Nishantha and E.D. de Silva</i>                        |
| 2.30 pm | 2-05            | Comparative GC-MS identification of value added coconut oil<br><i>D.L.S.M. Jayaratne, W.A.D.D. Wasalamuni, T.D.C.M.K. Wijayasiriwardena</i>   |
| 2.45 pm | 2-06            | Cyto-genotoxicity and quality of sediments in Dandugan Oya, Sri Lanka.<br><i>L.G.Y.J.G. Wadasinghe and W.M.D.N. Wijeyaratne</i>   |
| 3.00 pm | 2-07            | Isolation and identification of probiotic yeast from goat milk.<br><i>S.A.C.L. Ranatunga, D.U. Rajawardana, H.A.D. Ruwandeepika</i>   |
| 3.15 pm | 2-08            | Evaluation of dye decolorization capability of laccase producing fungi.<br><i>M. M. P. Shashikala, P. Wijesinghe and R. N. Attanayake</i>   |
| 3.30 pm | 2-09            | Etiology and thiophanate methyl resistance of a <i>Fusarium</i> spp. causing wilt of beans in Badulla district, Sri Lanka.<br><i>M. D. I. H. Seneviratne, R.N. Attanayake</i>   |
| 3.45 pm | 2-10            | Spatial distribution of corticolous lichens with respect to ambient air quality in Kegalle urban council area.<br><i>M.D.N.R. Dayananda, M.D.M.D.W.M.M.K. Yatawara</i>  |
| T       | E               | A   |
| 4.00 pm | 2-11            | Comparative analysis of solvent-free microwave extraction and hydro distillation of essential oil from leaves of <i>Cinnamomum zeylanicum</i> Blume.<br><i>R.A.G.N. Ranatunga, H.D.S.M. Perera, V.S. Bandara and R. Samarasekera</i>                                      |
| 4.15 pm | 2-12            | <i>In vitro</i> pro-inflammatory enzyme inhibitory activities of <i>Artocarpus altilis</i> .<br><i>G.D. Liyanarachchi, R. Samarasekera R*, K.R.R. Mahanama, K.D.P. Hemalal</i>  |
| 4.45 pm | 2-13            | Biocontrol potential of endophytic fungi associated with weedy and wild rice species in Sri Lanka.<br><i>Y De Silva and K.G.S.U. Ariyawansa</i>   |
| 5.00 pm | 2-14            | An outbreak of rotting disease on <i>Dendrobium</i> in Sri Lanka.<br><i>W.G.H. Jayalath and R.N. Attanayake</i>   |
| 5.15 pm | 2-15            | Morphological and molecular characterization of cyanobacteria in Maha Oya hot springs in Sri Lanka.<br><i>D. G. S. N. Samarasinghe, R. P. Wanigatunge, H. M. Herath, D. N. Magana-Arachchi</i>  |

### Parallel Session 03- Flora & Environment

| Time    | Abstract Number | Title  |
|---------|-----------------|--|
| 1.30 pm | 3-01            | A comparative analysis of the total phenolic and flavonoid contents and some antioxidant activities of <i>Centella asiatica</i> (Centella), <i>Coccinia grandis</i> (Ivy Gourd) and <i>Costus speciosus</i> (Crepe Ginger) in Sri Lanka.<br><u>Y. A. Jayasinghe and S. Dias</u>      |
| 1.45 pm | 3-02            | A preservative holding solution to enhance vase life and postharvest quality of Rosa hybrid var. 'Red Sky' (Red rose) cut flowers<br><u>H. P. H. C. Premarathna and P. S. Saputhanthri</u>   |
| 2.00 pm | 3-03            | Floristic diversity of Kikiliyamana mountain in Sri Lanka.<br><u>S.M. Pawuluwage, A.T.N. De Silva, H.S Kathriarachchi and A.M.A.S. Attanayake</u>  |
| 2.15 pm | 3-04            | Vegetative and reproductive trait analysis to characterize pepper ( <i>Piper nigrum</i> L.) accessions from four districts in Sri Lanka.<br><u>W. G. N. A. Wimalarathna, T. D. Silva</u>   |
| 2.30 pm | 3-05            | Meteorological and Hydrological drought analysis in Attanagalu Oya basin.<br><u>Devanmini Halwatura</u>  |
| 2.45 pm | 3-06            | Non-host status of forest tree species for <i>Pratylenchus loosi</i> and <i>Radopholus similis</i> affecting tea in low grown areas in Sri Lanka.<br><u>K. M. Mohotti, A. K. Prematunga and P. G. D. S. Amarasena</u>  |
| 3.00 pm | 3-07            | Adverse effects of induced high temperature stress and water stress on tissue cultured banana plants (AAA Cv Cavendish)<br><u>K.I.C. Amarasinghe, C.S De Silva and L.K.R.R. Jayakody</u>   |
| 3.15 pm | 3-08            | Study on Chalcone synthase and Chalcone isomerase partial coding sequences of selected Dendrobium cultivars.<br><u>R. P. I. V. Somasiri, H. M. Herath, S. P. Senanayake</u>  |
| 3.30 pm | 3-09            | Efficacy of powdered mature leaves of Terminalia arjuna in reducing the nitrate - N and total hardness of the domestic well water in Kondavil area, Jaffna Peninsula, Sri Lanka.<br><u>M. Shanthamareen and W.M.D.N. Wijeyaratne</u>   |
| 3.45 pm | 3-10            | Propagation of <i>M. dioica</i> using <i>in vitro</i> embryo and cotyledon culture.<br><u>D.S. Vanrooyen, T. D. Silva</u>  |
| T       | E               | A  |
| 4.00 pm | 3-11            | Impact of <i>Bamboosa vulgaris</i> plantations on soil properties under Sri Lankan eco-climatic setting.<br><u>W.A.R.T.W. Bandara, S.A.N.M. Senanayake, K.J.R. Madhubhashini, J.K.P. Jayawardana, K.A.D.D. Chandimali</u>  |
| 4.15 pm | 3-12            | Plant DNA barcoding of rbcL gene for eight endemic plant species of Dipterocarpaceae family for authentication.<br><u>R.D.B. Lavensan, N.P.S.K. Niroshana, H.H.K. Achala, W.W.P. Rodrigo, W.T.G.S.L. Withana, A.A.M.A.S. Attanayake, J.K.R.R. Samaresekera, A.M.M.H. Athapaththu</u> |
| 4.45 pm | 3-13            | Floristic investigation of the Wawekele Forest, Seethawakapura, Avissawella.<br><u>Masha Nishadi Matharage and Sudheera M.W. Ranwala</u>   |
| 5.00 pm | 3-14            | Leaf functional characteristics vary among of weedy <i>Panicum</i> L. species.<br><u>Dinuka Rukshan Witharana and Sudheera M.W. Ranwala</u>  |
| 5.15 pm | 3-15            | Use of bio char for the improvement of soil nutrient status of Calcic Red Yellow Latasol soil in Jaffna district of Sri Lanka for onion cultivation<br><u>Theepa Rageendrathas and C.S.De Silva</u>  |

