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Theme

Using the Resilience of Nature to Face the Reality of Climate Change

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About the Institute of Biology, Sri Lanka

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 over 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 to a complex audience of scientists, policy makers and implementers. The annual sessions continue for the 40th time this year.

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PRESIDENTIAL ADDRESS

Facing the reality of climate change – a botanical perspective

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The present and projected changes in the global climate are principally due to anthropogenic influences on the environment. The global atmospheric carbon dioxide concentration [CO₂] has risen steadily since pre-industrial times. Starting from the beginning of atmospheric monitoring at Mauna Loa, Hawaii in 1958, the carbon dioxide concentration has risen from a mean of 320ppm to 410 ppm by September 2020. Projections by the Intergovernmental Panel on Climate Change (IPCC) place CO₂ concentrations at 550 ppm by the year 2050.

The coupling between atmospheric [CO₂] and temperature is well accepted and supported by physiochemical experiments and geochemical modelling. Global mean surface temperatures have risen rapidly over the last 100 years and we have had the warmest years on record in the recent past. The enhanced green-house effect is chiefly due to increases in the atmospheric concentration of radiation absorbing gases such as CO₂, methane, nitrogen oxide and halocarbons. Burning of fossil fuel, deforestation, emissions from industries and agriculture are the main contributors to this phenomenon.

According to the Clausius-Clapeyron relation, the water holding capacity of the atmosphere increases by about 7% for every 1°C rise in temperature. It is estimated that over the 20th century, atmospheric water vapour increased by about 5% over oceans, leading to increased precipitation intensity. In parallel, extreme weather events such as periods of high temperature, torrential rains and droughts of increased intensity and length can be expected and has already been observed in the tropics and subtropics.

Thus, an increase in atmospheric carbon dioxide concentration, higher temperatures and extreme weather events - these and their associated effects are the realities that we are facing due to climate change.

Plants being sessile organisms have a limited capacity to avoid fluctuating environmental parameters. In order to survive, they respond to these changes by modifying their growth and developmental patterns. Climate has always had a control over plant growth as is demonstrated by the geographic distribution of plant species, vegetation types and agricultural cropping patterns. Fluctuations in [CO₂] and temperature are two important environmental parameters that affect plants as they have a strong effect on their physiology and morphology. Therefore, undoubtably climate change will have a profound effect on the plant life on Earth.

So, how will plants respond to these climatic changes? This question has been an area of intense research over the past two decades, particularly due to the pivotal role played by plants in biogeochemical cycles, agriculture and natural ecosystems. Today, I would like to discuss this research area, highlighting salient studies along with some of my own work with co-workers at the University of Colombo and other institutes.

Plant responses to elevated carbon dioxide

This response can be seen at different levels in a plant and my discussion will focus on the fundamental levels of physiology and anatomy, with a focus on the plant leaf.

Stomata are microscopic pores present predominantly on the abaxial surface of leaves. They play a crucial role in linking the atmosphere and terrestrial biosphere through the inward diffusion of CO₂ during photosynthesis and outward diffusion of water vapour during transpiration. This exchange of gases is controlled in the short term through changes in stomatal aperture size, facilitated by the surrounding pair of guard cells. In fact, most of the activities of plants and their multiple interactions with the environment are communicated to the atmosphere through the stomatal aperture and the associated stomatal conductance. A decrease in stomatal conductance is one of the most consistent responses of plants to growth under elevated [CO₂]. In a growth chamber study conducted on tea plants (*Camellia sinensis* [L.]O. Kuntze) grown under elevated [CO₂] of 800ppm, a reduction in stomatal conductance of 25% was observed. This decrease in stomatal conductance did not show a parallel decrease in stomatal numbers and therefore suggests that tea has a stomatal aperture level control in response to elevated [CO₂].

The primary enzyme involved in fixing CO₂ in C₃ plants, RUBISCO is not saturated at the present [CO₂]. Therefore, elevated levels of CO₂ can be expected to increase the velocity of carboxylation. As CO₂ and O₂ are competitive substrates, a high [CO₂] also inhibits photosynthetic carbon oxidation or photorespiration. Together, these two factors can contribute to an increase in net photosynthetic rates. Studies utilizing climatic data and satellite observations of vegetation activity have shown increases in global terrestrial Net Primary Production. This increase was attributed to climate related changes such as increased temperatures, CO₂ fertilization and higher rainfall regimes. However, it must be noted that a down regulation of light-saturated photosynthesis frequently occurs at elevated [CO₂] with time. This acclimation can be due to factors such as nitrogen limitation, repression of photosynthetic genes by carbohydrates, the inability to utilize additional photosynthate and accelerated leaf senescence.

Photosynthetic capacity scales linearly with the biomass and nutrient (eg: nitrogen) investment in the leaf, making leaf anatomy the main driver of the light saturated rate of photosynthesis. Studies have shown that elevated CO₂ accelerates growth and development of plants by affecting cell division, elongation and differentiation within apical meristems. Enhanced leaf growth is frequently reported under elevated [CO₂] and may include increases in leaf area, thickness and dry weight. In the earlier mentioned study on tea plants grown

under elevated CO₂, increases in leaf area and leaf mass per unit were observed along with an over 50% increase in photosynthesis. The accumulation of total non-structural carbohydrates due to the enhanced photosynthesis is a likely cause for the observed anatomical effects. Furthermore, both palisade and spongy parenchyma thickness increased and cell expansion was indicated as the main contributor to this result.

Plant responses to elevated temperature

In general plants grow over a limited temperature range of above freezing to around 40°C, with maximum growth seen in a further restricted range. Therefore, most plants may modify their growth and development in order to survive the predicted increases in temperatures under climate change. While higher temperatures may stimulate growth and photosynthesis, temperature extremes may lead to reduction in growth. Studies suggest that lower levels of warming may benefit plants though the degree of warming that elicits a response from each species may vary along with the direction of the response.

Photosynthesis shows an optimum temperature which corresponds to the middle of the nonharmful range and then decreases rapidly as temperature increases above the thermal optimum. Temperature can affect photosynthetic processes by altering the pigment content, light-saturated photosynthetic rate, the apparent quantum yield and photoinhibition. At increasing temperatures the affinity of RUBISCO to CO_2 decreases and the solubility of CO_2 in water declines relative to O_2 leading to increased photorespiration. The sensitivity of photosynthesis to variation in stomatal conductance also tends to increase with increasing temperature. Several elevated temperature studies have also noted an increase in chlorophyll content, possibly due to enhancement of the photosynthetic light saturation point by increasing temperatures.

Respiration rate, maintenance costs and sink growth rate are often stimulated by nonstressful increases in temperature. Increased temperature can stimulate carbohydrate utilization and thereby limit the degree of carbon accumulation. Carbon reserves can be depleted under elevated temperature as photorespiration and mitochondrial respiration are stimulated. This may have a direct effect on crop productivity under future temperature regimes. Other aspects such as changes in dormancy of buds and growing seasons would have an impact on agriculture.

Increased temperature may also influence functional properties of leaves such as their size and thickness. Leaf area tends to increase under elevated temperature which may be due to stimulation of cell division and cell elongation rates by heat stress. This increase in leaf area may be beneficial to plants under elevated temperature as it provides a larger surface for evaporational cooling.

Overall the impact of temperature on growth and development depends on the species, growth stage as well as the temperature regime, necessitating a species centred approach in elevated temperature studies.

Water use efficiency and plant responses to drought

Drought conditions are predicted to become both frequent and severe with rising temperatures. Therefore, water use efficiency (WUE) of crops is a concern under future climate change scenarios which in turn will affect crop production and food security. While increases in WUE is often reported under elevated [CO₂], this maybe offset by increases in evapotranspiration due to higher temperatures, which can increase the total amount of water required for crop production.

Water use efficiency, defined as the ratio between the simultaneous rates of net photosynthesis and transpiration, is mediated by changes in photosynthesis or transpiration or due to a combination of both. Thus, plants can achieve higher WUE by reducing stomatal numbers or aperture size as well as by increasing carboxylation. This can be utilised in agriculture in order to select suitable cultivars in terms of yield as well as to identify drought tolerant cultivars. For instance, a study on drought tolerance of rice (*Oryza sativa* L) genotypes indicated that those that were able to achieve a greater reduction in stomatal size were able to minimize yield reductions under drought treatments. A study to identify water stress tolerant tea (*Camellia sinensis* [L.]O. Kuntze) cultivars found that leaf area, number of leaves as well as dry matter accumulation were instrumental in identifying such cultivars at the nursery stage.

Response of plants at a community level

Plants can be regarded as the most important group of organisms in shaping habitats due to their role in harnessing energy from the sun through photosynthesis and thereby significantly influencing total biodiversity survival and richness. Other than determining primary productivity they play a crucial role in ecosystem structure, soil composition and potential carbon sequestration. Terrestrial ecosystems play a crucial role in climate due to their ability to both release and absorb greenhouse gases and their role in the water cycle. The Working Group II of the IPCC has concluded with 'high confidence' that anthropogenic climate change will have a strong effect on plant life cycles and species' interactions. They further estimate that 20-30% of assessed biodiversity could be at risk of extinction if average global temperatures reach the projected levels by 2100.

In Sri Lanka, tropical rainforests are an important ecosystem which performs many of the ecological roles discussed above. In a currently progressing research project, variation in structural, functional properties and biodiversity of wet zone rain forests across an altitudinal gradient is being assessed in order to determine their vulnerability to long-term climate change. Altitudinal gradients and plants that grow across them provide an opportunity to conduct 'natural experiments', and in this study a convenient manner to detect possible impacts of environmental changes on natural forests. Through a holistic research approach this project aims to provide guidelines for future management of wet zone forests under climate change uncertainties.

In the face of climate change plant species will show diverse responses based on their inherent characteristics. Some species may adapt to the new environmental conditions while others may become extinct. In the latter case plant species from mountainous areas, restricted ranges, those susceptible to climate extremes, and those that have long regeneration times are particularly vulnerable. Other than adaptation, some species may respond to climate change through phenotypic plasticity. In phenotypic plasticity organisms with identical genes alter their gene expression and thereby exhibit different traits in reaction to environmental conditions. Many climate change studies use ecotypes of the model plant *Arabidopsis thaliana* to elucidate responses at genetic, structural and physiological levels. In a growth chamber based study, 18 different ecotypes of *A. thaliana* originating from a wide altitudinal range [50–1260 m above sea level) was grown at 400 and 800 ppm [CO₂]. They were found to show diverse responses to elevated CO₂ in their stomatal characteristics and water use efficiency. This study highlighted the diversity in the response of the germplasm of *A. thaliana* and the need to consider this diversity when using *A. thaliana* as a model plant.

Similarly, an altitude based study on stomatal characteristics of 20 tea cultivars growing across an altitudinal gradient (29-1382m above sea level) showed a significant diversity in their response to environmental variables such as temperature. This study further demonstrated the need to be conscious of the diversity of responses within a crop germplasm when designing experiments.

The challenge ...

In summary, I have attempted to briefly explain the possible impacts on plants due to climate change with a focus on both natural ecosystems and agricultural crops. As could be observed there are both positive and negative impacts. Also, much of the work has concentrated on a single parameter such as temperature or carbon dioxide concentration alone whereas in nature what we see is a collective effect. Furthermore, there are limitations in translating results of laboratory experiments to the natural communities or agricultural fields. Hence, there is a degree of uncertainty as climate change experiments are not always good analogues to mimic effects of natural climate change. Species and ecotype effects can further confound these results. In order to truly elucidate what we can expect in the future, it is necessary to pay attention to these deficiencies, particularly by studying the complex interactions. Furthermore, though nature is inherently resilient we must be mindful that plants are facing other human induced environmental stresses such as pollution, invasive species, habitat fragmentation and degradation along with climatic variability. These stresses could severely impede their natural ability to adapt to a changing environment.

Climate change can be regarded as one of the greatest research challenges faced by plant biologists, irrespective of whether they are working on natural populations or crops. The need of the hour is to strive for a better understanding of plant responses to multiple environmental change pressures. Ultimately, this is a collective responsibility shared by all of us in order to be better prepared to face the uncertainties of climate change.

FELICITATION OF EMERITUS PROFESSOR M J S WIJEYARATNE

Citation Presented by

Prof Nelum Deshappriya F. I. Biol., C. Biol. Senior Professor, Department of Botany, Faculty of Applied Sciences, University of Sri Jayewardenepura



It is an honour and a privilege for me to present Emeritus Professor Mudiyanselage Jayantha Sisirakumara Wijeyaratne, better known to us as Professor M J S Wijeyaratne, an eminent scientist and an able administrator and a renowned academic to this august gathering of scientists. His valuable, and far-reaching contribution towards the enhancement of academic and research standards in Sri Lanka does indeed warrant felicitation and acclaim. Paying tribute to Professor Wijeyaratne is of special significance and pride to the Institute of Biology as he was a past President of the Institute.

Professor Wijeyaratne was born on the 4th of August 1952 at Mulleriyawa and the foundation of his illustrious career was laid at the Government Boys school (presently known as Tikiri Kumara Vidyalaya), Ambatale and Sri Dharmaloka Vidyalaya, Kelaniya and later at Royal College, Colombo 7. The foundation was further reinforced through the knowledge, skills and training garnered at University of Sri Lanka, Vidyalankara Campus which is currently the University of Kelaniya where he recieved a BSc Honours degree in Zoology in 1976. Professor Wijeyaratne was the recipient of the prestigious FullBright Scholarship in 1977, which gave him the opportunity to pursue studies for an MSc degree in Fish Biology at the University of Michigan, USA. He was awarded a PhD in Fisheries Management from the University of Kelaniya in 1984.

Professor Wijeyaratne has rendered 42 years of invaluable service at the Department of Zoology, the present Department of Zoology and Environmental Management- of the University of Kelaniya, as a Lecturer, Senior Lecturer, Associate Professor, Professor and Senior Professor and Chair. Of these 42 years, 24 were served in the positions of Professor and Senior Professor. He has been the Chair of Zoology at the Kelaniya University for 20

years. In appreciation of his long years of distinguished and dedicated service to the university system of Sri Lanka, Professor Wijeyaratne was appointed a Professor Emeritus by the University of Kelaniya and continues to serve the Department of Zoology and Environmental Management, and our motherland in numerous ways. It should be emphasised that during his long and illustrious career, he has been a dedicated teacher, guide and mentor to many a student, as evidenced by the number of students in attendance at this memorable occasion. He has always inspired and motivated his students to reach great heights and watched their achievements with great pride. His superior prowess as an administrator calls to mind a quote by the great Albert Einstein, "Intellectuals solve problems, geniuses prevent them". Professor Wijeyaratne's superior ability to overcome and resolve challenging situations has proven that he is both.

Professor Jayantha Wijeyaratne is an erudite scholar and an academic of the highest calibre, which is exemplified by his being the author of over 105 research papers published in peer reviewed journals, 15 books and 99 abstracts. His work has been cited approximately 600 times. In recognition of his excellence in research, he was awarded The Best Young Scientist in Biology in 1989 by the Third World Academy of Science, Italy and the Natural Resources, Energy and Science Authority of Sri Lanka, and the prestigious Lifetime Award of the Most Outstanding Senior Researcher in Biology which is awarded by the Committee of Vice-Chancellors and Directors (CVCD) of Sri Lanka. The government of Sri Lanka also bestowed several Presidential Awards for Research in acknowledgement of the high standards of his research.

Based on his merit and competencies, Professor Wijeyaratne has been appointed to many positions of great eminence. He was the Dean of the Faculty of Science of the University of Kelaniya from 1995 up to 2001 and Vice-Chancellor of the University of Kelaniya during the period 2005-2008. He is the first alumnus of the University of Kelaniya to be appointed to both these prestigious positions. He proved to be a true leader and upheld exemplary academic and professional standards of the institution during his tenure.

Professor Wijeyaratne is the Founder Chairman of the Research Council of the University of Kelaniya and held the position from 2014 upto 2017 and introduced many an initiative to encourage and support researchers and to enhance the research standards at the University. He also has served as the Chief Student Counsellor and as the Director of the Staff Development Centre of the University of Kelaniya.

Professor Wijeyaratne's contribution towards the betterment of the higher education of Sri Lanka include his services as the Chairman of the CVCD in 2008, as Deputy Project Director and Consultant of Sri Lanka Qualification Framework and Alternative Higher Education of the World Bank funded HETC (Higher Education for the Twenty First Century Project) during the period 2009-2013. He has also served as an Elected member of several Standing Committees and other committees of the University Grants Commission. Professor Wijeyaratne has held many prestigious positions at the national level, including Chairman, National Science and Technology Commission of Sri Lanka (2016 -2018), Member of the Governing Boards of Sri Lanka Standards Institution, Arthur C Clarke Institute of Modern Technology, National Institute of Fisheries and Nautical Engineering, National Aquatic Resources Research and Development Agency, National Science Foundation, National Institute of Fundamental Studies, Industrial Technology Institute Provincial Environmental Authority of the North-Western Province, Chairman, and Research Advisory Board of the National Science Foundation, Sri Lanka (2013 to date) and Chairman of several Expert Groups of the National Science and Technology Commission, National Education Commission, National Aquatic Resources Agency and National Science Foundation. Professor Wijeyaratne has served as a resource person in more than 100 continuous professional development programmes on quality assurance in higher education and as a Member of several Advisory Boards of the National Institute of Education and carried out more than 30 Quality Assurance Reviews in universities in Sri Lanka and Bangladesh. He participated in the exercise of developing the Sri Lanka Qualification Framework, Zoology Benchmark Statements for undergraduate degrees. Professor Wijeyaratne has served as an Environmental Consultant for seventy eight development projects both in Sri Lanka and overseas and has been a Reviewer of research papers submitted to 15 local and foreign scientific journals and 20 research conferences. He has served as the Editor in Chief or member of the Editorial Board of seven Research Journals.

Professor Wijeyaratne is a member of nine professional associations and has contributed actively towards the advancement of science by holding numerous positions in national level scientific and professional bodies. He held the prestigious position of General President of the Sri Lanka Association for the Advancement of Science (SLAAS) in 2009 and has been the Chairman of several statutory committees of SLAAS. He also was the Founder President of Sri Lanka Association for Fisheries and Aquatic Resources and was the General Secretary of the National Academy of Sciences, Sri Lanka. Furthermore, he was the Founder President of the Alumni Association of the Science Faculty of the University of Kelaniya, Sri Lanka and a Council Member of the National Academy of Sciences.

Professor Wijeyaratne is no stranger to the Institute of Biology and his contribution towards the IOB SL in many capacities deserves special commendation. He has held the prestigious position of President of IOBSL in 2004 and it is during his tenure that the presentation of research papers at the Annual Sessions of the Institute of Biology was initiated. He is the Founder Chairman of the Ethics Review Committee of the Institute of Biology (from its inception to date). He has been a member of the council of IOBSL numerous times and the Secretary, International Relations in 2014. His contribution towards the Biology Olympiad as setter and chief examiner of the National Biology Olympiad competition since its inception to date, as well as a Jury Member of the International Biology Olympiad since 2009 to date has been indispensable. Professor Wijeyaratne is also the Founder Editor in Chief of the Sri Lankan Journal of Biology published by the Institute of Biology.

He has fulfilled to the utmost, the roles of caring husband to Mrs Senani Wijeyaratne and loving and proud father of Pubudu and Dimuthu, who herself is a professor at the University of Kelaniya, and is a devoted grandfather of four grandsons.

Whilst appreciating Professor Wijeyaratne's scientific excellence and commendable service to the nation, we should also extol his professional and personal integrity which sets an example to future generations of scientists in Sri Lanka. Sir, we hope that you will continue to serve our motherland for many more years and we wish you good health and good fortune.

Distinguished members of IOB and colleagues, it is very fitting that the Institute of Biology SL recognizes a great scholar, an exemplary administrator, a dedicated researcher in Biology, and in appreciation of his long and devoted services towards the advancement of science, I am proud and honoured to present to you, Professor MJS Wijeyaratne for felicitation by the Institute of Biology Sri Lanka.

ABSTRACTS

Parallel Session - 1 (Zoological Sciences)

Larval Cannibalism among conspecifics of Fall Armyworm, *Spodoptera frugiperda* (Lepidoptera, Noctuidea) in Sri Lanka

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Cannibalism is a prevalent phenomenon with an ecological and evolutionary significance, seen in many non-carnivorous larval Lepidopterans. This intraspecific predation between the cannibal and the victim occur in conditions of low food quality and availability, confined space, large size disparity and high population density as well as due to significant changes in temperature and humidity of its living environment. Cannibalistic behaviour has been reported for larval Fall Armyworm (Spodoptera frugiperda) (FAW); an economically important pest worldwide. Therefore, 73 laboratory trials with not less than 5 replicates for each stage were conducted to determine cannibalistic behaviour among conspecifics of 1-6 FAW instar stages. Each laboratory reared larval stage was provided with their conspecifics along with sufficient food. Direct observations were carried out to record the missing larvae in 24 hours period and missing ones were presumed as cannibalized. Non-consumed potential victims were removed. Under laboratory conditions, larvae displayed cannibalism in different proportions even when adequate food was present. No cannibalism was observed in 1st and 2nd instar stages and the highest mean cannibalism proportion was recorded among 5th larval instars (0.22 \pm 0.05). An increasing trend from 3rd (0.16 \pm 0.04) to 5th instar stages was evident in significance to the higher energetic requirement in later stages. But the trend dropped at the 6^{th} instar stage (0.15 ± 0.10) which can be attributed to decreased feeding rate of larvae upon transition to pre-pupal stage. This study concludes the general cannibalistic behaviour of FAW larvae under laboratory conditions. Although, cannibalism is seemed as a costly process in terms of fitness of adult females who lay eggs in large clutch size, this can have a considerable impact on reducing the larval numbers in natural populations if viewed as a self-regulating measure of populations. Therefore, further studies on FAW larval cannibalism under field conditions are much required.

Keywords: Cannibalism, Spodoptera frugiperda, Fall Armyworm, Conspecifics, Sri Lanka

Diversity, distributional and habitat type variations between Collyridini and Cicindelini (Carabidae, Cicindelinae) in Sri Lanka

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Tiger beetles (Carabidae, Cicindelinae) belong to six tribes of which only two are found in Sri Lanka. The tribe Collyridini houses arboreal tiger beetles while the tribe Cicindelini houses ground-dwelling tiger beetles. Beetles of these two tribes show morphological, ecological and behavioural similarities and differences that have not been compared previously. The present abstract addresses these differences using information on ground dwelling tiger beetles investigated from the year 2002 to 2017 and arboreal tiger beetles studied from 2017 to 2020. Investigations for tiger beetles of both tribes were conducted in 597 locations of all the bioclimatic zones of the country, in all provinces and districts, and each location was surveyed twice for the presence of species. The species were surveyed mostly using visual encounter survey method (VES), and light traps were also used. These investigations recorded 14 species from tribe Cicindelini from 164 locations and eight species from tribe Collyridini from 22 locations of the island. Species of both tribes have large eyes that together with the head are wider than the thorax, an elongate body with a conspicuous pronotum, long sickle-shaped mandibles, thin and long cursorial legs and a grub-like larva. However, arboreal tiger beetles are larger than ground dwelling tiger beetles and have a flask-shaped slender and elongate body. Arboreal tiger beetles are uniformly coloured in black, dark blue or violet while ground dwelling tiger beetles are copper green, metallic brown, reddish brown or bronze in colour and have elytral patterns. When considering the behavior, Cicindelini are fast runners while Collyridini are slow walkers. Further, when considering the habitats of the species of the two tribes, Cicindelini prefer locations near water that are sparsely vegetated such as beaches, riverbanks and edge of reservoirs while Collyridini prefer vegetated habitats such as forests and agro-ecosystems. Cicindelini occur on the ground as large communities of single or multiple species while Collyridini occupy tree trunks and branches and exist in low numbers in a particular location. Studies on the morphological, distributional, habitat and behavioural differences of closely related insects are important in implementing the most suitable conservation measures for the species.

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Fish catch data of Family Mobulidae (Class Elasmobranches) in Negombo fishery harbor: implication for management

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Family Mobulidae (Rays) is one of the important families under Class Elasmobranches representing both manta and devil rays. Being food fish, there is a good international market for their gill plates and cartilage as soup filler. While some countries landed them as target fishery, some other countries land them as by-catch of tuna and billfish fishery. These mobulids are low numbers due to their low fecundity, long gestation period and late at maturity. Therefore, they have been categorized as endangered species (CITES appendix II and appendix I and II of CMS). The Present study was conducted twice a month from April to November in 2019, in order to provide some reliable information on landed mobulids. Biological (disc length, disc width, sex, etc.) and fisheries data from landed manta and mobula by examining the species were collected and boat skippers too were interviewed. The results showed significant differences between size of the captured mobulids in both single and multi-day vessels (mean: 8.60, SD: 10.05, P<0.05). The Present study revealed that among the species landed, high juvenile percentage (55%) was observed in *M. birostris*, high sub-adult percentage (46%) represented by *M. tarapacana* and high adult captured percentage (50%) for *M. kuhlii*. Most of the mobulids were entangled into gillnet (60%) where mesh size ranged from 13.6-16.0 cm. Majority of *M. birostris* observed during the present study was in juvenile stage indicating that nursery ground might be located close to the fishing ground. The Present study provides current status of the manta and devil rays caught in the Indian Ocean and also the most abundant species and their life stages with disc lengths and widths around Sri Lankan coastal zone. Therefore, these data might be helpful for policy-makers to implementing regulations and conservation measures on mobulid fishery in Sri Lanka.

Keywords: Conservation, Elasmobranches, Fishery, Mobulidae rays

Feeding ecology of Sri Lankan blue swimming crab (*Portunus pelagicus*) caught in Negombo coastal waters

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Blue swimming crab (*Portunus pelagicus*) is a tropical, marine crustacean. Feeding ecology reveals its function in the ecosystem, trophic interactions with other organisms and its nutritional requirements. This study was focused on the feeding habits of the crab in relation to their sex and size caught in Negombo coastal waters from April to October in 2019. Out of two hundred fifty (250) crab samples collected from Negombo fish landing centre, 48.8% were females and 51.2 % were males showing the sex ratio of 1:1.05. Carapace width and weight of crabs ranged from 3.06 cm to 15.8 cm and 22.45 g to 334.60 g respectively. Stomach contents were mollusc remains (55.37%), arthropod remains (20.66%), fish remains (10.74%), synthetic items (23.97%), sand and debris (36.36%), algae (4.13%) and miscellaneous (35.54%). Therefore, the results of present study indicate that blue swimming crabs are carnivores and scavengers feeding on a variety of food items. Two-way analysis of variance showed that there was no significant difference between food items or among size classes in frequency of occurrence (p>0.05), percentage points (p>0.05) and index of relative importance (IRI) (p>0.05). There was no significant difference in gastro-somatic index between males and females (P>0.05) as given by two sample T test. Identification of synthetic items in stomachs gives early alerts that the area is getting polluted and suitable conservation programmes should be enforced to conserve the marine environment. Therefore, present study provides baseline information for successful culture and responsible fishery of the crab.

Keywords: Blue swimming crab, Coastal, feeding, Fishery, Index of relative importance

Effect of bioaugmentation with *Bacillus subtilis* on growth, survival and rearing water quality of selected species of Family Poeciliidae

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Use of feed probiotics in ornamental fish culture has proven its beneficial effects on health and reproductive performance of cultured fish. Nevertheless, the studies of the effect of bioaugmentation in the rearing water on the growth of ornamental fishes and the water quality are still limited. The present study was planned to assess the effect of commercially available liquid bioaugmenter, Bacillus subtilis on the growth and survival of swordtail (Xiphophorus hellerii) and platy fish (Xiphophorus spp.) and the rearing water quality. Experiment included the determination of CFU/mL of *B. subtilis*, determination of weight and length gains, specific growth rates, condition factors and survival rates of fishes and quality of rearing water (pH, DO and NH₃) at two stocking densities (3 fish/L of water and 10 fish/L of water) and at two concentrations of *B. subtilis* (0.05 mL/L of water and 0.1 mL/L of water) respectively for 30 days (n=3). The results revealed 2.49 x 109 CFU per mL of liquid bioaugmenter. The results further revealed that bioaugmentation significantly increased ($p \le p$ 0.05; Students' t-test) the length and weight gains, the condition factors and the survival rates of fishes in tanks with stocking density of 10 fish/L of water, when compared to respective controls. In addition, these parameters were significantly increased when increasing the concentration of *B. subtilis*. Nevertheless, the selected water quality parameters did not show significant differences ($p \ge 0.05$) at two concentrations of *B. subtilis*. The present study therefore, concludes that the bioaugmentation contributed to increase the growth and survival rate of selected fish species but, it has no effect on water quality for selected study conditions.

Keywords: *Bacillus subtilis,* Bioaugmentation, Family Poeciliidae, Growth, Survival, Water quality

Study of urban wayside bird assemblages in the City of Colombo with special emphasis on environmental and social impacts of roadside trees

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The expansion of the urban cities associated with transformation of habitats and landscapes impose a major impact on urban wildlife. Many of these impacts are detrimental; however, the functional network of urban green islets results in suitable bird friendly habitats. Current study aimed to investigate the ecological services of roadside trees provisioned for urban bird life in two selected wayside stretches namely Thurstan Road (TR) and the Reid Avenue (RA) amidst the centre of the City of Colombo. Avifaunal richness, diversity, and composition were determined using line transect method and opportunistic surveys from 2017 to 2019. Margalef Species Richness Index (MI), Shannon-Weiner Diversity Index (SI), and Jaccard index (JI) were calculated to describe species richness, diversity and composition respectively. The tree cover in each road was quantified using a remote sensing method (GIS). Ecological services on birds offered by roadside trees were recorded. Structured interview through 100 in-person site-based surveys was conducted to evaluate public attitude towards the environmental and social impacts of roadside trees. Urban wayside avifauna represented 20 families, 22 genera and 24 species including two endemic species, *Psilopogon rubricapillus* (Crimson-fronted Barbet) and *Dinopium psarodes* (Red-backed Flameback). A higher species richness and diversity were recorded for TR (MI = 3.9 and SI= 0.7) than that of RA (MI = 1.7 and SI = 0.5). Species composition of two waysides was significantly distinct (II = 33.3%) while they shared only eight common species. The greater tree cover (TR 21905.43 m²> RA 18835.85 m²) and habitat continuity that resulted in a better green expanse may have made TR more appealing for birds upon providing a variety of microhabitats and ecological services that facilitate their feeding, breeding, anti-predatory and other behaviors. The public attitude test revealed that the majority of the respondents (82%) have a positive appraisal as they identified wayside trees as a beneficial entity in a city that has amenity, biodiversity, comfort and utilitarian values. The current study suggests a need for a conservation plan for urban wayside habitats.

Keywords: Road side trees, City of Colombo, Urban bird assemblages, Diversity, Richness

Morphometric characterization of buffalo skulls in Sri Lanka

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The globally and nationally threatened wild buffalo (*Bubalus arnee*) is a large bovine species native to the Indian Subcontinent and Southeast Asia. Its origin, taxonomy and present occurrence in Sri Lanka is still unclear. The present study characterizes buffaloes using the morphometry of skulls from museums, private collections and protected areas. Morphometric analysis was based on Principle Component Analyses (PCA) of 25 standard cranial and horn measurements and three ratios based on these measurements of 30 skulls. This study differs from the two previous investigations on morphometrics on *B. arnee* skulls (Groves 1996 and Groves and Jayawardene 2009) as a greater number of measurements and skulls are used, and the skulls include those collected from PAs of Sri Lanka as well. Documented information from three Asian mainland sub species of the wild buffalo (*B.a.arnee* from Central and Upper India, *B.a.fulvus* from Assam and *B.a.theerapati* from Thailand and Cambodia) were also included in the analyses. The generated PCA plot showed considerable scattering with no clear clustering. Nonetheless, a large majority of the local skulls (both from the wild and museums/private collections) were placed in close proximity to those of the Asian mainland suggesting that these might belong to *B. arnee*. The skulls both from collections and from PAs placed at the extremities most likely belong to *B. bubalis* as the biometric measurements falls within the range documented for *B.bubalis* in Turkey. The eigen values suggest that the greatest skull length (GSL), horn span (HS) and the ratios; maxillary tooth row length (MT): greatest skull length and horn span: greatest skull length, contributed most to the deviation between the skulls. The local *B. arnee* measurements are closest to *B. a. theerapati* from Thailand and Cambodia. The presence of individuals suspected to be those of *B. arnee* in the protected areas of the country highlights the critical necessity to safeguard these populations from possible mixing with feral herds.

Keywords: Bovine, B. arnee, Taxonomy, Horn measurements, Skull measurements

Seasonal variations in herd characteristics of elephants utilizing the Minneriya Tank

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The Minneriya National Park (MNP) has gained global recognition as a site that supports the largest gathering of Asian elephants. This gathering typically occurs at the Minneriya Tank during the peak of the dry season when ample fresh grass is available. The present study investigates the seasonal variations in herd characteristics of elephants utilizing the Minneriya Tank. The study was conducted over 12 months from February 2019 to January 2020. Observations were conducted at Rambawila and Thalgasduwa (two vantage points that provide a broad view of the Minneriya Tank) on two consecutive days each month from 1400 to 1700 h. Total elephant counts and herd characteristics i.e. herd size, and age and sex composition, were noted in a maximum of three focal groups which could be monitored simultaneously on each of the two sampling days. Monthly variation in grass biomass at the same approximate locations around the tank was also assessed to examine its impacts on herd size. The mean herd size during the study ranged from a minimum of 9.2 in July to a maximum of 20.5 in May. There were no identifiable seasonal trends in herd size, contrasting with previous observations by others that elephants form larger herds in the peak dry season when fresh grass is most abundant. Although there was a rapid increase in grass biomass with the onset of the dry season in the present study, there was no concurrent increase in herd size (Regression analysis F=0.19, P=0.66, R²=1.91%). This is very likely due to the erratic fluctuation in the total number of elephants utilizing the tank throughout the year with no seasonality being evident. The herds were dominated by adult females (over 25 %) across most months with the exception of four months when juveniles comprised a greater proportion. The data did not suggest seasonality in reproduction. Solitary adult males were seen to join the herd periodically, many of them being in musth. The mean adult sex ratio (male: female) was 1:4.6 during the study period which was different from previously recorded values for the same site. Some of the observed trends in the present study with respect to the seasonal variation in herd size and characteristics deviated from those reported previously for Minneriya and for other dry zone tanks. Further investigations are therefore necessary to understand the possible underlying factors (e.g. food and water availability) that influence herd size and composition of elephants utilizing the grasslands of the Minneriya Tank.

Keywords: Elephant herd, Grass biomass, Protected areas, Seasonal tank, Age and sex composition

Diversity of nest-dwelling ectoparasites of selected captive breeding birds of the National Zoological Gardens of Sri Lanka

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The National Zoological Gardens of Sri Lanka (NZG) plays a vital role in ex-situ conservation for many bird species from different geographical areas. NZG provides a conservation platform by providing nesting sites for captive breeding of birds. Nests act as incubators, provide protection to eggs and nestlings while inadvertently being miniature ecosystems that harbor nest dwelling ectoparasites. This pioneer study investigated the ectoparasitic diversity associated with nests of selected captive breeding birds comprised of native and exotic bird species: Eurasian Spotted dove (Spilopelia chinensis), Collared dove (Streptopelia decaocto), Diamond dove (Geopelia cuneate), Poultry pigeon (Columba livia), African lovebird (Agapornis sp.) and Budgerigar (Melopsittacus undulates). Ectoparasites were extracted from the nests using a portable electric mini-vacuum cleaner. From 50 nest samples, 350 ectoparasites including 346 mites and 4 lice were collected. It was revealed that a high diversity of nest dwelling mite species in captive breeding birds represented by ten (10) morphologically different types. Identification and authentication of specimens were done by the Canadian National Collection of Insects, Arachnids and Nematodes. Out of them 90.75% of mites represented Order Mesostigmata and the rest (9.25%) belonged to order Sarcoptiformes. Under Order Mesostigmata two species of mites were identified (Ornythonyssus bursa and O. sylvarium) that belongs to family Macronyssidae. Order Sarcoptiformes was represented by two families: Glycyphagidae and Oribatulidae. One species of lice *Columbicola columbae* was found in the nests of Collared dove and Poultry pigeon. The highest nest ectopatasitic infestation (25.80%) was observed in Budgerigar nests and the lowest infestation (9.10%) was observed in African lovebird nests. These findings form a baseline data set for further research on nest-dwelling ectoparasites of birds, focusing on ex-situ conservation of avifauna in Sri Lanka.

Keywords: Bird nests, Ectoparasites, Captive breeding, Zoological Gardens, Ex-situ conservation of birds

Study of short term variations of body condition of elephants in Udawalawe National Park

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Deteriorated body conditions of elephants inhabiting Udawalawe National Park (UWNP) has been a recent concern. Main aim of this study was to investigate short-term variations of body condition of elephants in UWNP. Elephant body condition was hypothesized to vary in a periodic manner. Also, it was hypothesized that adult male elephants show a superior body condition than female elephants occupying herds. Elephant body condition was evaluated using Body Condition Score (BCS) defined by Wemmer et al (2006) with slight modifications. A vehicle-based survey was conducted to obtain BCS, age and gender of elephants by direct observations by a single individual from August to November 2019. A total of 509 BCS were recorded. Monthly average rainfall data of Udawalawe were obtained from Department of Meteorology. BCS of the population depicted a normal distribution (Mean±SD:7.6±2.6). BCS of male elephants (9.1 ± 2.7) was significantly higher (t-test: p<0.05) than that of females (7.2±2.7). BCS of male adult elephants (9.6±2.5) was significantly higher (t- Test; P<0.05) than that of sub-adult (7.9±2.7) elephants. BCS of elephants observed in September (6.7±2.3) was significantly lower than August (7.7±2.7), October (7.8±2.2) and November (8.1±2.9) (One-way ANOVA: p<0.05). Further, female elephants have shown a significantly low BCS during September (6.1±2.1) than August (7.2±2.8), October (7.4±2.1) and November (7.6±2.1) (One-way ANOVA: p<0.05). Although a similar trend was observed in the male BCS, there was no significant difference between the monthly observed BCS. The cross correlation between time series of BCS and monthly rainfall indicated a high positive correlation (CCF=0.85) of body condition to the monthly mean rainfall two months earlier. Solitary, adult male elephants indicating a better BCS over herd occupying females could be attributed to large ranging that facilitate approaching better food resources. Lower BCS during September could be related to resource limitation affecting elephant body fat reserves antecedent to prior dry climatic conditions. Habitat enrichment of the UWNP is recommended to sustain body condition of herd occupying elephants.

Keywords: Elephants, Body condition, Udawalawe National Park, Sri Lanka

Relationship between the body condition and the gastrointestinal parasitic prevalence of wild elephants in Udawalawe National Park

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Gastrointestinal parasites in wild elephants could be used as an indicator of their condition and risk detection. The study was conducted with the objective of identifying the relationship between body condition and gastrointestinal parasite load of wild elephants in Udawalawe National Park (UWNP). Prevalence of gastrointestinal parasites were studied by microscopic analysis of freshly obtained dung samples from 26 elephants inhabiting the UWNP. Body condition, age group and gender of focal elephants were recorded before their dung samples were collected in the field. Body condition of elephants was evaluated using Body Condition Score (BCS) defined by Wemmer et al (2006) with slight modifications. Dung boluses were collected from freshly emitted dung piles, stored at 4°C in an airtight container and transported for parasitological analysis. Feacal samples were analyzed qualitatively and quantitatively in the laboratory using direct saline and Iodine mounts, Modified Salt Floatation technique and Formalin-Ether concentration technique. From the sampled elephants, 10 were adult males, while 16 were adult females. Their BCS ranged from 3 to the maximum possible score 14 with a mean BCS 8.15±2.98. Identified parasitic forms belonged to six groups that were eggs and rhabditiform larvae of *Strongyloides* sp. and hookworm, and eggs of Trichostrongyle sp., Ascaris sp., Fasciola sp. and trematode. Spearman rho coefficient indicated that there was a significant negative correlation (r = -0.755, p < 0.05) between the BCS and abundance of gastro-intestinal parasites. Abundance of gastrointestinal parasites did not show a significant difference between male and female elephants (t test, p = 0.452). Shannon-Weiner diversity index of the detected parasites in dung was 1.16 with an Evenness of 0.65 where Strongyloides spp. was found dominant. The study revealed that the gastrointestinal parasitic load in elephants of UWNP has a negative relationship with their body condition.

Keywords: Elephants, Gastrointestinal parasites, Elephant body condition, Sri Lanka, Udawalawe National Park

Profiling harmful diatoms and dinoflagellates in selected fishery harbours along the Southern coast of Sri Lanka with risk mapping

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Climate change is a timely discussed topic which is predicted to change many environmental conditions that could affect the natural properties of marine waters worldwide. Changes in the physico- chemical properties in the environment could favour the growth of harmful algal blooms (HAB) and set off numerous negative effects on the economy, environment and wellbeing of humans and marine species. Sri Lanka, being an island has a potential threat of HAB development. This study was conducted to investigate the occurrence of potentially harmful diatoms and dinoflagellates. The sampling was done in Ambalangoda, Hikkaduwa, Dodanduwa, Mirissa, Tangalle fishery harbours of Southern coastal waters, Sri Lanka from June to December 2019. Phytoplankton samples were collected using 55 µm plankton net and fixed with 1% of acidified Lugol's solution following natural sedimentation. Identification and enumeration of phytoplankton was done under the light microscope using standard microalgae identification keys. Physicochemical parameters of collected water samples were analysed following standard methods. During the study, 8 species from class Bacillariophyceae, 8 species from class Coscinodiscophyceae, 11 species from Mediophyceae and 10 species from class Dinophyceae were found. There have been records of 8 potentially harmful species amongst the identified diatoms namely, Asterionellopsis glacialis, Chaetoceros curvisetus, Chaetoceros lorenzianus, Guinardia flaccida, Leptocylindrus minimus, Nitzschia sp., Proboscia alata, Pseudo-nitzschia sp.. Most of these species are considered to be harmful in mass proliferations. There were 3 potentially harmful dinoflagellate species namely, Ceratium fusus, Ceratium furca, Dinophysis caudata. The risk maps generated depict that coastal area around Tangalle and Mirissa fishery harbours were at higher risk compared to the other sampling areas. Hence, special legislations are needed to control the pollution level and the algal profile is needed to be investigated in the coastal areas to avoid adverse impacts of potential HAB threat.

Keywords: Climate change, Harmful algal blooms, Dinoflagellates, Diatoms, Risk maps

PROCEEDINGS OF THE 40th ANNUAL SESSIONS OF THE INSTITUTE OF BIOLOGY

A future high altitude refugium for the white-eyes (genus *Zosterops*) of Sri Lanka is predicted as a result of dwindling climatic suitability

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Climate change leads to species loss and conservation strategies can be effectively targeted by modelling species distributions using climatic niche models (CNM). MaxEnt (Maximum Entropy) is a widely used powerful approach for such modelling using presence-only occurrence data. The two sympatric white-eye species in Sri Lanka are the Ceylon white-eye (CWE), broadly known to be distributed between 1000-2500m of elevation and goes as low as 600m in the Sinharaja rain forest, and the Oriental white-eye (OWE), predominantly inhabiting the lowlands but also ascending up to about 1800m elevation. Broad aim of this study was to model, past (mid Holocene; about 6000 years ago), current and future (2070) climatic niches of these two species and responsible drivers using MaxEnt. It was performed through data collection (from GBIF and Worldclim web resources) and preparation (using QGIS) variable selection (using Pearson's correlation test), model prediction and evaluation (based on the Area under the Receiving Operator Curve (AUC), past and future climatic projections, and estimation and comparison of climatic niche overlap (by calculating the Schoener's D and Hellinger distance). CWE's climatic niche is predominantly driven by the annual mean temperature and is comparable to their known distribution range which may narrow down in future. The wet zone provides a highly suitable habitat for OWE however, in contrast to the known distribution range, the MaxEnt model shows the dry zone to be unsuitable. Mean temperature of the warmest quarter predominantly drives their climatic niche which shifts up the higher elevation in future with a great overlap with the CWE's. This may lead to higher competition between the two species and may result in the extinction of the weaker species. This study also predicts the central highlands of Sri Lanka to become a refugium for the white-eyes in future, which may be true for other similar range restricted montane birds in Sri Lanka.

Keywords: *Zosterops*, White-eye, Climatic niche model, MaxEnt, Climate change, Biodiversity loss

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Abstract number 1-14

Reproductive and development performances of laboratory-reared *Aedes aegypti* on ABO and Rh blood groups

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Aedes aegypti is the primary dengue vector in Sri Lanka and it causes massive public health problems throughout the island. Ae. aegypti is an anthropophilic mosquito and preferential feeding on host blood types can be seen. The present study was carried out to investigate the reproductive and development performances of Ae. aegypti on ABO and Rh blood groups. The study will be served as additional support to the vector surveillances, while providing a comprehensive description of vector attraction and living history performances. Except for obtaining dengue infection status (Dengue Fever and Dengue Hemorrhagic Fever) and patient's blood group from the selected hospitals in the Western province, all the other experiments were conducted using laboratory-reared Ae. aegypti mosquitoes. Female Ae. aegypti were exposed to eight blood groups (A+, A-, B+, B-, AB+, AB-, O+, O-) at once in separate membrane feeders to investigate the landing and feeding preferences. After feeding, the blood group was determined by the direct agglutination test. Oviposition success was determined by the number of eggs laid at the first gonotrophic cycle. Adult and progeny longevity, larval and pupal duration, larval mortality were examined. Fecundity was determined by the right-wing length. In 2017 and 2018 years, both Dengue Fever and Dengue Hemorrhagic Fever patients showed variation with blood groups (P<0.05). "O" positive blood group had the highest number of patients in both infection statuses. The highest feeding preference was observed for the blood group O- (P<0.05). The mean landing number (14.37±9.33, 16.33±7.17, 3.33±0.66, 8.00±7.51, 7.33±4.84, 6.67±5.67, 16.33±2.19, 20.67±3.18 respectively) was not significantly different among ABO and Rh blood groups (P>0.05). Human ABO and Rh blood types did not affect on the life history parameters such as oviposition, adult longevity, progeny longevity, larval duration, pupal duration, larval mortality, and fecundity (P>0.05). Further studies are needed to confirm the feeding preference of mosquitoes as observed in the present study.

Keywords: Aedes aegypti, ABO and Rh blood groups, Reproductive and development performances

Intensity of occurrence of filariasis parasite species in adult mosquitoes and vector mosquito breeding habitats in selected areas in Gampaha district, Sri Lanka

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Filariasis is a parasitic disease caused by an infection of roundworms (Super Family Filarioidea; Phylum Nematoda) and spread by blood-feeding dipteran vectors. Lymphatic bancroftian filariasis (LF) is considered in its pre-eradication stage in Sri Lanka. A study was conducted to determine the filariasis parasite among vector mosquitoes in Kelaniya, Ragama, Seeduwa and Dompe Medical Officer of Health (MOH) areas during May to December 2019. Mosquitoes were captured for two hours per day; in the morning from 6.00 am to 7.00 am and evening from 8.00 pm to 9 pm, weekly using a battery-operated aspirator. Vector mosquito species abundance was determined in potential breeding habitats. Female adult mosquitoes (n=11834) belong to four genera, namely Culex, Armigerus, Mansonia and Aedes were examined for microfilaria determination. The results showed low level of microfilariae persistent only from Kelaniya MOH area where Wuchereria bancrofti (0.0613 %) and Dirofilaria (0.0674 %) species were recorded from Culex quinquefasciatus and Armigerus subalbatus mosquito species respectively. Mosquito larvae sampling was conducted during two weeks interval with three attempts for each locality in nine different breeding habitats namely blocked drains, polluted drains, blocked canals, large polluted water bodies, stagnant water bodies, marsh lands, rice field mudflats, concrete pits and waste water draining pipes. Culex (62.73%), Armigerus (25.62%) and Mansonia (11.64%) spp were recorded from these habitats. Large polluted water bodies (Shannon wiener diversity index/ H' = 1.5591) were the highest diverse habitat type. In breeding water, the average pH mainly lied in between 6-8 and average dissolved oxygen ranged from 3-7 mg/L. Present study revealed that LF situation is persistent at low level compared to Mass Drug Administration programme in 2011-2013 and Transmission Assessment Surveys conducted in 2013 by Anti Filariasis Campaign and disease occurrence is restricted to isolated pockets in Gampaha District in Sri Lanka. The zoonotic strains of filariasis; subcutaneous Dirofilariasis which caused by Dirofilaria spp is continuing with the availability of suitable reservoir hosts.

Keywords: Lymphatic filariasis, Wuchereria bancrofti, Dirofilaria, Mass Drug Administration

Toxic potential of the jewel of the seabed; Sea cucumber, Bohadschia vitiensis

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Sea cucumber is an important marine invertebrate group (Phylum Echinodermata, Family Holothuroidea) with high nutritional and medicinal value. Traditionally extracts of many sea cucumber species have long being consumed as a natural remedy for several ailments even without much of scientific evidences for their efficacy and safety. In this study, genotoxicity of water extract of *Bohadschia vitiensis* (WE) was evaluated using *Allium cepa* genotoxicity model. Sea cucumbers were collected from commercial catches of fishermen at Mannar, Sri Lanka and the water extract was prepared using established methodologies. The genotoxicity assay was conducted for a series of WE concentrations (500, 250, 125, 62.5 µg/mL) with a negative control (aged tap water) and a positive control (Dimethyl Sulfoxide) using grown onion roots. After 48hrs of exposure, the roots were examined for the existing stage of cell division and chromosomal aberrations. The mitotic index (MI), percentage mitotic inhibition (PMI) and percentage chromosomal aberrations (PCA) were calculated using established equations. According to the results, MI declined gradually exhibiting negative correlation (r=-0.935) with the selected concentrations. PMI (respected to the negative control) revealed a significant decline (33.9±6.3%) only at the highest dose, 500 µg/mL (DF=4, F=12.75, p=0.001). Nevertheless, the boundary level of genotoxicity (50% MI inhibition) was not exceeded by any exposed concentration. PCA of each exposed concentration of the extract remained approximately similar to the negative control and didn't indicate significant correlation with the concentration level (p>0.05). In toto, the water extract of Bohadschia vitiensis revealed no significant lethal genotoxic effects within the tested range of concentration (<500µg/mL). However, more comprehensive studies including *in vivo* models, should be conducted before recommending safe therapeutic applications of the extract.

Keywords: Sea Cucumber, Genotoxicity, Mitotic index, Percentage chromosomal aberrations
Changes in colour development induced by environmentally-relevant levels of lead and cadmium in hatchlings of the Japanese Quail (*Coturnix japonica*)

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Preliminary observations have revealed that birds in environments polluted with heavy metals have demonstrated changes in plumage colour, although evidence from systematic investigations is limited. The present study examined the effects of environmentally-relevant levels of Pb and Cd recorded in rice of Sri Lanka, on colour development in hatchlings of the Japanese quail (*Coturnix japonica*), through empirical trials. Colours are produced by selective absorption of light by pigments, which in order Galliformes is mainly melanin. Thus any change in light absorption would suggest changes in melanin and therefore manifestation of colour. Light absorption was used as a proxy to assess changes in colour development. Weekold chicks were exposed to field levels of Pb (250, 400 and 550 µgkg⁻¹) and Cd (50, 200 and 350 μgkg⁻¹, n=6 per treatment) over 28 days comprising 5 days of exposure (acute), 3 days of non-exposure, 13 days of exposure (chronic) and a further 7 days of non-exposure. Control trials were conducted simultaneously (n=6). Since the hatchlings were fed with recommended amounts of the metal impregnated commercial chick starter feed the average dietary exposure levels were calculated to be 3.79, 6.07, 8.34 µg per day for Pb and 0.76, 3.03, 5.31 µg per day for Cd. The quails were held in meshed cages with conditions maintained as per standard OECD guideline 205 (1984). Three regions (head, legs and iris) of the hatchlings where colour could be progressively assessed were photographed weekly and absorption of red, blue and green light was assessed using Adobe Photoshop CS4 software. The present study demonstrated that both Pb and Cd affected light absorption. For instance, with chronic dietary exposure to 8.34 µg per day of Pb the absorption of red and blue light by the iris reduced significantly in comparison to the control (Red F_{3,20}=5.1, P<0.05, R²=43.3%: Blue $F_{3,20}$ =14.28, P<0.05, R²=68.2%). Similarly chronic dietary exposure to 5.31 µg per day of Cd resulted in a significant reduction in light absorption by head feathers and iris (Head feathers - Green F_{3,20}=7.78,P<0.05,R²=53.9 %: Blue F_{3,20}=7.68, P<0.05, R²=53.5%: Iris Red F_{3,20}=5.65, P<0.05,R²=45.9%,: Green F_{3,20}=13.24,P<0.05,R²=66.5%: Blue F_{3,20}=20.20, P<0.05, R²=75.2%). No significant changes were noted in light absorption in feet. Interestingly, only Cd caused a significant decline in light absorption (in the iris) with acute exposure and at 5.31 µg per day (Red F_{3, 20}=3.46, P<0.05, R²=34.2%: Green F_{3, 20}=3.12, P<0.05, R²=31.9%). No dose dependency observed for Pb. Significant dose dependent decreases observed in all colours of light absorption by iris due to chronic Cd exposure and in green, blue light absorption by head feathers due to chronic Cd exposure. These findings are important given that they occurred at metal levels recorded in rice grains in Sri Lanka which means that granivores might be regularly exposed. Colour in birds is used for intra-specific communication, particularly for mate selection, and hence changes in colour would lead to long term negative implications on their survival and reproduction.

Keywords: Avifauna, Toxicity, Heavy metals, Colour development, Melanin

ABSTRACTS

Parallel Session - 2 (Plant & Environmental Sciences)

Development of an effective biocatalyst using *Gliricidia sepium* leaves and eppawela rock phosphate with *Gliricidia sepium* stem biochar

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Biochar has proven to be a remarkable material for sustainable agriculture. It could be enhanced with site-specific microbes from the target fields to activate biochar biocatalyst to produce enriched long-lasting fertilizers. Earlier studies revealed that Gliricidia (Gliricidia sepium) biocatalyst performs well than market wastes. Therefore, this study was conducted to produce biochar biocatalyst using *Gliricidia* leaves within a shorter period to use in developing high-quality organic fertilizer. To activate *Gliricidia* stem biochar (produced at 400-500°C and 2.5 hours residence time) of <4mm in size, two samples of aqueous biocatalysts were prepared using 1kg of size reduced *Gliricidia* leaves, 4L of water, and 8g of Eppawala Rock Phosphate (for each) in two aerobic reactors. 10g of soil was added initially to one reactor. Small amounts of biochar intermittently were added to the reactors with and without soil, requiring a total of 630g and 375g, respectively to reach neutral pH in biocatalysts slurries that were aerated continuously for 5 days. The catalyst with soil recorded the highest total nitrogen only on the first day but catalyst without soil showed the highest nutrient levels of total nitrogen 90.7mg/L, available potassium of 5,000mg/L and total phosphorous of 212.2mg/L at pH 6.9 after 5 days. While catalyst with soil showed total nitrogen content of 58.2mg/L, available potassium of 4,600mg/L, and total phosphorous of 196.7mg/L at pH 7. The soil reduced potassium and phosphorous concentrations by its physical presence while oxidizing nitrogen. The influence of soil inorganics in the form of ions on enzyme activity in the biocatalyst reactor can be avoided by adding only microbial inoculum extracts from soil with carbon sources like market waste to improve the microbial activity for enhancing nutrient availability. The biochar biocatalysts in five days could be used to produce high-quality site-specific organic fertilizers or directly as a soil inoculum.

Keywords: Activated biochar, Biocatalysts, Gliricidia, Market waste, Soil inoculum

Development of best fit models based on allometric equations to predict the clear bole height stem carbon content of *Avicennia marina* in Kadolkele and Rekawa mangrove forests

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Mangroves play an important role in sequestering carbon in tropical and subtropical coastal areas, and they have a considerable contribution towards carbon dioxide mitigation. The objective of the present study was to develop allometric equations to estimate the stem carbon content of Avicennia marina in Negombo and Rekawa mangrove forests. Forty-five trees of A. marina were selected from each mangrove forest. Stem core samples were obtained from each tree and their dry weights were measured. The organic carbon content of stem core samples was determined using loss on ignition method. This study used stem diameter at breast height (DBH), clear bole height of the stem (CBH), crown height (CH), total height (TH), leaf area (LA) of *A. marina* to develop allometric equations to estimate clear bole height stem carbon content. For each site, 75% of data were used for model construction and 25% were used in model validation. Stepwise regression model with backward elimination was used to develop the best fit model to predict the clear bole height stem carbon content. MINITAB 14 statistical software was used in statistical analysis. Results showed that clear bole height stem carbon content of *A. marina* can be determined using DBH and CBH. The best fit allometric equation of stem carbon content for A. marina in Rekawa was Ln C= -3.406 + 0.9763 Ln CBH+1.982 Ln DBH with a coefficient of determination (R^2) of 96.7%. In Negombo, the best fit model was Ln C = -4.496+1.937 Ln DBH+ 1.569 Ln CBH with a R² of 77.9%. This method provides valuable sustainable insight to predict the stem carbon content of A.marina using non-destructive method. Further, it is recommended this approach to be applied in prediction of stem carbon content in other common mangrove species in Sri Lanka.

Keywords: Allometric equations, Mangroves, Stem carbon, Sri Lanka

Litterfall and leaf litter decomposition of *Lumnitzera racemosa* in Kadolkele mangrove forest, Negombo estuary, Sri Lanka

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The present study assessed the litterfall and leaf litter decomposition dynamics of *Lumnitzera* racemosa in Kadolkele mangrove forest. Litterfall traps were used for litterfall analysis. The litter decomposition experiment was conducted at three sites (A: landward site; B: located toward the adjacent Avicennia zone; C: middle of the Lumnitzera zone) in the Lumnitzera zone of the Kadolkele mangrove forest. Initially fifteen litter bags (mesh size of 1 mm²) containing senescent leaves of Lumnitzera racemosa were placed on top soil and three litter bags were collected at three-week intervals (21, 42, 63, 84 and 137 days) from each location. The decomposition rate, decay constant, organic carbon and nitrogen content at each site at each sampling event were determined. The decomposition rate, decay constant, organic carbon and nitrogen content among sites at each sampling event were compared using one-way ANOVA followed by Tukey's pairwise comparison. MINITAB 14 statistical software was used for analysis. The mean litterfall during June, July, August, September was 4.0 g/ m²/ Day, 5.1 g/m²/Day, 6.3 g/m²/Day and 1.9 g/m²/Day respectively with leaves representing the largest fraction of litterfall. In the decomposition experiment, the litter samples in sites lost around 60% - 80% of its initial dry weight. There was no significant difference in decomposition rates among sites. However, the decay constants were different among sites (Site A: 0.012 d⁻¹; Site B: 0.006 d⁻¹; C: 0.018 d⁻¹). The lowest *t*₅₀ and t₉₅ were recorded from site C (38.5 days and 166 days respectively) and highest were from site B (115 days and 500 days respectively). The trend of organic carbon content in leaf litter showed a rapid increase during initial phase and gradually decreased towards the terminal phase. Nitrogen concentration gradually increased during the experiment period. The highest nutrient component in litter was carbon and the decomposition rate of leaf litter were controlled by C/N ratio in the plant material.

Keywords: Litter bag experiment, Litter decomposition rate, Percentage mass loss, Sri Lanka

Study on environmentally friendly approach to solve the water hardness problem - in Medawachchiya

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The present study focussed on identification of environmentally friendly, easily applicable remedial methods to reduce water hardness in domestic well water in Medawachchiya area. The suitability of using the seeds of *Terminalia arjuna* (Kumbuk) and *Strychnos potatorum* (Ingini) to reduce the water hardness was investigated by using randomly selected domestic well water samples in Medawachchiya. The temperature and electrical conductivity of well water at each site were measured on site. In the laboratory, the initial hardness of each water sample was measured using standard EDTA titrimetric method. Water treatment process was continued for 24 hours and the water hardness at 6 hours, 12 hours and 24 hours after immersion of seeds of Strychnos potatorum and Terminalia arjuna were measured. Paired t test in MINITAB 14 software was used to compare the water hardness before and after treatment. The mean hardness before treatment was 542.1 ppm and after treatment with Strychnos potatorum seeds for 6 hrs, 12 hrs, and 24 hrs it was 533.0, 522.2 and 513.5 ppm respectively. The mean percentage reduction of hardness after treatment with Strychnos potatorum for 6 hrs, 12 hrs and 24 hrs were 1.7%, 3.6% and 5.4% respectively. However, Terminalia arjuna seeds were identified as non-suitable for treatment, as an unpleasant colouration was observed during the treatment. Further, when the water was treated with Strychnos potatorum for more than 24 hours, the turbidity of the water was increased and it interfered the titrimetric end point. Therefore, the results indicated that there was a possibility to use *Strychnos potatorum* seeds to remove water hardness with an optimum time period of 24 hrs. However, further studies are recommended to be conducted in order to increase the efficiency of water hardness removal.

Keywords: *Strychnos potatorum*, Water treatment, Effects of water hardness, Home remedial water treatment

Chlorophyll-a estimation of Koggala lagoon using remote sensing

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Eutrophication is one of the most visible threats of anthropogenic changes in the biosphere, affecting aquatic ecosystems which lead to many socio-economic and environmental impacts. The most widely used proxy to measure the eutrophication status is the Chlorophyll-a (Chl-a) concentration. Yet, in-situ sampling and analysis of water quality are not always practically feasible. The present study aims at determining the level of eutrophication using Chl-a as an indicator in the Koggala Lagoon, a prominent water body of Southern Sri Lanka. Further, it attempts to develop an algorithm using in-situ Chl-a concentration coupled with remote sensing techniques to estimate the eutrophication status of the lagoon. Surface water samples were collected monthly in triplicate from randomly selected 10 locations of the lagoon from June to December 2019. Chl-a data were determined in the laboratory using a spectrophotometer. Landsat Enhanced Thematic Mapper (ETM+) and SPOT 7 satellite images were selected as remote sensing data sources. The dark object subtraction (DOS) method was used as an atmospheric correction technique to correct all the Landsat imageries using ENVI software. During the study period, in-situ Chl-a content ranged from 1.12 to 6.68 µg/L and there was a significant difference (P<0.05) between study sites. Koggala lagoon is transforming its status from oligotrophic to mesotrophic. Concentration of Chl-a ranges derived from satellite imagery are as follows: 7.867 -23.189 µg/L in 2005, 3.768 - 28.323 μ g/L in 2009, 0.013 – 32.144 μ g/L in 2011 and 0.001 μ g/L to 14.688 μ g/L in 2019. The results of the present study suggest that remote sensing provides a valuable tool to assess the temporal and spatial distributions of Chl-a in water bodies. The proposed algorithm of (B1/B2)=0.581-0.006[Chl-a] could be used to derive high-resolution Chl-a maps using the reflectance ratio of B1 to B2 of SPOT 7, for the sustainable management of Koggala Lagoon.

Keywords: Eutrophication, Chlorophyll-a, Remote sensing, Koggala lagoon

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Changes of land use and land cover in Madu Ganga Ramsar site, Galle Sri Lanka from 2005-2019

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Wetlands are one of the most productive ecosystems on earth. They provide many ecosystem services which are important ecologically and socio-economically. In Sri Lanka, wetlands are under immense anthropogenic pressure and the quality and quantity of these important ecosystems are being altered rapidly. The present study was conducted to investigate temporal changes of land use and land cover (LULC) of Madu Ganga estuary, Galle, Sri Lanka. This wetland has been declared as a Ramsar site in 2003 especially due to the significance of mangroves in and around the estuary. The LULC maps of the study area were developed for the period 2005-2019, by using Google Earth Pro and Arc GIS 10.1 software, followed by a ground verification based on 2019 satellite image and an accuracy assessment. The LULC maps were overlaid and the land transitions were investigated. Although the mangrove cover of Madu Ganga has identified as one of the last remaining tracts of pristine mangrove forests in Sri Lanka, the area has reduced by 1.6%. Most of the mangrove areas have transformed into open waters of the river (15.15% during 2005-2010 and 10.45% during 2010-2019) and some into cinnamon cultivation (3.68% during 2005 – 2010 and 5.13% during 2010 - 2019). In certain areas mangroves have been replaced by other terrestrial vegetation. The erosion of exposed estuarine banks due to heavy usage of motorboats linking with tourism activities may have increased water surface area of the estuary. The results of the present study can be used by policy makers and practitioners in preparing management strategies to restore and conserve mangroves in Madu Ganga estuary.

Keywords: Land Use and Land Cover (LULC), Madu Ganga, Mangroves, Conservation

Acknowledgement: The authors are grateful to the support extended by the University of Colombo

Is "Green" always the "Most Clean"? – A comparison of Resource Efficient and Cleaner Production (RECP) between a green hotel and a conventional tourist hotel

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Sri Lankan hospitality industry is one of the major contributors to the national economy. Yet, this sector affects the environment in a significant way due to higher resource consumption and waste generation. Even though Sri Lanka is paying increased attention to tourism planning and greening hotels, systematic investigations on sustainability practices are scarce. This study compared the Resource Efficient and Cleaner Production (RECP) practices and environmental performance, between two popular five-star hotels: a Green Globe and LEEDcertified, Green hotel and a conventional hotel. A set of absolute and relative indicators for resources use (energy and water usage) and pollution generation (air emission and waste) were employed to assess the performance from 2014 to 2018. Further, energy performances were compared with the national energy benchmark. However, the conventional hotel had low energy use and waste generation, 65.4 kWh per guest night (GN) and 1.82 kg/GN, respectively, opposed to the environmentally friendly hotel, where energy and waste intensities were 85.7 kWh/GN and 2.53 kg/GN. Further, the conventional hotel had maintained the energy intensity well below the national benchmark level (137.4 kWh per room Night) while the environmentally friendly hotel had intensities above the benchmark level throughout the study period, under the same occupancy level (77%). Moreover, the conventional hotel had comparatively better progress with water and energy productivities and waste intensities at the end of 2018. Nevertheless, due to increasing thermal factor in the grid electricity, both hotels had increased air emissions. Results revealed that "Green" is not always the most "Clean" and highlights the need of introducing an efficient environmental performance rating system for hotels. Hotel managements too should take steps to build their image in the "sustainable industrial community" through proper reporting and brand positioning.

Keywords: Resource Efficient and Cleaner Production (RECP), Hotel industry, Sri Lanka

Performance of *Azorhizobium* bio-fertilizer in low cost substrate assessed by growth and yield parameters of rice (*Oryza sativa*) under field conditions

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Excessive use of nitrogen fertilizers has many negative effects on the environment and human health. As an alternative, nitrogen fixing bio-fertilizers have been introduced to reduce the farmer's dependency on nitrogen fertilizer. Azorhizobium caulinodans is a diazotrophic bacterium with ability to fix nitrogen as a symbiont and free living organism. Use of Azorhizobium bio-fertilizer successfully replaces 50% of the recommended urea requirement for rice. The growth medium (substrate) used for Azorhizobium caulinodans was Yeast Extract Broth (YEB). The high cost of YEB growth medium is a limiting factor in the application of the bio-fertilizer in large-scale field applications. Therefore, finding an alternative low-cost substrate to replace the YEB medium is a present need. Two of the developed low-cost substrates (LCM 1 and 2) have shown the capability for reducing the cost by 50% under green house conditions. The main objective of this research was to compare the performance of the Azorhizobium bio-fertilizer, grown in low cost substrates 1 and 2 with YEB medium for rice under 50% of recommended urea levels in the field. The three substrate treatments with three replicates were arranged in a completely randomized block design in the paddy field. Relative leaf chlorophyll content, shoot and root length, number of leaves, number of tillers, dry weight of the shoot and roots were measured as growth parameters while filled and unfilled grain weight, total grain weight, number of filled and unfilled grains per plant, total number of grains per plant and weight of 100 grains were measured as yield parameters. Both low-cost substrates 1 and 2 did not show significant difference in the performance of Azorhizobium bio-fertilizer grown in YEB under field conditions, compared to YEB medium. This indicates that costly YEB can be replaced for growing *Azorhizobium* bio-fertilizer by either of the low-cost substrates tested.

Keywords: Bio-fertilizers, Diazotrophs, Azorhizobium, Low cost substrate

Growth responses of the potential aquatic invader *Echinodorus cordifolius* (L.) Griseb. under different stimulated nutrient availabilities

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Echinodorus cordifolius (L.) Griseb. of family Alismataceae has been identified as a potential aquatic invader in the Western Province of Sri Lanka. As there are no records on its tolerance capacity in eutrophic waters, the present study aimed to identify the growth responses and propagation ability under Nitrogen (N) and Phosphorus (P) enriched conditions hypothesizing that high eutrophic conditions may increase its growth. Thirty mature, thirty young and twelve very young plants were categorized based on size and biomass and potted separately in mud obtained from the same location. Nutrient treatments represented low (L, N= 425 μ gdm⁻³ and P= 10 μ gdm⁻³), moderate (M, N= 850 μ gdm⁻³ and P= 20 μ gdm⁻³) and high (H, N= 1700 μ gdm⁻³ and P= 40 μ gdm⁻³) eutrophic conditions. Distilled water was used as the control. Treatment H was lethal to very young and young plants, thus received L and M treatments. Mature plants were subjected to M and H treatments to reflect an effective growth. The pots were kept in a complete randomized design. Over a period of 10 weeks, cumulative number of plantlets from underground root stock (PR), leaves (LP), inflorescences, flowers and vegetative propagules from inflorescence nodes (PN) were recorded, root and shoot dry mass was obtained at the end of experiment. Absolute Growth Rate (AGR in terms of dry biomass and leaf production), root: shoot ratio and percentage allocation of above ground biomass (AB%) were determined. Data were statistically analysed using oneway ANOVA with R software (ver. 3.6.2). Results revealed that LP, AGR (leaves/plant), inflorescences, flowers and PN were significantly higher in mature plants under M treatment than H and control while H nutrient treatment favoured PR and AB%. In young plants shoot biomass (AB), LP, AGR (leaves/plant) and AB% was significantly high in M and L compared to the control. Very young plants did not show significant responses, except AB% to L and M treatment levels. Plants subjected to control treatment in all age categories showed the greatest root: shoot ratio. Study confirmed that E. cordifolius plants grow, reproduce and propagate better in moderate eutrophic conditions, root production is promoted at low nutrient levels while a trade-off between shoot and root growth occur at high eutrophic level. Potential of *E. cordifolius* becoming an aquatic invader may be triggered by moderate level of nutrient enriched eutrophic waters.

Keywords: *Echinodorus cordifolius*, Potential aquatic invader, Nitrogen, Phosphorus, eutrophic conditions, Absolute Growth Rate, Root: shoot ratio

Tree species diversity and tree cover mapping in urban green spaces of a metropolitan university: A case study from University of Colombo, Sri Lanka

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Urban green spaces mitigate negative impacts of climate change aggravated in urban landscapes and provide many ecosystem services for urban dwellers. Understanding the urban tree species diversity is crucial to maintain the ecosystem stability and resilience. This study was conducted to investigate the tree species diversity and to delineate the speciesspecific tree cover in green spaces of University of Colombo (Colombo 03) aiming to improve the site as an urban landscape. Trees with Diameter at Breast Height (DBH) >3 cm were recorded and were identified up to species level. The DBH, height and location were recorded. A measuring grid of 10 m x 10 m was overlaid on the satellite view of the study area to calculate the Important Value Index (IVI). Spatial distribution profiles of species were prepared by ArcGIS software (10.3). The site-specific tree cover was on-screen digitized using high-resolution satellite image of 2019. Individual tree crowns were identified using ground truthing information. A total of 1380 trees belonging to 48 families, 110 genera and 141 species, were recorded. From the recorded species, one was endemic, 59 were indigenous and 81 were introduced. About 66.7 % were evergreen and 33.4 % were deciduous. A percentage of 53.2 % of tree species usually found in dry zone climate and 46.8 % usually found in wet zone climate. The most dominant species with the highest IVI was Mangifera indica. Diameter distribution of the trees revealed a modified reverse j-shaped curve. The Shannon's diversity index, evenness and Simpson's index of diversity was 4.22, 0.85 and 0.97, respectively. The site-specific tree cover was 5.24 ha amounting to 24.5 % of the total land. The largest contribution to the tree cover was given by *M. indica* (12.4 %) followed by *Ficus* benghalensis (8.3 %), Samanea saman (7.1 %), Tabebuia rosea (5.9 %) and Peltophorum pterocarpum (5.6 %). Although the tree cover in the urban green spaces of University of Colombo has a remarkable diversity, endemism and indigenous species were rare. Tree selection should prioritize beneficial and adaptable tree species to improve the tree cover.

Keywords: Urban green spaces, University of Colombo, Tree species diversity, Tree cover

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Variation of stomatal anatomy of genus *Syzygium* in tropical forests along an altitudinal gradient in Sri Lanka

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Plants growing along altitudinal gradients are subjected to environmental gradients of atmospheric temperature, total atmospheric pressure and partial pressure of all gases (CO₂, O₂, etc.), radiation, humidity and availability of water and land area. Hence, altitudinal gradients provide opportunities to conduct experiments that discover ecological and evolutionary responses of biota to geophysical influences as "natural experiments". This study focused on investigating the variations in stomatal anatomy of 10 selected species of genus *Syzygium* using forests across an elevational gradient in Sri Lanka. Leaf samples were collected from permanent sampling plots established in the Kanneliya-Dediyagala-Nakiyadeniya forest complex (117-174 m asl), Sinharaja Forest Reserve at Enasalwatta (1042-1065 m asl), Hakgala Strict Nature Reserve (1804 m asl) and Piduruthalagala Forest Reserve (2080 m asl). Variation of guard cell length (GCL), stomatal density (SD), epidermal density (ED), stomatal index (SI) and potential conductance index (PCI) with altitude were studied. Analysis of data of these variables provided evidence for a declining trend of GCL, ED and PCI with increasing altitude. In addition, an initially increasing and thereafter a decreasing trend was shown by SD and SI. This reveals the impact of environmental conditions prevailing in each altitude apart from genetically determined variations within the genus on the stomatal characteristics of genus Syzygium. This could be interpreted as influence of genetic factors as well as adaptive or evolutionary responses to ensure survival and/or optimum productivity of plant species in different geophysical environments. Findings of this type of study are important for climate change predictions, to identify potential conservation areas based on geophysical characteristics that influence a site's resilience to climate change, to identify widely adaptable species and to understand the delimitation of optimum survival range of species.

Keywords: Syzygium, Stomatal anatomy, Sri Lanka, Altitude

Geo-accumulation index determination and spatial distribution analysis of heavy metals in sediments of the Ulhitiya reservoir, Sri Lanka

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In modern society, environmental pollution is a significant concern. Among the various types of pollution, the high levels of contamination in aquatic ecosystems with environmental toxicants such as heavy metals are a major burden as these elements are non-biodegradable. Furthermore, long-term exposure to heavy metals leads to various chronic diseases comprising Chronic Kidney Disease of unknown etiology (CKDu). Therefore, this investigation attempts to assess the contribution of heavy metals in reservoir sediments as potential risk factors for CKDu in a prevailing area of Sri Lanka. Heavy metals including Cadmium (Cd), Chromium (Cr), Copper (Cu), Zinc (Zn), and Arsenic (As) were analyzed in fifteen sediment samples collected from the Ulhitiya reservoir in Badulla District, Sri Lanka. Through the use of Igeo, the degree of pollution caused by heavy metals was determined. Each analysis was performed in triplicates. Inverse distance weight (IDW) and spatial autocorrelation (Moran's Index - MI) tools in ArcMap 10.2.2 software was used to interpolate the spatial distribution patterns of analyzed heavy metals in collected sediment samples. The mean concentrations obtained for Cd, Cr, Cu, Zn, Pb, and As were 1.568±0.561 mg/Kg, 95.865±21.350 mg/kg, 15.794±2.357 mg/kg, 59.832±5.68 mg/kg, 10.223±1.236 mg/kg and 12.565±5.654 mg/kg respectively. Igeo values for Cd, Cr, Cu, Zn, Pb and As were 1.3859 (moderately 0.3541 (uncontaminated to moderately contaminated), contaminated), -0.24020.0040 (uncontaminated to moderately contaminated), (uncontaminated), -1.136 (uncontaminated), -1.2557 (uncontaminated) respectively. Based on the results, it can be concluded that the sediments in Ulhitiya reservoir were uncontaminated to moderately contaminated. However, long-term exposure to heavy metals coming from various Anthropogenic activities and some natural environmental events can lead to the occurrence of chronic health issues including CKDu. Therefore, the development of water and sediment pollution prevention strategies is an urgent need to reduce the different pollution sources of reservoir sediments such as some agricultural practices including excessive usage of agrochemicals.

Keywords: Sediments, Heavy Metals, Spatial Distribution, Igeo

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Impacts of Land Use and Land Cover changes in an urban wetland on flood disaster: A case study from Muthurajawela wetland complex

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Rapid urban expansion is one of the most challenging global phenomena with significant socio-economic and environmental impacts. Sri Lanka is no exception. Unsustainable transformation of land use and irreversible influences on hydrological process in urban areas are increasingly apparent in the island. As a result, many cities are experiencing impacts of flood events more frequently. Managing flood risks demand effective actions and therefore the current study highlights the significance of Ecosystem-based Disaster Risk Reduction (Eco-DRR) and explore the link between wetlands and flood impacts. The study attempts to investigate any link between the impacts of floods and deterioration of Muthurajawela marsh which is the largest coastal wetland in the country. Changes in Land Use and Land Cover (LULC) were detected in twelve Grama Niladhari (GN) divisions in Wattala, using Arc GIS 10.1 version providing thematic maps for the past three decades, 1988-2019. Community perception of Ecosystem services (ES) offered by the wetland was assessed and analysed using a questionnaire survey and SPSS 20.0. Flood data were collected from relevant government departments. The results reveal that nearly 48.5% (1,285.1 ha) of the wetland area has been replaced by built-up, agricultural, and barren lands during the past three decades. Also, a new LULC class; marshy area with mixed vegetation has appeared (202.8 ha, +6.1%). As such, Kerawalapitiya, with the highest wetland loss records the largest damage in relation to number of people affected, frequency and duration of floods. Impairments of ES services (11 vs 27 total studied) too was highest there. In contrary, Mahapamunugama, where the wetland is relatively protected (19 ES services were apparent), has experienced the lowest flood damage. The occurrence of wetland as a natural flood attenuating structure and ecosystem services provided to the community to increase their resilience raises the need to embrace integrated approaches for wetland conservation.

Keywords: Ecosystem based Disaster Risk Reduction (Eco-DRR), Ecosystem Services, Flood mitigating role of wetlands

Assessing selected heavy metal levels in biotic and abiotic components of Diyasaru wetland park

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Heavy metal contamination has been a major concern around the world, with urban wetlands being particularly at risk. The purpose of this study was to determine the levels of three toxic heavy metals cadmium, lead and chromium in selected biotic and abiotic components in an urban wetland. The study was conducted at the Diyasaru Wetland Park which is a part of the wetland complex in the Colombo city and known for its high biodiversity. Samples of water, sediment, leaves (Annona glabra) and grubs (Oryctes rhinoceros) were collected from several locations within the site whilst otter tissues (Lutra lutra) were collected from a road kill at the site. The levels of the three heavy metals were determined using the Microwave Plasma Atomic Emission Spectroscopy after wet digestion. The levels of all three metals in water (n=25) were below detectable limits, whereas the sediment had 0.82 ± 1.54 of Cd, $43.16 \pm$ 20.03 of Cr and 3.18 ± 2.80 of Pb (mean ± standard deviation, n=25). The leaves contained 0.89 ± 0.74 of Cd, 13.82 ± 23.39 Cr and 0.15 ± 0.28 of Pb (n=25) and the grubs had 6.42 ± 5.46 of Cd, 0.67 ± 0.92 of Cr and 35.75 ± 46.85 of Pb (n=8). The otter tissue contained 0.60 ± 0.55 of Cd, 212.60 \pm 34.08 of Cr and 10.60 \pm 2.61 of Pb (n=5; liver). Statistical analyses (two-way Anova) showed that there were significant component-wise and location-wise differences for all three metals. When considering the accumulation among the components, the highest levels were in the faunal tissue; Otter (maximum 212.60 ± 34.08 of Cr). The present study highlights the necessity to consider varying components of ecosystems in monitoring heavy metal pollution if meaningful assessments are to be made with regard to the safety of the inhabitants and users.

Keywords: Accumulation, Biodiversity, Biota, Ecosystems, Heavy metal

Epiphytic association of *Acaryochloris marina* (a cyanobacterium) with the green alga *Valoniopsis*

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Epiphytic associations in marine environments contribute to the ecosystem productivity and play a significant role in ecological survival mechanisms. Acaryochloris marina is a unicellular, photoautotrophic cyanobacterium which contains chlorophyll d as its predominant photosynthetic pigment that uses far-red light for photosynthesis. Nevertheless, a substantial investigation has not been carried out on the epiphytic association of A. marina with its related host organisms from Sri Lankan coast. This study provides the first evidence for an epiphytic association between A. marina and marine green alga Valoniopsis. Specimen collection of morphologically different marine green algae was carried out in October 2019 from Beruwala reef, Sri Lanka and analyzed based on morphological characters and tufA sequences. *tuf*A gene is proposed as a DNA marker with the strongest amplification rate and species discrimination power. The respective green algal specimen was identified as Valoniopsis based on its morphological characters. The *tuf*A gene was amplified from genomic DNA extracted from Valoniopsis by polymerase chain reaction and sequenced using the Sanger sequencing method. The sequence alignment with the NCBI database showed 86.27% sequence identity to A. marina. Greenish aggregates could be observed in the green alga Valoniopsis under the phase contrast microscope and it could be identified tentatively as A. marina since it is a unicellular organism. Based on these results, the presence of A. marina could be confirmed in the respective specimen identified as *Valoniopsis* sharing an epiphytic relationship with it. Further studies are needed on the distribution of epiphytic Acaryochloris spp. on marine green algae using molecular methods for a better understanding of its diversity and host selection mechanisms in marine environment.

Keywords: Acaryochloris marina, Algae, Epiphytic association, tufA, Valoniopsis

Identification and characterization of heavy-metal tolerant fungi from Ussangoda serpentine soil, Sri Lanka

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Weathering of serpentinites leads to soils with elevated levels of certain heavy metals and depleted plant essential nutrients. The plants and microbes surviving on heavy-metal rich serpentine soils receive attention since they provide genetic material for bioremediation practices. Therefore, it is of great importance to characterize and conserve these unique habitats and their exceptional species. The present study isolated, identified and characterized several heavy metal tolerant fungi from the Ussangoda serpentine in the Hambantota District. In October 2019, soil samples from eleven locations (representing different features) within and adjacent to the serpentine area were collected at a depth of 10 - 15 cm below the surface. Each sample was analyzed individually following standard methods. Soil moisture content of the samples ranged 6.74% - 16.45% and soil organic matter ranged 1.42% -17.89%, with acidic soil pH 4.27 - 5.16. Sixteen soil fungi isolated and purified using standard methods were screened for tolerance for a range of Ni²⁺, Cr³⁺ and Cu²⁺concentrations incorporated into PDA plates, based on significant differences at $p \le 0.05$ in the measured mean (n=3) growth rates compared to the control. All sixteen isolates were able to tolerate up to 1500 ppm of Cr³⁺, six isolates were able to tolerate 1200 ppm of Cu²⁺and only four isolates were able to tolerate up to 2500 ppm of Ni²⁺. Attempts were made using molecular methods to identify eight of the fungal isolates showing significant tolerance to the tested metals. Fungal genomic DNA was PCR amplified using universal primers ITS_1F and ITS_4, and the PCR products were sequenced. Bioinformatics analysis of the sequences and sequence similarity search using GenBank NCBI led to the identification of three isolates. All the three identified isolates showed significant (p < 0.05) differences compared to their controls in Cr³⁺, Cu²⁺and Ni²⁺ enriched media. The isolate showing tolerance up to 1500 ppm Cr³⁺, 1000 ppm Cu²⁺ and 2500 ppm Ni²⁺ incorporated into the PDA growth medium has the nearest sequence identity to *Fusarium equiseti*. The other showing tolerance up to 1500 ppm Cr³⁺, 1200 ppm Cu²⁺and 1500 ppm Ni²⁺was identified as a *Trichoderma* sp., and the other showing tolerance up to 1500 ppm Cr³⁺, 800 ppm Cu²⁺ and 2000 ppm Ni²⁺ was identified as a Talaromyces sp. The results indicate that the three identified isolates may have tolerance or resistance to the tested metals, at least under the experimental conditions used. Further investigations are required to identify to the species level, to characterize their physiological and biochemical properties, and to evaluate their potential in bioremediation.

Keywords: Serpentine, Heavy-metal tolerant fungi, Bioremediation

Smartphone based effective navigation method for sample collection over a large geographical area

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Conventional, grid-based sampling location tracking approach with global positioning systems (GPS) or topographic maps is time-consuming and inconvenient. Therefore, this study combined the freely available virtual/digital globe with recent advancements of smartphone geo-browsers to develop a new sampling location tracking approach. The sampling frame was developed to collect soil samples from paddy fields of Sri Lanka with preuploaded point map formulated in geographical information system (GIS) environment by combining land-use map and one-km grid which was coded with Universal Transverse Mercator (UTM) center coordinates. Then the sampling location grid was uploaded to smartphone and each point was tracked with Google Map pathfinder using point-ID (coded grid coordinate) when searching each sampling location. The suitability of the new approach was tested for soil sample collection from paddy lands distributed in approximately 0.9 M ha in Sri Lanka. Out of the 65,610 of one km² grids in the country 35,537 grids contained paddy lands, and 9000 grids that contain the highest percentage of paddy lands were selected for the study. These 9,000 grids consisted of 6,134, 1,802 and 1,064 from the Dry, Intermediate and Wet Zones, respectively. The sampling locations could be reached conveniently with the help of Google pathfinder voice direction guide and optional routes. The efficiency of location navigation of the new approach was over 99% considering the 9000 locations. Moreover, these sampling locations could be covered with twelve-member field investigation crew who were guided through smartphones uploaded with sampling point grid on six motorbikes within 60 days. Therefore, the new sampling location tracking approach is effective in terms of cost, time and human resource requirements, thus can be adopted in large-scale soil/plant sampling frames with high accuracy.

Keywords: GIS, GPS, Geo-browser, Location tracking, Sampling, Surveys

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ABSTRACTS

Parallel Session - 3 (Molecular Biology & Biotechnology)

Seed priming with polyamines improves germination of tomato under water stress

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Polyamines (PAs) are aliphatic amine growth regulators that play key roles in diverse plant developmental processes including seed germination and defence responses against an array of environmental stresses. The diamine putrescine (Put), the triamine spermidine (Spd), and the tetramine spermine (Spm) are ubiquitous in plant cells. Water stress causes delayed seed germination and consequently hinder seedling establishment and growth. The study was aimed at finding the effect of priming tomato seeds with PAs; Put, Spd and Spm on seed germination under water stress. Surface sterilized seeds were primed with 50 µM of Put, Spd and Spm or with distilled water (control) for 12 hours. Primed seeds were then sown on water agar medium supplemented with 5% polyethylene glycol-600 (PEG-600) to enforce water stress or on PEG-600 free medium. Germination parameters namely percent of germination, mean germination time and germination index (GI) were assessed. After 7 days, seed germination in control was significantly reduced in PEG-600 supplemented medium (17%) compared to germination in PEG-600 free medium (47%). After 7 days, percent germination of control, Put, Spd and Spm-primed seeds were 17%, 25%, 33% and 35% respectively in PEG-600 supplemented medium and after 10 days, compared to control (27%), percent germination was significantly enhanced in Put (35%), Spd (42%) and Spm (44%) primed seeds. PA-priming resulted in reduction of mean germination time. Spmpriming resulted in reduction of mean germination time from 8.7 days (control) to 8.4 days. Highest GI was observed in Spm primed seeds accounting to 4.5, while in controls GI was 1.31. Increased percent germination, reduced mean germination time and high GI in PAprimed seeds compared to control clearly indicate positive effects of PAs in tomato seed germination under water stress conditions.

Keywords: Germination, Polyamines, Seed priming, Tomato, Water stress

An *in silico* study on elucidating the mechanism of alkane 1-monooxygenase 2 (AlkB2) enzyme catalysis of *Pseudomonas aeruginosa* PAO1

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Pseudomonas aeruginosa encodes an integral membrane alkane monooxygenases (AlkB2) which catalyzes the oxidation of *n*-alkanes into primary alcohols, with the aid of electron transfer proteins, Rubredoxin and Rubredoxin reductase. In order to construct a model organism to be used in bioremediation of oil spills and as an efficient biocatalyst for industrial purposes, structural and functional features of AlkB2 were assessed in silico and its mechanism of action was proposed. AlkB2 amino acid sequence retrieved from NCBI was used in identifying alpha helices as major secondary structural elements, through PSIPRED Workbench. Among them, six long alpha helices were identified as transmembrane helices with N terminal and C terminal domains oriented towards the cytoplasmic side of the inner membrane. As an experimentally determined crystal or NMR structure is currently unavailable for AlkB2, a *de novo* 3D model structure with a template modeling score of 0.53 was generated using DMPfold accessed via PSIPRED Workbench. The ConSurf server was used to estimate the evolutionary conservation of amino acid positions within AlkB2 homologs obtained from UniRef. Highly conserved 9 Histidine residues at positions 138, 142, 168, 172, 173, 273, 312, 315 and 316 in the amino acid sequence were predicted to be involved in formation of a conserved Histidine motif. Based on the active site of the AlkB2 of *P. putida*, an oxo-bridged non-heme diiron center is proposed as the catalytically active site of the AlkB2 enzyme. Non polar amino acid residues F53, I56, P57 in α_2 transmembrane helix, A131 in α_4 transmembrane helix and residues A340 and I343 were found to line the putative hydrophobic substrate binding pocket. These *in silico* revelations provide a better structural and functional mechanistic insight into the 3D structure and the catalytically active site of AlkB2 of *P. aeruginosa* PAO1.

Keywords: *Pseudomonas aeruginosa,* Alkane monooxygenase, *De novo* protein modeling, Mechanism of action

Rv3095; A probable virulence regulator in Mycobacterium tuberculosis

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Tuberculosis is an ancient disease caused by Mycobacterium tuberculosis. To enhance the treatment system against antibiotic resistance, studies need to be focused on finding novel drug and drug targets. The MarR family transcriptional regulators control several cellular processes in bacterial domains including antibiotic resistance and biosynthesis of virulence factors. Rv3095 in *M. tuberculosis* H37Rv is a MarR family transcriptional regulator, where it has been previously shown that it binds to its own promoter region and act as a potential drug target. Here, the potential binding site promoter regions of Rv3095 were investigated in a global manner. Shared promoter regions including the promoter of chromosomal replication initiator protein and DNA gyrase (regionI); embCAB operon (regionII); sigma factor SigE and serine protease htrA (regionIII); cell division proteins (regionIV); catalase peroxidase (KatG) and ferric uptake regulator protein (regionV) were predicted as potential binding regions based on sequence similarity of promoter region of Rv3095. Protein was purified with Ni-NTA binding followed by imidazole elution series. Electrophoretic mobility shift assay was carried out using 50 mM tris buffer, 0.05% triton, 1.25% glycerol and 20 Ig/ml BSA to identify the binding affinity of the predicted binding regions. For each reaction equal amout of cognate DNA was allowed to reach with increasing concentration of protein. Results depicts that the transcriptional regulator binds to all the predicted binding sites with different binding affinities and in most cases the promoter regions are overlapping with the potential binding region. Therefore, binding of transcriptional regulator towards the promoter region interrupt the binding of RNA polymerase and regulate the transcription level. Considering the binding affinities of the binding regions of Rv3095, region I shows better binding whereas region II and V show weak and less specific binding. However, under the complex regulatory network of the bacterium, these may play a role in virulence regulation in Mycobacterium tuberculosis.

Keywords: MarR regulators, *Mycobacterium tuberculosis*, Electrophoretic mobility shift assay

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Genome-wide identification and analysis of *Late Embryogenesis Abundant (LEA)* genes in Banana (*Musa acuminata* L.)

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Banana (*Musa acuminata*) is a nutrient-rich tropical fruit which provides a good source of energy for humankind. Drought stress is considered the main constraint that affects M. acuminata production. Identification of candidate genes engaged in such stress responses is important. Late Embryogenesis Abundant (LEA) proteins are a group of highly hydrophilic and intrinsically unstructured proteins associated with desiccation tolerance in plants. In the present study, a genome-wide analysis of the LEA gene family in banana was performed using a variety of bioinformatics tools including MEGA7, BLAST2GO, WolfPsort, and ProtParam to compile a reference list of these genes in banana. LEA protein sequences from Arabidopsis thaliana, Oryza sativa, and LEA family seed alignment data were used to infer LEA protein sequences of banana through homology searches. This study identified a total of 84 members in this family grouped in to eight LEA subfamilies. The LEA 2 subfamily was the largest and most diverse, and comprised of 57 members. Repeated motifs which are specific to LEA subfamilies were present in the banana LEA proteins. The majority of MaLEA proteins were hydrophilic. Functional analysis predicted various functions including response to stress, binding, structural components and embryo development. The majority of MaLEA proteins are associated with the cytoplasm and chloroplast. MaLEAs have few introns, indicative of stress response genes. *MaLEAs* are distributed unevenly across all chromosomes of banana, indicating that a significant portion of these genes originated by tandem or segmental duplications. The upstream sequences of these genes contain cis-actingelements associated with stress responses. The present study broadens the understanding of *MaLEA* gene family and provides evidence for the association of *LEA* genes in stress tolerance. The information generated in the present study provides valuable insights for future functional studies of *MaLEA* genes which may be useful for developing drought-tolerant banana varieties.

Keywords: LEA gene family, Abiotic stress, Banana, Cis-acting elements

Phylogenetic affinities of a near-endemic montane insectivore; Hill Swallow

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An endemic species is one that restricted to a defined geographical location. Islands provide a strong degree of geographical isolation to form new species and thus lead to endemism. This study is focused on resolving evolutionary history of Hill Swallows among closely related taxa in the Pacific Hirundines (Swallows of the genus *Hirundo*). There are three groups within Pacific clade; *Hirundo neoxena* is distributed in New Zealand and Australia, *H. tahitica* is distributed in Tahiti islands and *H. javanica* is distributed in Southeast Asia and Pacific islands. *H. j. domicola* (Hill Swallow) is considered as one of the subspecies of *H. javanica* and it has distribution of Sri Lanka and Western Ghats of India. Phylogenetic analysis and phenotypic analysis were performed to resolve the evolutionary history of Swallows within the Pacific clade. Maximum likelihood and Bayesian analysis with ~ 2000bp from two mitochondrial (cytochrome b and ND2) gene regions indicate that *H. j. domicola* (Sri Lanka) is phylogenetically distinct separate entity. Results obtained from phenotypic species delimitation test and principal component analysis using morphometric measurements support their phylogeographic status. It is also found that, *H. j. domicola* split its congeners around 1.08 million years ago. Therefore, our study implies that, *H. j. domicola* is a separate entity and can be elevated to the species status.

Keywords: Endemicity, Isolation, Hirundo, Molecular and Phenotypic markers

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Abstract number 3-06

The phylogenetic status of aberrant phenotypes of *Dicrurus lophorinus* (Sri Lanka Drongo): Hybrids or products of inbreeding depression

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The advancement of modern molecular phylogenetic techniques allows the studies of evolutionary relationships of closely related species. Two closely related Drongo species are found in Sri Lanka; the endemic *D. lophorinus* found in the wet zone of the country and the widespread continental species D. paradiseus ceylonicus inhibits the dry zone. The phylogenetic relationships among the members of this *D. paradiseus* cluster were debated throughout the past century due to records of aberrant phenotypes in the heart of the territory of these Drongos. The aberrant individuals were found with an erected crest similar to D. lophorinus and elongated outer-tail feathers with 'rackets' similar to D. paradiseus ceylonicus. Here we studied the phylogenetic status of *D. paradiseus* allospecies complex in Sri Lanka to understand the phylogenetic status of aberrant phenotypes of Sri Lanka Crested Drongo. We examined the genetic relationship using Drongos caught in the wild and specimens from museums across their range. A total number of six *D. paradiseus ceylonicus* and eight *D. lophorinus* with four samples from an aberrant population were used for the genetic analysis. The genetic variations were tested using two nuclear (Myo 2, Cmos) and two mitochondrial (ND2, Cytb) markers. We constructed a gene tree using Bayesian inference coalescent-based species tree estimation method to reveal the phylogenetic position of aberrant forms. The phylogenetic tree did not support the idea of hybridization since the individuals of aberrant population placed in both *D. lophorinus and D. paradiseus ceylonicus* clades. The results of phylogenetic analysis and the distribution of aberrant forms hint an extensive inbreeding rather hybridization between D. paradiseus ceylonicus and D. lophorunus.

Keywords: Dicrurus lophorinus, Aberrant Phenotypes, Hybridization, Inbreeding Depression

Phylogenetic Relationship of the Genus Ratufa (Giant Squirrels) in Tropical Asia

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Ratufa is giant arboreal squirrels restricted into South and South East Asia. They have different diverged into four phenotypically taxa; Ratufa macroura, R.indica, R.bicolor and R.affinis. Sri Lanka's Grizzled Giant squirrel; R.macroura is the most range-restricted species of the genus being endemic to Southernmost India and Sri Lanka. The phylogenetic and phylogeographic relationships within this group are yet to be resolved. We sequenced the cytochrome-b gene and 12s gene from nine fresh skins and preserved museum specimens to construct the phylogeny of all four species of *Ratufa*, including *R.macroura* subspecies. Both ML and Bayesian analyses were carried out for concatenated gene regions of 16 individuals obtained either through sequencing or through public archives such as GenBank. The analyses revealed the existence of two strongly supported clades within monophyletic Ratufa. R.macroura and R.affinis with lighter body colorations get grouped into the lighter-clade and *R.bicolor* and *R.indica having darker coat coloration* into the darker- clade. R.macroura (Grizzled Giant Squirrel) becomes sister to R.affinis (Cream-Colored Giant Squirrel). Both species together are related to *R.bicolor* (Black Giant Squirrel) and R.indica (Indian Giant Squirrel). R.macroura population in Sri Lanka exists as three different subspecies; R.m.macroura, R.m.dandolena, and R.m.melanochora isolated into the three climatic zones with drastically different coat coloration. This study would be the first to confirm the state of being subspecies which is supported by molecular phylogenetics. The minimum spanning network suggested that *R.bicolor* populations are related to lighter clades than *R.indica*. Tajima's D statistics gave a negative value suggesting that a probable recent selective sweep, a population expansion after a recent bottleneck, or a linkage to a swept gene. *Ratufa* shows a phenotypic variation in coat coloration. *Ratufa* with lighter-coat color are found in dry and lighter colored habitats and *Ratufa* with darker coat-color are found in wet and dark-colored habitats. R.macroura in the wet zone shifts to a melanistic form with respect to the dorsal body coloration. A similar pattern of melanism has been reported in mammals such as carnivores, deer mice and ungulates as well.

Keywords: Phylogenetic relationships, Grizzled giant squirrel, *Ratufa*, Melanism

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Molecular phylogeny of Sri Lankan wild buffaloes based on genetic variability of the mitochondrial cytochrome b gene

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The wild water buffalo (Bubalus arnee) is a globally and nationally threatened bovine species native to the Indian Subcontinent and Southeast Asia. The taxonomic status of the Sri Lankan wild buffaloes, however, is still uncertain and their origin and genetic status remains unresolved. The present study aimed to document the molecular phylogenetics of the wild buffaloes in Sri Lanka, as an attempt to shed light on some of these uncertainties. Skull fragments from museum specimens and from those collected from the wild (n=9 in total) were used for the genetic analysis. Based on available reference sequences, forward and reverse primers were used to amplify a 169 bp fragment of mtDNA from skull fragments. Phylogenetic analysis was performed using MEGA6 software. ML trees were generated using RaxML and rapid bootstrap, for 500 replicates with the GTR+G model. The generated DNA sequences were matched with those of the only available sequences for related species; B. bubalis (Water buffalo) and B. arnee bubalis (Water buffalo from China). The local skulls clustered into two main clades; the first containing *B. bubalis* and *B. a. bubalis*, and the second, which was well separated from the first, most likely of the local *B. arnee*. The first clade comprised of two sub clades, one containing *B. bubalis* and *B. a. bubalis*, and the second suspected to be of a hybrid. The skulls collected from the wild (Minneriya and Kumana) clustered with the clades represent B. bubalis (Water buffalo) and B. arnee bubalis (Water buffalo from China) and suspected hybrids and were not in the clade suspected to be of the local *B. arnee*. This is the first report of the DNA sequences of the wild buffaloes in Sri Lanka. The findings suggest the critical necessity to extend the study to cover other protected areas within the country to reveal the possibility of the occurrence of the local *B. arnee*.

Key words: B. arnee, Taxonomy, Genetic analysis, Skull fragments, mtDNA

"The Signaling Iris"; Sex-biased iris dichromatism in endemic Sri Lanka Bush Warbler (*Elaphrornis palliseri*)

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Sexual dimorphism driven by exaggerated phenotypes is widespread among birds. Besides their evolutionary function, there are many associating costs. Hence some species of birds have evolved optimized signaling mechanisms enabling them to overcome the cost of conspicuousness. Iris dichromatism plays a key role in making one sex is distinguishable from the other. The current study focused to investigate the basis of iris dichromatism of the Sri Lanka Bush Warbler (*Elaphrornis palliseri*) coupling molecular and morphometric analysis. The sex of each individual was determined using P2/P8 molecular sexing method. The withinspecies variations in morphometric traits were statistically analyzed using one-way Anova, sexual size dimorphism (SSD) and coefficient of variation. The iris dichromatism of *E. palliseri* was sex-biased as the individuals possessing red irises expressed one single band in P2/P8 sexing method indicating the male sex while the yellow eyed ones gave two bands indicating the female sex. E. palliseri has no significant sexual dimorphism in size however the measurements show slight variations. Difference of measurements between female and male *E. palliseri* was greatest for bill depth (9.7%) followed by the length of the longest primary, flat wing length, head width, head length, exposed culmen, tarsus length, total culmen whilst the bill width did not show any variation. In all the morphometric measurements, coefficient of variation (%) consisted within a range of 2.5 -10 and the flat wing length is the relatively most distinguishable character between sexes as it presented the lowest coefficient of variation (2.5%). Among all the morphometric measurements only the wing length is longer in the male than females (one way Anova: F= 6.00, P= 0.05). These results suggested that the iris dichromatism makes *E. palliseri* sexually discernible as usual morphometric traits are conserved between opposite sexes.

Keywords: Sri Lanka Bush Warbler, Sex-biased iris dichromatism, Morphometrics, Sexual Size Dimorphism

Weighted gene co-expression network analysis (WGCNA) of Arabidopsis somatic embryogenesis

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Embryogenesis is a key developmental process in the life cycle of plants. Many efforts have been taken to elucidate the underlying molecular aspects of embryogenesis. However, little is known about the underlying gene regulatory networks controlling somatic embryogenesis. Weighted Gene Correlation Network Analysis (WGCNA) is a powerful statistical method widely used for analyzing correlations between genes, identifying modules of highly correlated genes, relating modules to phenotypic traits and identifying hub genes based on transcriptomic datasets. In the present study, WGCNA was employed to identify significant gene modules and hub genes in somatic embryo (SE) transcriptomes of Arabidopsis thaliana. Transcriptome datasets of four SE developmental stages generated through microarray were retrieved from the NCBI Gene Expression Omnibus database (GSE48915). In total, 6,959 differentially expressed genes were filtered ($|\log_2 \text{ Fold Change}| \ge 2.0$) and used to construct a scale-free gene expression network. This resulted in 19 distinct co-expression modules; of these, 04, 04, 02 and 03 modules were specifically correlated with stage I (zygotic embryos), II (proliferating tissues at 7 days of induction), III (proliferating tissues at 14 days of induction) and IV (mature SE), respectively. Functional enrichment analysis performed on the modules showed that stage I is primarily enriched (P < 0.05) with expression of genes involved in cell communication, signal transduction and ion transport. Stages II and III are enriched (P < 0.05) with expression of genes involved in auxin polar transport, pattern specification and response to stimulus. The maturation phase expression is significantly enriched (*P* < 0.05) with genes involved in lipid transport, post-embryonic development, cell wall organization and seed dormancy. Analysis of the top hub gene of each module showed that 07 hub genes encode hypothetical proteins. Furthermore, hub genes: EXPA23 (AT5G39280), AT5G58660, AT1G19540, EDA4 (AT2G48140) and BGLU3 (AT4G22100) exhibited an embryo-specific pattern of expression and might be considered as putative SE marker genes. The findings of the present study will provide insights for further elucidating molecular mechanisms underlying somatic embryogenesis in Arabidopsis.

Keywords: WGCNA, Co-expression networks, Somatic embryogenesis, Arabidopsis

Predicting important proteins/genes involved in root development of *Oryza sativa* through protein-protein interaction (PPI) network module analysis

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Rice is consumed by more than two thirds of the world's population and hence requires improved varieties adapted to climate change and capable of tolerating environmental stresses to maintain an adequate supply for the increasing population. It is a known fact that the plant root system immensely contributes to the yield and stress tolerance. Therefore, understanding the underlying molecular components is essential for crop improvement. This requires identification of genes associated with root development first. Although wet-lab methods can be used to identify novel gene candidates, they are high in resource and time consumption. Alternatively, faster bioinformatics methods, such as sequence-based and network-based candidate gene prediction, can be used for this purpose. Network-based gene prediction usually employs PPI networks to predict new gene candidates for a selected phenotype based on their interactions with known genes (seeds) for that phenotype. This method has shown a higher accuracy and is preferred over other methods for predicting gene candidates for complex diseases and developmental phenotypes in animals. However, it has been rarely used on plants, and to our knowledge, has never been used on root development in rice. Therefore, a PPI network-based method was used to identify the network module and accurately predict new candidate genes for root development in rice. Rice PPI network from the STRING database was retrieved and genes with strong experimental evidence of their contribution to root development were extracted from literature and were used as seeds. Genes predicted in genomic studies lacking experimental evidence were excluded. These seeds were used to predict 75 new gene candidates for root development in rice using the popular Hishigaki algorithm. The predicted genes were then computationally validated using enrichment analysis. They were revealed to be associated with molecular pathways related to root development and abiotic stress tolerance, confirming applicability of our approach.

Keywords: Root development, PPI network analysis, rice (Oryza sativa)

Transcriptome analysis of *Arabidopsis POL2* mutants – an insight to gene functions at a global scale

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DNA polymerases (DNA Pols) are the key enzymes of DNA replication and repair. Here we explore the functions of the large multi-subunit protein complex, DNA Pol epsilon (ϵ) in Arabidopsis. The catalytic subunit of this complex is encoded by two genes, DNA polymerase epsilon catalytic subunit A (AtPOL2a, AT1G08260) and B (AtPOL2b, AT2G27120). Although *AtPOL2a* has been functionally characterized to some extent, the functional characterization of *AtPOL2b* is hampered due to the functional redundancy of these two genes. Hence, the present study aimed to explore the functions of *AtPOL2a* and *AtPOL2b*, by investigating the effect of mutations in each on the Arabidopsis transcriptome. The leaf transcriptomes of atpol2 mutants and wild type (WT) were retrieved from the ArrayExpress database (E-MTAB-2465) and analyzed using a range of bioinformatics tools. The quality-filtered reads were aligned and assembled using the Arabidopsis thaliana reference genome and transcriptome (TAIR10); TopHat 2.1.1 coupled with the Cufflinks package were employed. Cufflinks and HTSeq-counts were used to the estimate gene-level expression, and cuffdiff (a part of the Cufflinks package), DESeq and edgeR packages were employed to identify differentially expressed genes (DEGs). Interestingly, transcriptional activation of transposable elements (TEs) distributed around the centromeric region was noted in *atpol2a* mutant as compared to the WT and *atpol2b* mutants. This suggests a potential role of *AtPOL2a* in the regulation of TEs, directly or indirectly at a transcriptional level. In addition, DEGs identified in *atpol2a* were enriched for biological pathways such as DNA replication and repair, homologous recombination and mitogen-activated protein kinase (MAPK) signaling pathway. Although the transcriptome of *AtPOL2b* was closely similar to the WT, we found significant enrichment of stress-responsive genes in *AtPOL2b* mutants as compared to the WT and *atpol2a* mutants; AtPOL2b is more likely to interact with stress-responsive genes. The findings of the present study provide insights into the functions of both copies of *AtPOL2* and suggest new avenues for future research into their functions.

Keywords: DNA polymerase epsilon, Arabidopsis, Transcriptome

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DNA barcoding of lichen inhabiting fungi and phycobiont and probing for biologically active molecules from lichen inhabiting fungi

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Sri Lanka is a lichen hotspot for over 1,200 species. Lichen is a symbiotic association between a fungal partner a photosynthetic partner. Lichen inhabiting fungi may reside in lichens without involving in the symbiosis. Unique secondary metabolites, especially lichen inhabiting fungi are reputed for antimicrobial, anti-inflammatory, anti-proliferative and antioxidant activity. This denotes the importance in identification and conservation of lichens. A total of 36 lichen specimens were collected from Nonpareil Estate (NE) and Samanalawewa Wilderness (SW), Sri Lanka, for the study. Based on morphology, anatomy and chemistry, 18 lichen specimens were identified up to genus level from NE and nine from SW. Five lichens; Parmotrema tinctorum, Cladonia macilenta, Heterodermia leucomela, Teloschistes flavicans and *Dirinaria picta*, were identified up to species level. Foliose forms such as *Parmotrema* spp. and *Heterodermia* spp. were dominant at NE (62.5%) and crustose forms such as *Pertusaria* spp. were dominant at SW (61.5%). Lichen inhabiting fungi were isolated and cultured on potato dextrose agar, and algae in Albert's solution. Isolated algal and fungal counterparts were identified using colony characteristics, micromorphology and DNA barcoding. The internal transcribed spacer (ITS) region was amplified using ITS 1 and ITS 4 primers to identify fungi. For the molecular analysis of algae and cyanobacteria, primers *p23SrV_f1* and p23SrV r1 were used. Symbionts from two lichens were directed for molecular analysis. Trebouxia corticola and two Penicillium species from lichen Parmotrema tinctorum, and Fusarium solani from a Heterodermia lichen had over 90% identity. Crude extracts were obtained from fungal isolates via solvent extraction using ethyl acetate. Then they were screened in triplicate for antimicrobial activity by agar disk diffusion assay using bacteria: Escherichia coli (ATCC[®] 25922), Pseudomonas aeruginosa (ATCC[®] 27853) and Staphylococcus aureus (ATCC[®] 25923) and a clinical isolate of the fungus *Candida albicans*. A total of 11 crude extracts showed antibacterial activity against both Gram positive and negative bacteria while four showed antifungal activity.

Keywords: Lichen, Lichen inhabiting fungi, DNA barcoding, Antimicrobial activity, Disk diffusion

In silico analysis of effector proteins to elucidate infection strategies of fungal plant pathogens

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Plant pathogenic fungi infect plants to fulfill their nutrient requirements, and this process (pathogenesis) usually leads to disease development. The susceptibility or resistance of host plants against pathogens is partly determined by both pathogens derived elicitors/signal compounds and the corresponding host plant receptors. "Effector proteins" are low molecular weight proteins secreted by microbes during the pathogenesis process and play a significant role as specific elicitors. Recognition of effector proteins (encoded by Avr genes) by corresponding receptors (R proteins, encoded by R genes) in host plants leads to activation of "Effector triggered immunity (ETI)". The main focus of this study was to conduct an in silico analysis to identify and characterize effector proteins of pathogenic fungi and to elucidate their interactions with host receptors. Accordingly, the proteomes of nine fungal pathogens representing three life strategies, viz., biotrophic hemibiotrophic and necrotrophic, were downloaded from UniProt knowledgebase and analysed through a predesigned series of various bioinformatics tools (SignalP, PrediSi, Phobius, TMHMM, PredGPI, Wolf psort, and EffectorP) to predict the secretome (collection of all secreted proteins) followed by the effectome (collection of all effector proteins) for each proteome. The predictions resulted in varying numbers of effector proteins for each proteome (155, 180, 57, 69, 189, 259, 381, 338, 143 effectors were found in Cochliobolus heterostrophus, Fusariumo xysporum, Sclerotinia sclerotiorum, Ustilago maydis, Blumeria graminis, Puccinia graminis, Magnaporthe oryzae, Colletotrichum orbiculare, Zymoseptoria tritici respectively) and showed very low conservation among them. Protein functional domain analysis of effector proteins (using bioinformatics webservers Expasy, InterPro, BLASTp, and HMMER) failed to reveal any life strategy linked functional domains while protein kinase and cell attachment associated domains were distinctly abundant in all nine effectomes No conserved motifs were found among the nine effectomes. The protein docking method used to elucidate interactions between the pi54 resistance protein in Oryza sativa subsp. Japonica and the putative effector proteins of hemibiotrophic fungal pathogen *Magnaporthe oryzae* (based on the gene for gene hypothesis) revealed a number of candidate effector proteins (67 effectors) that could interact with pi54 R protein. This preliminary study underpinned the low conservation among the effector proteins. Effector-receptor interaction studies will continue with the long term focus on developing natural resistance in crop plants.

Keywords: Effector proteins, AVR genes, Effector triggered immunity, R proteins

In vitro meristem tip and nodal culture of Passiflora edulis

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Passiflora edulis, commonly known as passion fruit, is cultivated in Sri Lanka mainly for the fruit juice industry. Because it is cross-pollinated seed propagation results in undesirable variation. Vegetative propagation by stem cuttings is inefficient due to poor rooting and the spread of viral diseases. This study was initiated to develop a protocol for *in vitro* propagation of locally developed *P. edulis* varieties. Three types of explant; meristems, internodes and nodal segments, were used. Surface sterilization was successfully achieved by treating explants with 70% ethanol for 1 min. followed by treatment with 30% Clorox for 20 min. which resulted in meristems (89%), nodal segments (76%) and internodes (89%) surviving in culture without microbial contaminations. Meristem tips produced multiple shoots through axillary bud proliferation and the highest number of shoots per meristem (5.17±0.27) was obtained on MS medium with 1.0 mgl⁻¹ BAP. Nodal explants of different maturities, obtained from 4th – 8th nodes from the shoot apex, were tested on MS medium to identify the most responsive maturity stage. Of these, 4th, 5th and 6th nodes from the shoot apex were the most successful and 69%, 86% & 61% nodal explants respectively, responded by initiating axillary bud development. Nodal explants from 4th – 8th nodes were tested for improvement in response after supplementing the MS medium with BAP. Addition of BAP in the culture medium caused an increase in bud length compared to the control. The highest increase in bud length was observed in the fifth node cultured on MS medium supplemented with 2.0 mg I⁻¹BAP (16.26 mm). This study developed a protocol for surface sterilization of meristem tips, nodal segments and internodes of *P. edulis* by treatment with 30% Clorox for 20 min. Multiple shoot proliferation from meristem tips and bud development and elongation from nodal explants was obtained on MS media supplemented with BAP.

Keywords: Passiflora edulis, Meristem tips, Nodal explants, 6-Benzylaminopurine (BAP)

In vitro response of Sudu heenati and Pokkali rice varieties to salinity stress at early seedling stage

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Salinity stress negatively affects plant growth and causes significant crop yield losses worldwide. Rice is an economically important cereal crop affected by high salinity. Two traditional rice varieties, viz. Pokkali (which is known to be salt-tolerant) and Suduheenati, were evaluated in vitro for their responses to salinity in early seedling stages. Seedlings and embryo derived calli were subjected to 50, 100 and 150 mM sodium chloride (NaCl), for 15 days to emulate high salinity, after which growth rate, antioxidant capacity and proline accumulation were measured. Ten replicates were used for each treatment and the experiments were repeated twice. Fresh callus and seedling were used for proline assay whereas methanolic extracts of dried callus and seedling samples were used for antioxidant assays. Data were analyzed by Analysis of variance using R software. Differences were considered significant at p < 0.05. There was a significant effect of NaCl concentration on calli weight gain. A drastic decline of calli weight gain of both varieties was observed at 100mM NaCl which provides evidence that the growth of cells has been affected by high salinity. The callus growth of Pokkali variety increased at 50 mM and declined at 100 mM and 150 mM NaCl. Increments in the NaCl concentrations resulted in significant decreases in lengths of the shoots and roots and the values varied between the two cultivars. The proline content and the 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity in both varieties increased with increasing NaCl concentration. The increase of the DPPH radical scavenging activity was more distinct in Suduheenati shoots than in Pokkali while vice versa was observed in roots. The total phenolic content under salt stress was significantly different from the control and the amounts were more pronounced under moderate salinity. Furthermore, shoots of both varieties have shown a higher flavonoid content in the control than in treatments. The analysis of the above parameters under salinity could unravel the protection mechanism against increased salt stress in rice.

Keywords: Traditional rice, Sodium chloride, Proline, Antioxidant capacity
Endophytic *Trichoderma atroviride* as biocontrol agents and growth promoters of the rice variety Bg 360

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Fungal endophytes that reside symbiotically inside plant tissues are ubiquitous in nature and are known for their multifaceted functional roles against biotic and abiotic stresses in plants, thus recognized as a valuable tool in sustainable agriculture. In view of this, the current study attempted to evaluate the potential of fungal endophytes isolated from wild rice varieties in Sri Lanka to enhance rice plant growth and reduce the disease incidence and severity of sheath blight disease caused by Rhizoctonia solani. Putative fungal endophytes isolated during a previous study were screened for antagonism against R. solani under in vitro conditions using the dual culture assay and the ability to produce plant growth hormone Indole-3-Acetic Acid (IAA). Amongst them, Trichoderma atroviride (isolated from wild rice species Oryza nivara), identified via ITS sequencing, demonstrated significant (P<0.05) antagonistic activity against *R. solani* and IAA production ability (22.57 ±0.32 µg/ml) in culture. Prior to conducting pot trials, pathogenicity of *R. solani* on rice variety Bg 360 was evaluated by following Koch's postulates and a procedure to obtain endophyte free rice plants by soaking seeds in systemic fungicide carbendazim (for 48 hours in 0.3% w/v) was developed. Direct contact of seedlings with actively growing mycelia as oppose to dipping in a spore suspension proved to be the best method to inoculate seedlings of rice variety Bg 360 with putative endophyte *T. atroviride*. Re-isolation of *T. atroviride* solely from roots (88%) of inoculated mature rice plants indicated that the fungus is able to establish a stable endophytic relationship with the root system. Preliminary pot trials conducted using T. atroviride infected Bg 360 rice plants exhibited a significant increase (P < 0.05) in shoot length and a significantly (P<0.05) lower disease incidence compared to the non-inoculated plants. Furthermore, dual culture assays conducted as an extension to this study indicated that T. atroviride isolate has significant (P<0.05) antagonistic activity against four putative pathogens isolated from rice plant samples displaying characteristic symptoms of sheath rot, blast, grain discoloration and false smut diseases. Accordingly, investigations conducted thus far have indicated that putative endophytic fungal isolate, T. atroviride has promising biocontrol and growth enhancement potential in commercial rice variety Bg 360.

Keywords: Endophytes, Biocontrol, Sheath blight, Disease incidence, Indole Acetic Acid

ABSTRACTS

Parallel Session - 4 (Microbiology & Chemical Biology)

Probiotic activity of microorganisms used in traditional curd production in Gangabada, Gonnoruwa and Agbopura

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This study was intended to identify the regional diversity of the microorganisms used for the traditional curd production process and their probiotic potential manly focusing on traditional producers as they are utilising spontaneous cultures with undefined microbial composition, and carrying forward through "back-slopping" method. Three sites were selected for the study and eleven isolates were obtained in total and coded for convenience. The selected sites were Gangabada in low country wet zone (WZ), Gonnuruwa and Agbopura in low country dry zone (DZ). A sample was collected from a randomly selected product from each zone and enumerated on Lactic Agar. The highest lactic acid bacterial count was observed in the Gangabada sample $(15.9 \times 10^{10} \text{ CFU/ml})$ while the other counts were as 2.16×10^{10} CFU/ml for the sample from Gonnoruwa and 1.62×10^{10} CFU/ml for Agbopura. Climatic parameters were obtained from the closest agrometeorological centre of the sample collection site. No significant correlation was observed for average rainfall, average ambient temperature, humidity or elevation and the bacterial density for the tested samples according to the spearman correlation tests (p>0.005) in a 95% confidence interval (for average rainfall p=0.485, average temperature p=1.00, humidity p=0.485, elevation p=0.485). The microscopic observations were done and all the eleven isolates were gram-positive and KOH negative cocci and bacilli. According to biochemical tests, the isolates and found to be Indole, Methyl Red, Voges-Proskauer, Citrate (IMViC) and catalase negative. Tests were performed for the hydrophobicity%, the viability of isolates after treating with simulated gastric juice (pH=2), susceptibility to common antibiotics; Erythromycin and Amoxycillin and antagonistic activity against Escherichia coli, Staphylococcus aureus and Pseudomonas aeruginosa. These tests indicate the important characteristics of probiotic bacteria. Based on that, the isolates DZ 11, DZ 14, DZ 04 and WZ 03 were identified to have a probiotic potential.

Keywords: Traditional curd, Probiotic microorganisms, Back-slopping

Effects of different homogenization time durations for enumeration of microorganisms from black tea: A case study in low country tea in Sri Lanka

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The homogenization of the food matrix is the preliminary step in the microbial culture recovery process. This process depends on the particle size and duration of homogenization. Considering the importance of sample preparation, this study employed a systematic approach to compare the effects of different homogenization time durations on enumeration of microorganisms from black tea. Five different black tea grades with varying particle sizes, namely BOP, OP, Pekoe, OPA and Dust were selected for the analysis. Ten samples were collected from each tea grade from different tea factories located in the low elevation of Sri Lanka. Enumeration of aerobic bacteria and yeast & moulds were performed following the international standard procedures. The collected tea samples were analysed in duplicates with varying homogenization times; 30 seconds, 1, 2 and 5 minutes. The results were analyzed using the R statistical program. The results indicated that the bacterial counts were significantly different among the tea grades (P<0.01), but there was no significant difference between the homogenization time and the recovery of bacteria from different tea grades. The interaction effects between time and tea grades were also not a significant factor (P>0.05). Similar results were observed for recovery of yeast and moulds from different tea grades. Mean aerobic bacterial counts obtained for Dust grade were significantly higher than the other tea grades (P<0.01). Though homogenization time effect did not seem to be a significant factor for the recovery of microorganisms within each tea grade, the homogenization time corresponding to the maximum microbial count will be the optimum time for homogenization of tea samples. Despite the particle size, the results demonstrated that best time duration for homogenization is 60 seconds to obtain optimum recovery of yeasts and moulds and total aerobic bacteria in tea.

Keywords: Black tea, Homogenization time, Particle size, Microorganisms

Screening for lipid degrading bacteria in polluted Kalu Oya river water and analyzing their lipase activities

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This study was focused on finding out an efficient bioremediating bacterium which can be used to treat lipid contaminated water. A site of Kalu Oya river close to Ragama, was selected to isolate lipid degrading bacteria as it was reported to be highly contaminated with oils and grease, in a previous study. Screening for lipid degrading bacteria was carried out on Tween 80-peptone medium which gives opaque haloes around colonies that produce extracellular lipases. Three lipid degrading bacterial strains were identified by using 16S rRNA gene sequences as; Acinetobacter baumannii strain a1 (MT256198), Staphylococcus xylosus strain b1 (MT256199) and Acinetobacter baumannii strain a2 (MT256200). Lipase activities of these isolates and their combinations in Tween-80 broth medium were quantified using a spectrophotometric method at three pH values; 6, 7.5 and 9 and a temperature of 30±2 °C. Triplicates were maintained for each simulation. Lipase activities were statistically analyzed using one-way ANOVA and means were compared using Tukey's pairwise comparison in MINITAB 17.10. A. baumannii strain a1 and S. xylosus strain b1 showed their highest lipase activities at both pH 6 and 7.5 and the least lipase activity at pH 9. However, the lipase activity of *A. baumannii* strain a2 was not significantly different at pH 6 and 9. Between the two combinations studied, A. baumannii strain a1 with a2 exhibited the highest lipase activities at pH 7.5 and 9. In general, at pH 6, the three individual isolates showed significantly higher lipase activities compared to the combinations. At pH 7.5 A. baumannii strain a2 and its combination with strain a1 showed the highest lipase activity. At pH 9 all individuals and their combinations showed statistically similar lipase activities. According to the results, there is a potential of using these isolates and combinations to treat polluted water.

Keywords: Lipid degrading bacteria, Lipase activity, Water pollution

Screening for polyethylene degrading fungi from decaying hardwoods and plastic debris

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Each year nearly 300 million metric tons of plastics are produced globally and 75% of them are accumulated as waste. Among them, low density polyethylene (LDPE) is the most common solid waste. Even though biodegradation seems to be the best eco-friendly method to handle this menace, Sri Lanka is yet to implement a similar strategy. The first step in such a plan would include identifying locally available microbial consortia with polyethylene degradation capacity. The objectives of this study were to isolate fungal species from plastic debris and decaying hardwoods and to determine their polyethylene degradation abilities. Fungi were isolated from decaying polyethylene samples collected from Meethotamulla garbage dump (MGD) and decaying hardwood samples collected from dry zone, Sri Lanka. Isolates were incubated with 150 µm LDPE sheets for 45 days in minimal salt and mineral salt media. Biodegradation of LDPE sheets were detected via scanning electron microscopy (SEM) and *Fourier*-transform infrared spectroscopy (FTIR) analyses. In addition, percent reduction in weight, tensile strength and thickness of LDPE sheets were determined. Four fungal isolates from Meethotamulla (MGD 07, MGD 10, MGD 13 and MGD 16) and five fungal isolates from decaying hardwoods (KH2, DZFK2, DPW, DHF5B and IMF1A) were isolated. Percent weight loss ranged from 3.04-6.35% and 7.24-10.38% in mineral salt and in minimal salt medium respectively whereas the control remained 0.00%. Percent reduction in maximum tensile stress ranged from 32.43-54.28% and percent reduction in thickness ranged from 7.895-11.875%. Appearance and disappearance and shifting of FTIR peaks were observed compared to the control sheets. SEM analysis also indicated the presence of cracks, holes and splits in the treated sheets and control sheets remained intact. From this study, it was found that the minimal salt medium was a better medium for further analysis and the best isolates for LDPE degradation were those obtained from decaying hardwoods; KH2, DZFK2 and DPW.

Keywords: Analyses of degradation, Biodegradation, Fungi, Low density polyethylene

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Assessment of Cd, Cr and Pb concentrations of leaves, roots and soil of compost applied *Centella asiatica in* Padaviya area

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Present study was conducted to assess the Cadmium (Cd), Lead (Pb) and Chromium (Cr) concentrations in *Centella asiatica* (Gotukola) harvested from the compost applied cultivation sites located in Padaviya area in Anuradapura District during rainy and dry seasons (n=10). Heavy metal concentrations in soil (Cd_{soil}, Cr_{soil}, Pb_{soil}), roots (Cd_{root}, Cr_{root}, Pb_{root}) and leaves (Cdleaves, Crleaves, Pbleaves) of the *C.asiatica* were analyzed by atomic absorption spectroscopy. Student t test in MINITAB 14 software was used for comparison of heavy metal concentrations. During rainy season, mean Cd_{soil} , Cr_{soil} and Pb_{soil} were 3.4 ± 0.66, 21.5 ± 3.9 and 3.7 ± 0.5 mg/kg respectively. The mean Cd_{soil} (0.3 ± 0.05 mg/kg) during dry season was significantly lower than that of the rainy season. However, Cr_{soil} (19.0 ± 5.9mg/kg) and Pb soil $(3.4 \pm 0.7 \text{ mg/kg})$ during dry season were not significantly different from those of the rainy season. Further, soil heavy metal concentrations were below the EU safe limits (300 mg/kg for Pb; 180 mg/kg for Cr and 6.4 mg/kg for Cd) during both sampling events. Variation of the metal concentrations in roots and leaves of *C.asiatica* during rainy and dry seasons showed a different pattern. Mean Cdroot, Crroot, Pbroot concentrations in C.asiatica during dry season were 1.8±0.5, 3.4±0.7 and 0.2±0.01 mg/kg respectively and during rainy season they were 0.2±0.01, 8.6±1.2, 1.8±0.5 mg/kg respectively. During rainy season, Crroot and Pbroot were significantly higher and Cd_{root} was significantly lower than those recorded in dry season. A significantly high Cd_{leaves} during the rainy season (2.8±0.8 mg/kg) were recorded compared to dry season (0.9±0.2 mg/kg). However, there were no significant differences in Cr_{leaves} and Pbleaves during the rainy (Crleaves: 8.8±0.8 mg/kg, Pbleaves: 2.4±0.6 mg/kg) and dry (Crleaves: 9.8±3.0 mg/kg, Pbleaves: 2.8±0.8 mg/kg) seasons. Mean metal concentrations of leaves exceeded the WHO safety limits for consumption. The Crleaves and Pbleaves were higher than their respective root concentrations in both sampling events. However, Cd_{leaves} were higher than Cd_{root} in the rainy season and lower during the dry season. The present study provides base line data for Cr, Cd and Pb in roots and leaves of Gotukola harvested from compost applied soil in Padaviya area. The concentration differences during rainy and dry seasons can be possible due to the non-point source runoff leading to accumulation of heavy metals in soil and consequently in roots and leaves of the plants.

Keywords: Heavy metals, Bio-concentration factor, Translocation factor, Green leafy vegetables

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Effects of dietary exposure of dietary lead and cadmium on vocalization of hatchlings of the Japanese Quail (*Coturnix japonica*)

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This study investigates the impact of exposure to Pb and Cd on vocalization of hatchlings of the Japanese Quail (*Coturnix japonica*) through empirical trials. To increase environmental relevance commercial chick starter feed was impregnated with metal levels recorded in rice in Sri Lanka (250 - 550 µgkg⁻¹ of Pb and 50 - 350 µgkg⁻¹ of Cd) and used as feed for the trials. Since the hatchlings were fed with recommended amounts of the metal impregnated feed the average dietary exposure levels were calculated to be 3.79, 6.07, 8.34 µg per day for Pb and 0.76, 3.03, 5.31 ug per day for Cd. The trial was conducted with week-old hatchlings (n=6 per treatment) over 21 days (5 days of exposure - acute, 3 days of non-exposure, 13 days of exposure – chronic). Controls with no exposure were also conducted. All conditions were maintained as per standard OECD guideline 205 (1984). The calls were recorded using the TASCAM DR- 40 Linear PCM Recorder and six randomly picked sonograms of the distress call were analyzed using Raven Pro 1.5 software to compare vocalization patterns in exposed and unexposed hatchlings. Both Pb and Cd induced alterations in the distress call. In comparison to the control hatchlings, those exposed to the highest dietary level of Pb (8.34µg per day) had a higher pitch, shorter syllables, and fewer notes, lower inter-note spacing and was of a shorter duration(P < 0.05). Similarly, those exposed to the highest dietary level of Cd (5.31µg per day) also had shorter syllables, lower number of notes per syllable and lower spacing between two notes (P < 0.05). Cd also had the potential to change quality of the distress calls with short term exposure, though this was not evident with Pb. Significant dose dependent decreases in duration of a syllable, number of notes per syllable, inter note duration were recorded in chronic dietary exposure to both Pb and Cd. These findings are novel since limited information is available on the impacts of heavy metal exposure on vocalization in birds. In birds, mate selection and communication are considerably dependent on vocalization and hence, any alteration in the quality of the call would be detrimental. The noted changes in calls are of particular concern as they were recorded at environmentally relevant levels of the two metals in Sri Lanka.

Keywords: Avifauna, Toxicity, Heavy metals, Vocalization, Distress call

Comparative study of heavy metal contaminants in inland fish (*Etroplus suratensis*) during dry season

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Inland fish is one of the available protein sources of the diets of remote communities in Sri Lanka. In dry seasons, fish may contain heavy metals in high concentrations when the water and sediments of the reservoirs are contaminated with agricultural runoff. Those metals can enter the body via ingestion and may cause severe damage to humans when the concentrations reaches a toxicological thresholds. Therefore, this study attempted to assess the heavy metal contaminants in inland fish; *Etroplus suratensis* (most common edible fish species in the sampling areas) in Ulhitiya reservoir, Girandurukotte, Badulla district. Namaloya reservoir, Dambethalawa, Ampara district was selected as the reference for fish sampling in dry season. Ten fish samples were collected from each reservoir. Triplicated, washed, and oven dried edible fish parts were separately microwave digested and analyzed for heavy metals using inductively coupled plasma-mass spectrophotometry. Dietary essential heavy metal concentrations in fish samples of Ulhitiya; Fe (23.68±4.74 mg/kg), Zn (22.33±8.67 mg/kg), Cu (1.62±0.52 mg/kg) and Mn (7.45±3.45 mg/kg) were but a significant difference cannot be found with the reference. Toxic heavy metals, Cd, Pb, As and Cr concentrations in Koraliya (Etroplus suratensis) from Ulhitiya reservoir were $115.62\pm32.30\mu g/kg$, $206.85\pm14.30\mu g/kg$, $45.20\pm36.90\mu g/kg$ and $84.31\pm5.44\mu g/kg$, respectively, compared with 0.00 μ g/kg, 91.12 \pm 1.74 μ g/kg, 0.00 μ g/kg and 5.55 \pm 1.02 μ g/kg of the above elements from the Namaloya reservoir. Cd, Pb and As concentrations were significantly (P < 0.05) higher in edible parts of *Etroplus suratensis* caught from Ulhitiya compared to the reference. These levels are below the FAO standards but the long-term consumption of *Etroplus suratensis* which were contaminated with toxic heavy metals can have an adverse impact on human health.

Keywords: Inland fish, *Etroplus suratensis*, Dietary essential Heavy metals, Toxic heavy metals, Long-term exposure

Status of water quality in Malala-Embilikala lagoon system in Bundala National Park, Sri Lanka

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Coastal areas around the world are facing immense threat due to the increasing human population and other anthropogenic activities like urbanization, industrial developments, and extended land-use patterns. Bundala National Park (BNP) which is a coastal habitat located on the south coast of Sri Lanka has affected by the upstream irrigation works. Therefore, this study was aimed to analyses the water quality status of the Malala-Embilikala lagoon system in BNP. Water samples were collected from ten and fifteen random locations throughout the Embilikala and the Malala lagoon respectively, twice in both dry and wet seasons during 2018/19. Conductivity and pH were measured using Sension⁺ MM150 Portable Multi-Parameter, while nitrate-nitrogen (NO3--N), ammonia-nitrogen (NH3-N), total nitrogen (TN), total reactive phosphorus (TRP), and total phosphorus (TP) were measured using spectrophotometric methods. Data were statistically analyzed using IBM SPSS 22 software. Malala Lagoon showed higher mean pH (7.78±0.27), depth (121.2±44.7 cm) and conductivity (1283.02±458.08 µS/cm) than in Embilikala Lagoon (7.14±0.06), (112.8±35.1 cm), $(359.57\pm244.04 \ \mu\text{S/cm})$ respectively. Nitrate-N (0.4331±0.0631 mg/L), Total-N (1.0586±0.4423 mg/L), Ortho-P (0.0172±0.0326 mg/L), and Total-P (0.0326±0.0132 mg/L) levels were higher in the Embilikala lagoon than Malala lagoon, while the Ammonia-N (0.3070±0.0841 mg/L) was higher in the Malala lagoon. Higher pH and conductivity in the Malala lagoon were due to its direct connection to the sea and higher concentrations of nitrogen and phosphorous species in Embilikala lagoon might be due to its regular exposure to the agricultural runoff. This study provides an insight into the present status of water quality of the Malala-Embilikala lagoon system and further work is needed to an extensive assessment of water quality dynamics and the impact of the external water and nutrient inputs to the lagoon system.

Keywords: Malala- Embilikala, Bundala National Park, Water quality, Coastal wetlands

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Some nutritional properties of *Leiognathus* sp., a common by-catch from shrimp trawl fishery in Jaffna, Sri Lanka

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Shrimp trawl is unfortunately catching large quantity of non-targeted species. This by-catch which most often is discarded at sea has increased during the last years. The objectives of this survey were to analyze total and free amino acids, fat content and fatty acid composition of dried whole and minced *Leiognathus* sp. landed as by-catch during shrimp trawling outside Jaffna, Sri Lanka. One portion of collected sample was minced using a cleaned grinder. Both whole fish and minced fish were dried in an oven at 80°C until constant weight. Fatty acid compositions were determined by direct methylation. Gas Chromatography (GC) analyses were performed and the results were expressed in GC area%. Total lipid was determined gravimetrically. Amino acid analyzer was used to analyze total amino acids and free amino acids. Wilcoxon rank sum test was performed to test for significance (p<0.05) between both samples using RStudio (version 1.2.5001). A total of 13 fatty acids in whole fish and 14 fatty acids for minced fish were identified. The n-3 polyunsaturated fatty acids (PUFA n-3) were found to be one of the highest compounds and the amount was 26.2% and 25% in whole fish and minced fish respectively. Docosahexaenoic acid (DHA) is found at 13.3% and 11.3% in whole fish and minced fish respectively. There was no significance difference in fatty acid composition between both samples. The total sum of amino acids ranges from 229.8 and 174 mg/g raw protein, indicating that analyzed protein is mainly explained by the amino acids identified. Small sized amino acids such as glycine and proline were found in higher level. The total lipid was 5.5% and 7.3% in whole dried fish and minced dried fish respectively. In the sense of higher availability of protein, storage of whole dried fish will be a better option than minced dried fish.

Keywords: Discards, Fatty acids, Leiognathus sp., Protein, Shrimp trawling

In-vitro anti-radical activity of Stylissa carteri and Axinella sp. marine sponge extracts

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Marine sponges are recognized as an abundant source of bioactive natural products. Despite the unique biodiversity, Sri Lankan marine sponges largely remain as untapped resources for their bioactive-properties. The aim of the present study was to investigate anti-radical activity of crude extracts of Stylissa carteri and Axinella sp. sponges from Sri Lanka. The sponges were collected from shallow water near to Polhena, Matara (5.9363 °N, 80.5263 °E) and identified as Stylissa carteri and Axinella sp. based on their morphology, spicule and skeleton analysis. The sponge crude extracts (SCE) were prepared by extraction in methanol/dichloromethane (1:1 v/v), followed by rotary evaporation. The SCEs were used for qualitative zoo-chemical analysis and 5 doses of each SCE was tested for anti-radical activity by DPPH, ABST, NO and peroxide radical assays. The IC₅₀ was calculated and compared with the reference drugs. The SCEs showed presence of alkaloids, flavonoids, terpenoids, quinone, saponins and unsaturated sterols, while sterols, tannins, anthraquinones and proanthocyanidin were absent. According to the results, SCE of *Stylissa carteri* was more potent than SCE of Axinella sp. with respect to DPPH assay (IC₅₀ values of 32.55±5.270 and 42.09±7.291 µg/mL respectively). However, the potency of NO radical scavenging of Axinella sp. was higher than Stylissa carteri (IC₅₀= 50.63 ± 10.451 and 58.64 ± 6.324 µg/mL respectively). ABTS and peroxide radicals were scavenged effectively by reference drugs (IC₅₀=28.77±5.146 and 35.67±3.865 µg/mL respectively) than those of SCEs of *Stylissa carteri* (IC₅₀=31.77±4.750 and 81.53±8.496 µg/mL respectively) and Axinella sp. (IC₅₀=42.49±8.398 and 323.52±15.302 µg/mL respectively). The results of present study evidenced the antiradical activity SCEs of Stylissa carteri and Axinella sp. The presence of zoo-chemicals in the SCEs may responsible for the resulted anti-radical activities. However, a comprehensive research, based on *in-vivo* and *ex-vivo* models and bioactivity guided fractionation to isolate the active compounds are highly recommended in future research.

Keywords: Marine sponges, Anti-radical activity, Zoo-chemicals

Phytochemical content and antioxidant activity of the leaves and stems of *Plectranthus amboinicus* (Mexican mint) in Sri Lanka

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Phytochemicals present in plants act as antioxidants by reducing the reactive oxygen species (ROS) and the reactive nitrogen species (RNS), with minimized side effects. Plectranthus *amboinicus* is rich in phytochemicals with potential antioxidant activity. The objective of this study was to analyse the phytochemical content and the antioxidant activity of the leaves and stems of *P. amboinicus*. The novelty of this research was to identify the correlation between the phytochemical content, and antioxidant activity within the different concentrations of the different parts extracted using the different solvents. The leaves and stems of *P. amboinicus* were extracted using absolute methanol and acetone as solvents. The total phenolic content (TPC) and total flavonoid content (TFC) was assayed using Folin – Ciocalteu and aluminium chloride colourimetry techniques, respectively. Ferric Reducing Antioxidant Power (FRAP), 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) and 1, 1- Diphenyl-2picrylhydrazyl (DPPH) assay were used to analyse the antioxidant activity. All samples were triplicated. At 1mg/mL and 0.5mg/mL, the methanol leaf extract showed a higher TPC (p<0.05) than the methanol stem extract (p<0.05). At 1mg/mL, the methanol leaf extract showed a higher ABTS activity (p<0.05) than the methanol stem extract (p<0.05), whereas, at 0.5mg/mL, the methanol stem extract showed a higher ABTS activity (p<0.05) than the methanol leaf extract (p<0.05). At both concentrations, the activities of DPPH and FRAP activity of methanol stem extracts were higher than the methanol leaf extract (p<0.05). At 1mg/mL, acetone leaf extract showed a higher TFC (p<0.05) than the acetone stem extract (p<0.05), whereas at 0.5mg/mL methanol stem extract showed a higher TFC (p<0.05) than the methanol leaf extract (p<0.05). A positive correlation was observed between the antioxidant activities and the phytochemical contents (FRAP and TFC – methanol: r = 0.959, acetone: r = 0.966, p<0.05). In conclusion, the leaves of *P. amboinicus* exhibited higher phytochemical content and antioxidant activity than that of the stems. Methanol may be a better solvent in extracting the phytochemicals in the leaf and stem of Plectranthus amboinicus than acetone.

Keywords: Plectranthus amboinicus, Phytochemical content, Antioxidant activity

Anti-glycation and glycation reversing properties of Ceylon white tea

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Tea is the most popular beverage in the world next to water and reported to have array of health benefits. Sri Lanka is a country which is well known for Ceylon tea and currently country produces variety of tea including white tea. However, health benefits of Ceylon white tea are poorly documented although it's the most highly priced tea in the international trade. Present study evaluated anti-glycation and glycation reversing properties of two commercially important Ceylon white tea (TRI 2043) namely silver tips and golden tips. Hot water extracts of white tea were studied for anti-glycation and glycation reversing properties in Bovine Serum Albumin (BSA)-glucose model in vitro (n=3 each). Two grades of commercially important Ceylon black tea namely Pekoe Fannings (PF) and Broken Orange Pekoe Fannings (BOPF) were also studied for comparison (n=3 each). Significant differences (p<0.05) were observed among tea samples for both anti-glycation and glycation reversing properties. Anti-glycation activity of golden tips (IC₅₀: 24.20±0.29 µg/mL) was significantly high (p<0.05) compared to silver tips (IC₅₀: 26.99 \pm 1.37 µg/mL). Both silver tips and golden tips exhibited significantly high (p<0.05) anti-glycation activities compared to BOPF (IC₅₀: 31.49 \pm 1.01 µg/mL) while golden tips showed comparable activity to PF (IC₅₀: 23.05 \pm 1.70 μ g/mL). However, observed anti-glycation activity of both silver tips and golden tips was significantly low (p>0.05) compared to the standard drug rutin (IC₅₀: 21.59±0.09 µg/mL). For glycation reversing activity, silver tips (21.91±1.18 µg/mL) and golden tips (23.26±0.46 μ g/mL) was statistically insignificant (p>0.05). Observed glycation reversing activities of both silver tips and golden tips were significantly high (p<0.05) compared to PF (27.92±1.96) μ g/mL) and comparable to BOPF (21.42±2.73 μ g/mL). It is concluded that tested Ceylon white tea had both anti-glycation and glycation reversing properties.

Keywords: Ceylon white tea, Golden tips, Silver tips, Anti-glycation, Glycation reversing

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In vitro anti-diabetic activity of *Passiflora suberosa* aqueous leaf extract and its fractions

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Leaves of Passiflora suberosa are used in Sri Lankan traditional medicine to treat various ailments including diabetes, skin diseases, and hypertension. The current study investigated the in vitro anti-diabetic activity of the aqueous leaf extracts and its fractions (hexane, chloroform, ethyl acetate, and 70% methanol). The phytochemicals were analyzed qualitatively and quantitatively. Anti-diabetic activity was determined using alpha-amylase inhibition, alpha-glucosidase inhibition, and anti-glycation assays. The active fraction (ethyl acetate fraction) was subjected to gas chromatography/mass spectrometry (GC/MS) analysis to identify the active components. Phytochemical screening revealed the presence of phenols, sterols, tannins, flavonoids, alkaloids, and saponins. The highest (p<0.05) total phenolic (267.69±0.52 µg GAE/g) and flavonoid (123.33±0.26 µg QAE/g) contents were exhibited by the ethyl acetate fraction, while the aqueous extract had the highest total proanthocyanidin content (984.17±2.88 µg CAE/g). The highest alpha-amylase inhibition was exhibited by the ethyl acetate fraction with IC₅₀ of 284.63 \pm 0.51 µg/ml compared to the positive control (Metformin) 197.51±0.32 µg/ml. The crude aqueous leaf extract and the hexane fraction revealed the lowest anti-diabetic activity. Similarly, the ethyl acetate fraction had the highest potential to inhibit the alpha-glucosidase (IC₅₀: 120.80±1.33 µg/ml) compared to the positive control (Metformin). Similar results were also observed with anti-glycation assay with the lowest IC₅₀ value of 29.18±0.39 µg/ml exhibited by the ethyl acetate fraction compared to the standard rutin (IC₅₀: 26.83±0.25). According to the results, ethyl acetate fraction is found to be the most active fraction with the highest anti-diabetic potential.

Keywords: *Passiflora suberosa*, Fractions, Alpha-amylase inhibition, Alpha-glucosidase inhibition, Anti-glycation

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In vitro hypoglycemic potential in different fractions of methanolic extract of *Caulerpa racemose*

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Marine algae are abundant with natural bioactive compounds, resulting potential therapeutic ability. As Sri Lankan marine algae are yet to be exploited, current study was undertaken to determine the *in vitro* hypoglycemic potential in different fractions of methanolic extract of green algae Caulerpa racemosa (family: Caulerpaceae). Freshly collected cleaned lyophilized powdered algae was depigmented with acetone and extracted twice with 70% methanol using ultra sound assisted extraction at 25 °C. De-polysaccharide methanolic extract was sequentially partitioned with hexane, chloroform, ethyl acetate and distilled water. The antidiabetic activity of crude methanol extract and its fractions were determined using alpha amylase inhibitory activity, alpha glucosidase inhibitory activity and anti glycation assays. Metformin (alpha amylase and alpha glucosidase assays) and Rutin (anti glycation assay) were used as the positive control. Among the tested crude extract and the fractions, 70% methanol extract exhibited higher hypoglycemic potential in alpha amylase inhibition assay (IC₅₀: 381.14 \pm 0.36 µg/mL) and in anti-glycation assay (IC₅₀: 35.21 \pm 1.25 µg/mL) with lower IC₅₀ values (p < 0.05). Corresponding IC₅₀ values of the positive controls were 198.03 ± 0.33 μ g/mL (Metformin) and 28.84 ± 0.15 μ g/mL (Rutin). Further, the ethyl acetate fraction was more potent towards inhibiting the alpha glucosidase (IC50 value: 147.2± 0.42 µg/mL) and was comparable with the positive control (Metformin: $135.90 \pm 0.21 \,\mu\text{g/mL}$). In conclusion, 70% methanol extract, and the ethyl acetate fraction of *Caulerpa racemosa* contain promising hypoglycemic properties and hence it may have the possibility to develop novel drug leads against diabetes.

Keywords: *Caulerpa racemosa*, Anti-diabetic activity, Alpha-amylase inhibition, Alpha-glucosidase inhibition, Anti-glycation activity

Acknowledgement: University research grant ASP/01/RE/SCI/2018/13 is acknowledged

PROCEEDINGS OF THE 40th ANNUAL SESSIONS OF THE INSTITUTE OF BIOLOGY

Abstract number 4-15

Antioxidant potential of Ceylon white tea

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Present study evaluated antioxidant potential of Ceylon white tea. Hot water extracts of two commercially important Ceylon white tea namely, silver tips (ST) and golden tips (GT) were used in this study. Two grades of commercially important Ceylon black tea namely, Pekoe Fannings (PF) and Broken Orange Pekoe Fannings (BOPF) were also studied for comparison. Antioxidant potential was evaluated using Total Polyphenolic Content (TPC), Total Flavonoid Content (TFC), Ferric Reducing Antioxidant Power (FRAP) and 2, 2-diphenyl-2-picrylhadrazyl (DPPH) radical scavenging activity antioxidant assays (n=3 each) in vitro. Significant differences (p<0.05) were observed among tea samples for the investigated antioxidant properties. Mean TPC(mg Gallic Acid Equivalents/g of extract), TFC (mg Quercetin Equivalents /g of extract), FRAP (mg Trolox Equivalents /g of extract) and DPPH (IC₅₀ µg/mL) antioxidant properties of ST and GT were in the range of 155.14±9.45-163.45±5.68, 9.28±0.66-12.02±0.30, 330.99±9.75-354.78±5.22 and 8.87±0.41-19.49±0.27 respectively.GT exhibited significantly high (p<0.05) TFC and FRAP compared to ST while STshowed the highest DPPH radical scavenging activity. TPC was comparable (p>0.05) between ST and GT. Interestingly, TFC and FRAP of GT were significantly high (p<0.05) compared to BOPF (TFC: 7.99 ± 0.43; FRAP: 236.88 ± 11.51) and PF (TFC: 8.97 ± 0.32; FRAP: 163.29± 1.99). However, DPPH radical scavenging activity of white tea was significantly low (p>0.05) compared tested black tea (BOPF: 5.62 ± 0.77; PF: 12.79 ± 0.41). Further, TPC of white tea was significantly low (p>0.05) compared to BOPF (238.34 ± 2.99) while ST showed comparable TPC to PF (171.22 ± 3.99). In conclusion, Ceylon white tea had antioxidant activity via multiple mechanisms, and this is the 1st study to report antioxidant activity of Ceylon white tea.

Keywords: Ceylon white tea, Silver tips, Golden tips, Ceylon black tea, Antioxidant potential

Acknowledgement: AHEAD Project is greatly acknowledged for the financial support in obtaining multi-mode micro plate reader. Further, University of Colombo Research Grant No: AP/3/2/2020/SG/29 is also greatly acknowledged

Effectiveness of seed priming on germination and growth at the early seedling stage of selected Sri Lankan rice varieties, under saline conditions

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Seed priming is one promising strategy that has been employed in enhancing stress tolerance in plants. The present study aimed to assess the effectiveness of five seed priming treatments (hydropriming and 1% concentration of KCl, CaCl₂, KNO₃, and ZnSO₄) on seed germination and growth at early seedling stage of five Sri Lankan rice varieties (kaluheenati, rathdel, kuruluthuda, BG 369 and pokkali), under 100 mM NaCl salinity level. The experimental data were analyzed using two-way ANOVA. It was observed that seeds of kaluheenati, kuruluthuda and pokkali primed with CaCl₂, H₂O, ZnSO₄ and KCl improved their germination as compared to unprimed seeds, under non-salinity stress condition. Further analysis of mean germination percentages revealed that there is a statistically significant interaction between rice varieties and priming treatments for germination, under non-stress conditions. However, analysis of mean germination percentages of primed and unprimed seeds under saline conditions showed that there is no statistically significant interaction between rice varieties and priming treatments. Of the five seed priming treatments, ZnSO₄ primed seeds showed significantly enhanced seed germination as compared to unprimed seeds (P-value = 0.0068). This suggests that seeds primed with ZnSO₄ may be successfully applied on rice to alleviate the detrimental effects of salinity stress during the initial stage of plant development. Findings also revealed that when seedlings are grown from primed and unprimed seeds under saline conditions, there is a significant interaction between rice varieties and priming treatments for shoot lengths of seedlings. However, there was no significant interaction between rice varieties and priming treatments for root lengths. Overall results suggest that 1% ZnSO₄ priming and hydropriming treatments could enhance germination of local rice varieties, under saline conditions although reduced shoot growth by hydropriming, under high saline conditions were evident with some rice varieties.

Keywords: Seed priming, Salinity stress, Rice varieties

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Schedule of the Scientific Sessions

40th Annual Sessions of the Institute of Biology, Sri Lanka

26th September, 2020 at the Faculty of Graduate Studies, University of Sri Jayawaradenapura, Gangodawila, Nugegoda

Parallel Session 1- Zoological Sciences

Time	Abstract Number	Title
8.30 – 10.30 am	1-01	Larval Cannibalism among conspecifics of Fall Armyworm, Spodoptera frugiperda (Lepidoptera, Noctuidea) in Sri Lanka
	1-02	Diversity, distributional and habitat type variations between Collyridini and Cicindelini (Carabidae, Cicindelinae) in Sri Lanka
	1-03	Fish catch data of Family Mobulidae (Class Elasmobranches) in Negombo fishery harbor: implication for management
	1-04	Feeding ecology of Sri Lankan blue swimming crab (Portunus pelagicus) caught in Negombo coastal waters
	1-05	Effect of bioaugmentation with Bacillus subtilis on growth, survival and rearing water quality of selected species of Family Poeciliidae
	1-06	Study of urban wayside bird assemblages in the City of Colombo with special emphasis on environmental and social impacts of roadside trees
	1-07	Morphometric characterization of buffalo skulls in Sri Lanka
	1-08	Seasonal variations in herd characteristics of elephants utilizing the Minneriya Tank
	1-09	Diversity of nest-dwelling ectoparasites of selected captive breeding birds of the National Zoological Gardens of Sri Lanka
10.30 – 10.45 am		SESSION BREAK
10.45 – 12.30 pm	1-10	Study of short term variations of body condition of elephants in Udawalawe National Park
	1-11	Relationship between the body condition and the gastrointestinal parasitic prevalence of wild elephants in Udawalawe National Park
	1-12	Profiling harmful diatoms and dinoflagellates in selected fishery harbours along the Southern coast of Sri Lanka with risk mapping
	1-13	A future high altitude refugium for the white-eyes (genus Zosterops) of Sri Lanka is predicted as a result of dwindling climatic suitability
	1-14	Reproductive and development performances of laboratory-reared Aedes aegypti on ABO and Rh blood groups
	1-15	Intensity of occurrence of filariasis parasite species in adult mosquitoes and vector mosquito breeding habitats in selected areas in Gampaha district, Sri Lanka
	1-16	Toxic potential of the jewel of the seabed; Sea cucumber, Bohadschia vitiensis
	1-17	Changes in colour development induced by environmentally-relevant levels of lead and cadmium in hatchlings of the Japanese Quail (<i>Coturnix japonica</i>)

Parallel Session 2 – Plant & Environmental Sciences

Time	Abstract Number	Title
8.30 – 10.30 am	2-01	Development of an effective biocatalyst using Gliricidia sepium leaves and eppawela rock phosphate with Gliricidia sepium stem biochar
	2-02	Development of best fit models based on allometric equations to predict the clear bole height stem carbon content of Avicennia marina in Kadolkele and Rekawa mangrove forests
	2-03	Litterfall and leaf litter decomposition of Lumnitzera racemosa in Kadolkele mangrove forest, Negombo estuary, Sri Lanka
	2-04	Study on environmentally friendly approach to solve the water hardness problem - in Medawachchiya
	2-05	Chlorophyll-a estimation of Koggala lagoon using remote sensing
	2-06	Changes of land use and land cover in Madu Ganga Ramsar site, Galle Sri Lanka from 2005-2019
	2-07	Is "Green" always the "Most Clean"? – A comparison of Resource Efficient and Cleaner Production (RECP) between a green hotel and a conventional tourist hotel
	2-08	Performance of Azorhizobium bio-fertilizer in low cost substrate assessed by growth and yield parameters of rice (Oryza sativa) under field conditions
	2-09	Growth responses of the potential aquatic invader Echinodorus cordifolius (L.) Griseb. under different stimulated nutrient availabilities
10.30 – 10.45 am	SESSION BREAK	
10.45 – 12.30 pm	2-10	Tree species diversity and tree cover mapping in urban green spaces of a metropolitan university: A case study from University of Colombo, Sri Lanka
	2-11	Variation of stomatal anatomy of genus Syzygium in tropical forests along an altitudinal gradient in Sri Lanka
	2-12	Geo-accumulation index determination and spatial distribution analysis of heavy metals in sediments of the Ulhitiya reservoir, Sri Lanka
	2-13	Impacts of Land Use and Land Cover changes in an urban wetland on flood disaster: A case study from Muthurajawela wetland complex
	2-14	Assessing selected heavy metal levels in biotic and abiotic components of Diyasaru wetland park
	2-15	Epiphytic association of Acaryochloris marina (a cyanobacterium) with the green alga Valoniopsis
	2-16	Identification and characterization of heavy-metal tolerant fungi from Ussangoda serpentine soil, Sri Lanka
	2-17	Smartphone based effective navigation method for sample collection over a large geographical area

Parallel Session 3- Molecular Biology & Biotechnology

Time	Abstract Number	Title
8.30 - 10.30 am	3-01	Seed priming with polyamines improves germination of tomato under water stress
	3-02	An in silico study on elucidating the mechanism of alkane 1-monooxygenase 2 (AlkB2) enzyme catalysis of Pseudomonas aeruginosa PAO1
	3-03	Rv3095; A probable virulence regulator in <i>Mycobacterium tuberculosis</i>
	3-04	Genome-wide identification and analysis of Late Embryogenesis Abundant (LEA) genes in Banana (Musa acuminata L.)
	3-05	Phylogenetic affinities of a near-endemic montane insectivore; Hill Swallow
	3-06	The phylogenetic status of aberrant phenotypes of Dicrurus lophorinus (Sri Lanka Drongo): Hybrids or products of inbreeding depression
	3-07	Phylogenetic relationship of the Genus Ratufa (Giant Squirrels) in Tropical Asia
	3-08	Molecular phylogeny of Sri Lankan wild buffaloes based on genetic variability of the mitochondrial cytochrome b gene
	3-09	"The Signaling Iris"; Sex-biased iris dichromatism in endemic Sri Lanka Bush Warbler (Elaphrornis palliseri)
10.30 – 10.45 am		SESSION BREAK
10.45 – 12.30 pm	3-10	Weighted gene co-expression network analysis (WGCNA) of Arabidopsis somatic embryogenesis
	3-11	Predicting important proteins/genes involved in root development of <i>Oryza sativa</i> through protein-protein interaction (PPI) network module analysis
	3-12	Transcriptome analysis of Arabidopsis POL2 mutants – an insight to gene functions at a global scale
	3-13	DNA barcoding of lichen inhabiting fungi and phycobiont and probing for biologically active molecules from lichen inhabiting fungi
	3-14	In silico analysis of effector proteins to elucidate infection strategies of fungal plant pathogens
	3-15	In vitro meristem tip and nodal culture of Passiflora edulis
	3-16	In vitro response of Suduheenati and Pokkali rice varieties to salinity stress at early seedling stage
	3-17	Endophytic Trichoderma atroviride as biocontrol agents and growth promoters of the rice variety Bg 360

Parallel Session 4 - Microbiology & Chemical Biology

Time	Abstract	
	Number	Title
8.30 - 10.30 am	4-01	Probiotic activity of microorganisms used in traditional curd production in Gangabada, Gonnoruwa and Agbopura
	4-02	Effects of different homogenization time durations for enumeration of microorganisms from black tea: A case study in low country tea in Sri Lanka
	4-03	Screening for lipid degrading bacteria in polluted Kalu Oya river water and analyzing their lipase activities
	4-04	Screening for polyethylene degrading fungi from decaying hardwoods and plastic debris
	4-05	Assessment of Cd, Cr and Pb concentrations of leaves, roots and soil of compost applied <i>Centella asiatica</i> in Padaviya area
	4-06	Effects of dietary exposure of dietary lead and cadmium on vocalization of hatchlings of the Japanese Quail (Coturnix japonica)
	4-07	Comparative study of heavy metal contaminants in inland fish (Etroplus suratensis) during dry season
	4-08	Status of water quality in Malala-Embilikala lagoon system in Bundala National Park, Sri Lanka
	4-09	Some nutritional properties of Leiognathus sp., a common by-catch from shrimp trawl fishery in Jaffna, Sri Lanka
10.30 – 10.45 am		SESSION BREAK
10.45 – 12.30 pm	4-10	In-vitro anti-radical activity of Stylissa carteri and Axinella sp. marine sponge extracts
	4-11	Phytochemical content and antioxidant activity of the leaves and stems of <i>Plectranthus amboinicus</i> (Mexican mint) in Sri Lanka
	4-12	Anti-glycation and glycation reversing properties of Ceylon white tea
	4-13	In vitro anti-diabetic activity of Passiflora suberosa aqueous leaf extract and its fractions
	4-14	In vitro hypoglycemic potential in different fractions of methanolic extract of Caulerpa racemosa
	4-15	Antioxidant potential of Ceylon white tea
	4-16	Effectiveness of seed priming on germination and growth at the early seedling stage of selected Sri Lankan rice varieties, under saline conditions



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