

# ANNUAL REVIEW



NATIONAL INSTITUTE OF FUNDAMENTAL STUDIES  
SRI LANKA

2017



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## **Vision**

To be a renowned center of excellence for research in fundamental studies

## **Mission**

Initiate, promote and engage in advanced research in fundamental studies for the enhancement of scientific knowledge and development of human resources contributing to national development



**Prof. Vijaya Kumar**, Chairman of the Board of Governors, National Institute of Fundamental Studies is Professor Emeritus of University of Peradeniya, Sri Lanka having retired as Senior Professor in Chemistry. He was also Dean of the Faculty. He is the immediate Past President of the Science Council of Asia and of the National Academy of Sciences of Sri Lanka. He obtained his degree in Chemistry from the University of Ceylon and his doctorate from the University of Oxford. He has over 70 international publications and 130 scientific communications in the fields of Insect Related Chemistry, Biopesticides, Natural Products Chemistry and has made contributions in the debates on Science Education and Science Policy. He is the former Chairman of the Industrial Technology Institute, Sri Lanka and of the UN Commission on Science and Technology for Development. He was also a member of the UN Millennium Development Project Task Force 10 on Science, Technology and Innovation. He was also a Board Director of the ICT Agency of Sri Lanka. He has received several presidential Awards for Research and was bestowed the national Honour of Vidya Nithi in 2005.

# **Message from the Chairman, Board of Governors**



I am pleased to provide a message on the occasion of the 2017 Annual Review of the National Institute of Fundamental Studies (NIFS).

The NIFS is mandated to conduct research into fundamental studies in general, taken in the broadest sense, in the natural sciences, social sciences and philosophy.

The scientists of NIFS who are renowned in their fields have a great deal of freedom in choosing their areas of work and research projects. They are expected to carry out research at the cutting edge of science or on projects which will have an impact on problems faced by the people of Sri Lanka.

The Annual Research Review should provide scientists with an opportunity to demonstrate the high quality of the work they have carried out and to highlight the impact their work has had on the citizens of Sri Lanka. Scientists agree that scientific research should be subjected to critical peer review and I hope the reviewers and scientists invited to the review will critically analyze the work, identify any deficiencies or shortcomings and make suggestions on improving it while being lavish with praise where it is due. It is only through critical thinking and encouragement that science can flourish.

Although I have been Chairman only for a few months beginning this year, I am well aware of the impact the work of our scientists is having, the contribution that NIFS makes on popularizing science particularly among schoolchildren and the support provided by the technical and administrative staff in ensuring the smooth operation of the Institute.

I wish the Annual Review all success with the hope it will lead to a sharpened focus on good science and the achievement of results that can potentially have a high impact. It should hopefully result in identifying of new areas of work which would project the image of the Institute as the leading institution in the country engaged in basic research and the calibre of its scientists.



Vijaya Kumar, *D.Phil.(Oxon.)*

Chairman, Board of Governors, NIFS.

Immediate Past President, National Academy of Sciences, Sri Lanka.

Professor Emeritus, University of Peradeniya, Sri Lanka

The Annual Review 2017 is co-organized by the NRDF of the  
Ministry of Science, Technology and Research

## Message from the Director



I send this message with great pleasure on the occasion of the 2017 Annual Review of the National Institute of Fundamental Studies, Sri Lanka. This activity is designed as an open review of the scientific progress and discoveries made by NIFS scientists during the past year. The NIFS is a unique organization in Sri Lanka, designed to conduct and disseminate research at the frontiers of basic sciences for National Development. Some of the significant contributions made by NIFS scientists for the advancement of scientific knowledge are showcased on this occasion. Presently we focus on 16 different thematic research areas, under six research units. There are 16 project leaders and many young scientists engaged in this arduous task. The six research units are - Energy & Advanced Materials, Theoretical Physics & Computational Studies; Natural Product & Food Chemistry; Microbiology & Carbon Sequestration; Earth, Environment & Biodiversity; and Molecular Biology & Biotechnology. These research programs engage in active collaboration with national, regional and international scientific groups. NIFS scientists have been successful in securing competitive research funding from national and international donors, to support their research activities. During 2017, the NIFS was able to appoint five senior scientists to work in the Environmental Science, Food Science & Nutrition and Bioinformatics research projects. We have also initiated collaborative programs with organizations concerned with national development. The NIFS is now recognized as a major training center for postgraduate research in the country. Currently over 80 postgraduate students are at the NIFS, pursuing their scientific research programs leading to postgraduate degrees. In addition, the NIFS provides a platform to disseminate significant research findings and science education activities through the Science Education and Dissemination Unit of the NIFS.

I wish great success for the NIFS Annual Review – 2017.

A handwritten signature in black ink, appearing to read "ULB Jayasinghe".

Prof. Lalith Jayasinghe,  
Actg. Director / NIFS

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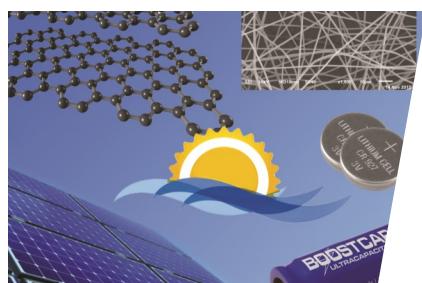
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## Editorial Board

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**Academic Activities**

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- Board of Governors
- Research Council
- Director's Office
- Administration Division
- Science Education & Dissemination Unit
- Consultative & Collaborative Division
- Sam Popham Arboretum, Dambulla
- Internal Audit Division
- Accounts Division
- Procurement & Laboratory Stores Division
- Technical Staff
- Library
- Budget
- Staff of the NIFS



## National Institute of Fundamental Studies

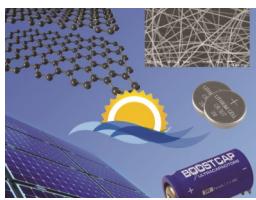
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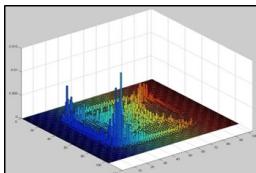
# Research Clusters and Units

## Energy & Advanced Materials



- Condensed Matter Physics & Solid State Chemistry
- Nanotechnology & Advanced Materials
- Energy & Advanced Material Chemistry
- Material Processing & Device Fabrication

## Theoretical Physics & Computational Studies



- Quantum Physics and Applied Electronics

## Natural Product & Food Chemistry



- Natural Products
- Nutritional Biochemistry

## Microbiology & Carbon Sequestration



- Microbial Biotechnology
- Bioenergy & Soil Ecosystems

## Earth, Environment & Biodiversity



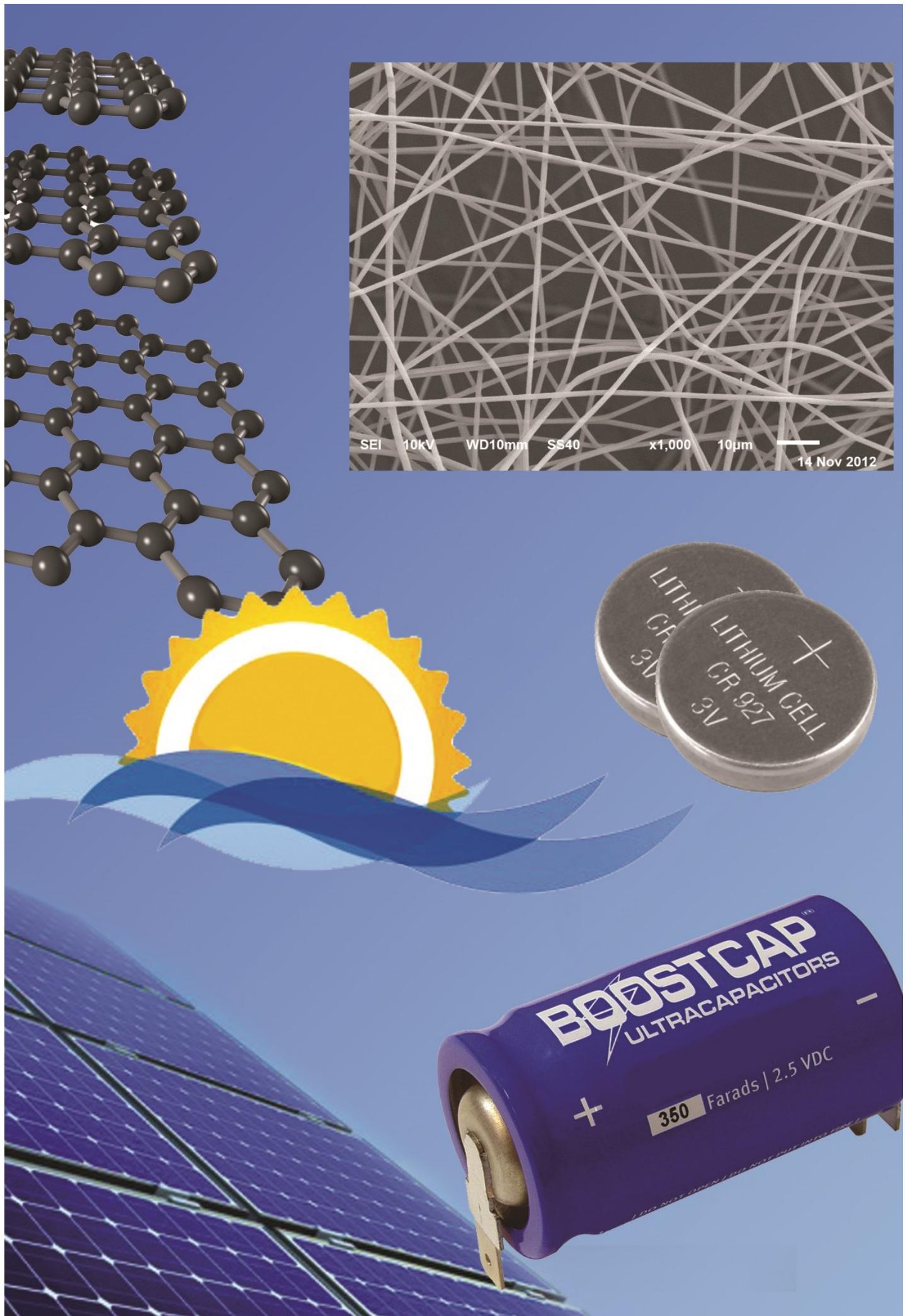
- Earth Resources and Renewable Energy
- Environmental Chemo-dynamics
- Ecology & Environmental Biology
- Plant & Environmental Science
- Plant Taxonomy & Conservation
- Primate Biology

## Molecular Biology & Biotechnology



- Molecular Microbiology & Human Diseases
- Medical Entomology

Project Leaders are responsible for authenticity of reports they have submitted



# Energy & Advanced Materials

Energy and Advanced Materials project unit at the National Institute of Fundamental Studies covers several ambitious projects dealing with technologically important novel materials and devices. These are being investigated under four broad themes: Condensed Matter Physics and Solid State Chemistry project mainly deals with synthesis and characterization of novel polymeric electrolytes for dye sensitized solar cells, rechargeable batteries and electrochromic display devices. Nanotechnology and Advanced Materials project covers target oriented fundamental and advanced investigations leading to develop Sri Lankan minerals and related materials for nano-technological and advanced materials based applications. Energy and Advanced Materials Chemistry project focuses on chemistry and physics of novel materials for the conversion of solar energy into chemical and electrical energies. Material Processing and Device Fabrication project involves experimentation and basic studies in Materials Processing and Device Fabrication with emphasis on graphite, graphite based devices and carbon supercapacitors.

- **Condensed Matter Physics & Solid State Chemistry**
- **Nanotechnology & Advanced Materials**
- **Energy & Advanced Material Chemistry**
- **Material Processing & Device Fabrication**

# Condensed Matter Physics & Solid State Chemistry

During 2017, the Condensed Matter Physics & Solid State Chemistry projects continued research studies on several scientifically intriguing and technologically important sub-projects. The main focus has been on (a) nitrogen doped TiO<sub>2</sub> based novel multilayer electrode for improved photovoltaic performance in dye sensitized solar cells. (b) PbS:Hg quantum dot-sensitized, high efficiency solar cell structures with triple layer TiO<sub>2</sub> photoanode, (c) efficiency enhancement in dye sensitized solar cells using nanostructurally modified tri-layer TiO<sub>2</sub> photoanode, (d) development of (PVdF-HFP) co-polymer nanofibre based gel electrolytes for dye sensitized solar cells, (e) development of Mg<sup>++</sup> ion conducting polymer electrolytes for rechargeable magnesium batteries and (f) fabrication of low cost, polymer nanofibre based water filter for arsenic removal from drinking water.

In addition, the group also continued to play a key role in the multi-university, “Solar Edu-Training” R&D and training programme administered through the Science, Technology and Research Ministry for building up a workforce of about 2000 youth ranging from A-Level students to MPhil/PhD researchers, competent in solar energy technologies.



**Vidya Nidhi M.A.K. Lakshman Dissanayake**, B. Sc. (Ceylon, 1970), M.S., Ph.D. (Indiana, USA, 1977), D.Sc. (Wayamba, Sri Lanka, 2013), Research Professor, National Institute of Fundamental Studies, Sri Lanka & Team Leader, Condensed Matter Physics & Solid State Chemistry Division (2011 to date); Professor Emeritus (Physics), University of Peradeniya. Formerly, Senior Professor of Physics & Professor of Solid State Physics, Head, Department of Physics, Director, Postgraduate Institute of Science (PGIS), University of Peradeniya; Visiting Research Professor, University of Illinois at Chicago, USA, Visiting Postdoctoral Research Fellow, Chalmers University of Technology, Sweden. **Awards:** “Vidya Nidhi” National Award (2005), Committee of Vice Chancellors and Directors (CVCD) Award for the Most Outstanding Researcher in Physical Sciences (2010), Doctor of Science (Hon. D.Sc.) (2013) for contributions to Physics research and Physics Education; Sri Lanka Association for the Advancement of Science (SLAAS) General Research Committee (GRC) Award, 2015, NSF Merit Awards for Research (1993, 2007), Presidential Research Awards for scientific publications (2000, 2010, 2013, 2014, 2015). **Distinctions:** Fellow, National Academy of Science, Sri Lanka; Fellow, Institute of Physics, Sri Lanka; President, Section E1 (Physical Sciences), Sri Lanka Association for Advancement of Science, 1990; Editor-in-Chief, Ceylon Journal of Science (from 2016); Founding Member & Council Member, Asian Society for Solid State Ionics (ASSSIS); President, Asian Physics Education Network (ASPEN: 2003-2008);

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## Visiting Research Professor



**G.K. Rohan Senadeera** B.Sc. (Sp) Physics 1991, (Perad), Ph.D. (Solid State Physics, 1996, Perad, (sandwiched with DTU-Denmark), Post Doc. Dip.(Chemistry and Chemical Engineering, TIT, Japan (1998). M.Sc. (Medical Physics, Reading),

Google Scholar *h*-index : 21 (No. of citations 1963) (2018 March)

Senior Lecturer (I) , Department of Physics, The Open University of Sri Lanka, (OUSL) (From 2010 to date). Visiting Associate Research Professor (NIFS) (From 2010 to date). Academic Coordinator, Faculty of Natural Sciences, Kandy Regional Centre, (2013-2016), OUSL

Project Leader - Solid State Chemistry Project, Research Fellow(1999-2004), Senior Research Fellow (2004-2007), Associate Research Professor (2007-2010) –Solid State Chemistry Project, National Institute of Fundamental Studies, (NIFS), Sri Lanka

Postdoctoral Researcher, CENIMAT, New University of Lisbon, Portugal (2008). JSPS Postdoctoral Research Fellow, Osaka University, Japan (2002-2003), UNESCO-MOMBUSHO Postdoctoral Research Fellow (1997-1998) , Tokyo Institute of Technology, Japan. International Program in Physical Sciences Fellowship, Uppsala University, Sweden for Ph.D. Research work at the Technical University of Denmark. (1992-1993) and (1994-1995).

Visiting Lecturer, Rajarata University, Sri Lanka (2002&2013), Visiting Lecturer, Postgraduates Institute of Science, University of Peradeniya, Sri Lanka (2012), Temp. Senior Lecturer (II) , Dept. of Physics, University of Peradeniya, Sri Lanka (1997).

Presidential Research Awards for years 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2007, 2008, 2010, 2013, 2014, Merit Award for Scientific Publication (2012) and (2015), National Research Council, Sri Lanka; The Open University Research Awards (2012,2013,2014,2015,2016)

Fellow, Institute of Physics Sri Lanka

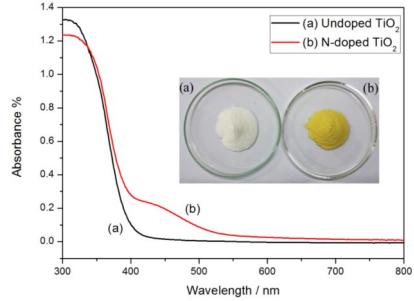
Editorial Board Member, Journal of Solar Energy Research Updates, Awanti Publishers (2015-), . Journal of Solar Energy Research Updates, Awanti Publishers (2015-), International journal of Inventions in Engineering & Science Technology, International journal of Inventions in Electronics & Electrical Engineering, International Journal of Research in Science and Technology, IRA publications , India.

Sri Lanka patent No. 11982, Japanese Patent applied by Nippon Kayaku Co, Ltd, Japan – NKS (JP2005135656) ([lens.org/lens/patent/JP\\_2005135656\\_A](https://lens.org/lens/patent/JP_2005135656_A))

([https://www.lens.org/lens/patent/JP\\_2005135656\\_A](https://www.lens.org/lens/patent/JP_2005135656_A)). Portugeese Patent by Y-Dreams – Portugal, PT 104634A ([https://www.lens.org/lens/patent/PT\\_104634\\_A](https://www.lens.org/lens/patent/PT_104634_A)).

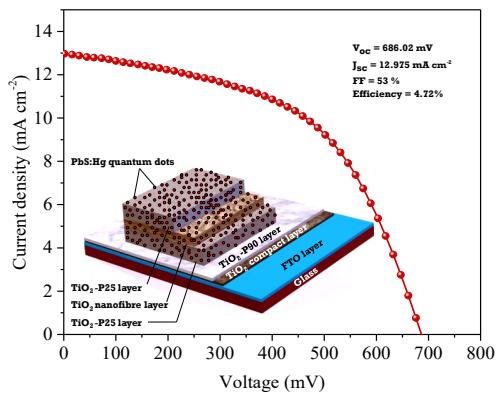
**Lecture Courses conducted for undergraduates/Postgraduates:** Geometrical and Optics, Senior Course coordinator), Medical Physics, (Senior Course coordinator), Bio Physics, (Senior Course coordinator 2013-2015), Atmospheric Physics, Waves and Vibrations, Electricity and Magnetism, Mechanics, Nuclear and particle physics, Basic and advanced electromagnetism, Solid State Physics, Conducting Polymers, Solar cells (for M.Sc), Radiation Physics (For M.Sc).

Nitrogen doped  $\text{TiO}_2$  based novel multilayer photoanode has been successfully used for improved photovoltaic performance in dye sensitized solar cells. The best energy conversion efficiency of 8% was achieved for the DSSCs with Compact Layer /P25/N-doped  $\text{TiO}_2$  three layer electrodes, which was 47% higher than the DSSCs with compact Layer /P25/ Undoped  $\text{TiO}_2$  three layer electrode. The DSSCs with the N-doped  $\text{TiO}_2$  possess higher photocurrent due to increased light harvesting by modified energy band gap and higher dye uptake.



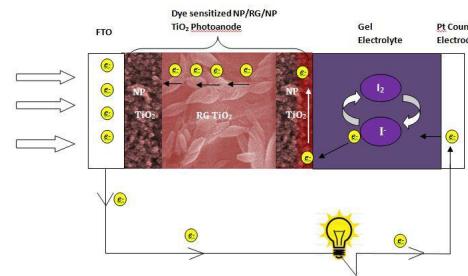
**Fig. 1:** (a) Undoped  $\text{TiO}_2$  powder in white colour (left) and (b) N-doped  $\text{TiO}_2$  (right) powder in yellowish colour prepared in this work. UV-VIS optical absorption spectra of the (a) Undoped  $\text{TiO}_2$  and (b) N-doped  $\text{TiO}_2$  powders.

Hg-doped PbS quantum dot-sensitized solar cells (QDSSCs) have been fabricated using successive ionic layer adsorption and reaction method with  $\text{TiO}_2$  single layer, double layer and triple layer nanostructures. The triple layer  $\text{TiO}_2$  photoanode was fabricated by using a  $\text{TiO}_2$  nanofibre layer sandwiched between two  $\text{TiO}_2$  nanoparticle layers in order to enhance light harvesting through effective light scattering process.  $\text{TiO}_2$  triple layer nanostructure based QDSSC showed a significantly higher energy conversion efficiency of 4.72 %.



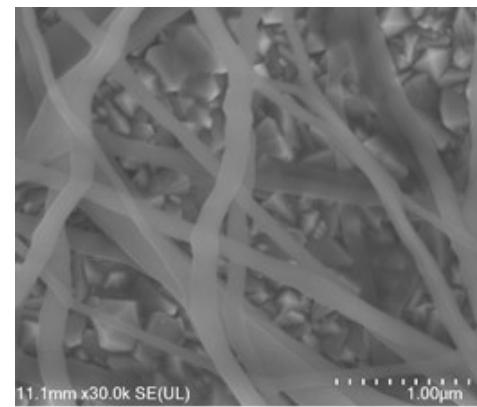
**Fig. 2:** A novel, PbS:Hg quantum dot – sensitized, high efficiency solar cell structure with triple layer  $\text{TiO}_2$  photoanode

A nanostructured, tri-layer  $\text{TiO}_2$  photoanode consisting of a rice grain-shaped (RG), electrospun  $\text{TiO}_2$  nanofiber layer (NF) sandwiched between two  $\text{TiO}_2$  nanoparticle (NP) layers has been successfully used for the efficiency enhancement in quasi-solid-state electrolyte-based dye-sensitized solar cells (DSSCs) (Fig.3). DSSCs fabricated with three-layer composite  $\text{TiO}_2$  nanostructured photoanode ( $\text{TiO}_2$  NP/RG/NP) showed an enhanced efficiency of 6.90%. Post-treatment of the three-layer photoanode with  $\text{TiCl}_4$  further enhanced the efficiency up to an impressive 7.30% which is among the highest for a quasi-solid-state DSSC.



**Fig. 3:** Schematic diagram of the solar cell fabricated using rice grain -shaped  $\text{TiO}_2$  nanostructure (not in scale).

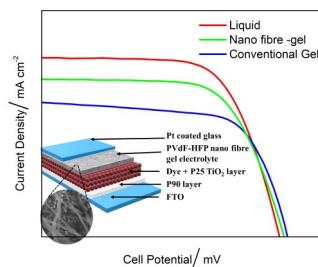
Quasi-solid state dye sensitized solar cells have been fabricated using poly (vinylidene fluoride-*co*-hexafluoropropylene) (PVdF-HFP) nanofiber membrane based quasi solid electrolytes. These solar cells showed an energy conversion efficiency of 5.36% whereas the efficiency of the DSSC made with the liquid electrolyte based cell was 6.01%.



**Fig. 4:** SEM images (top view) of the electro-spun PVdF-HFP nanofibre membrane deposited on FTO glass.

The polymer membrane used for the highest efficiency solar cell had a thickness of about 14  $\mu\text{m}$  and consisted of a three-dimensional network of polymer nanofibers with diameters between 100-300 nm.

This shows the possibility of replacing the liquid electrolyte in DSSCs by electro-spun polymer nanofiber based gel electrolyte and thereby minimizing some major drawbacks associated with liquid electrolyte based solar cells while maintaining a reasonably high efficiency.



**Fig. 5:** Performance of DSSCs with PVdF-HFP nanofiber membrane based quasi-solid electrolytes.

#### Research Students :

Ph.D. : CA Thotawattage

T Jaseetharan

M.Phil. : JMKW Kumari

AMJS Weerasinghe

M.Sc. : RA Jayarathna

#### Key publications:

M Dissanayake, J Kumari, GKR Senadeera, CA Thotawathage, B-E. Mellender, I. Albinsson, A novel multi-layered photoelectrode with nitrogen doped TiO<sub>2</sub> for efficiency enhancement in dye sensitized solar cells, *Journal of Photochemistry and Photobiology A: Chemistry* 349, 63-72, 2017.

T. M. W. J. Bandara, H. D. N. S. Fernando, M. Furiani, I. Albinsson, M. A. K. L. Dissanayake, J. L. Ratnasekera and B.-E. Mellander, Effect of the alkaline cation size on the conductivity in gel polymer electrolytes and their influence on photo electrochemical solar cells, *Physical Chemistry Chemical Physics*, 18 (16), 10873-10881, 2016.

M.A.K.L. Dissanayake, H.K.D.W.M.N. Divarathna, C.B. Dissanayakea, G.K.R. Senadeera, P.M.P.C. Ekanayake, C.A. Thotawattage, An innovative TiO<sub>2</sub> nanoparticle /nanofibre/nanoparticle, three layer composite photoanode for efficiency enhancement in dye-sensitized solar cells, *Journal of Photochemistry and Photobiology A: Chemistry*, 322, 110-118, 2016.



**From Left:** Mr S. Senthuran, Mr A.MJS Weerasinghe, Mr. T Jaseetharan, Prof. MAK Lakshman Dissanayake,

Prof. GK R Senadeera, Mr. CA Thotawattage, Ms. MG CM Kumari.

# Nanotechnology and Advanced Materials

Nanotechnology and Advanced Materials are two emerging fields that primarily responsible for the recent technological advancements in creating a new sort of highly profitable high-tech industrial applications. These applications are mostly dependent on material resources, specially acquired through upgrading natural minerals. In the light of this, Sri Lanka possess a variety of technologically important minerals, which can play a major role in these high-tech applications. However, upgrading of our minerals suitable for these applications has almost been lacking in the country, due to dearth of advanced scientific research conducting along higher value addition to our mineral resources.

Therefore these factors inherent to our country are carefully considered when planning our research activities through adapting or contributing to the advancement of Nanotechnology and Advanced Materials fields. Accordingly, this project highly emphasizes on performing fundamental, but target oriented, advanced scientific investigations through developing our mineral resources for those highly profitable industrial applications. Investigation on novel advance semiconductors for energy conversion/storage, mainly for novel rechargeable batteries, is another important research area carried out by this project. Under that, a number of research investigations are been performed to develop transition metal based semiconductors by introducing modern nano technological techniques/processes.

Based on the outcome of this project, already three local patent applications have been applied and some of these findings have a higher potential for commercialization. Presently, arrangements are being made for collaborations on R&D and product development leading to commercialization of lithium batteries, upgraded graphite and graphite based nano materials.



**Athula Wijayasinghe** obtained his B. Sc. (1994) from University of Peradeniya in Sri Lanka, LIC (Eng.) and Ph.D. (2004) in Materials Science from KTH (Royal Institute of Technology) in Sweden; Research Fellow (Nanotechnology & Physics of Materials)/National Institute of Fundamental Studies, Sri Lanka (2013 to date); Senior Lecturer/Specialization area Coordinator/Research Coordinator (Materials Science and Technology) (2009-2013)/Uva Wellassa University, Research Fellow (Electrochemical Materials) (2005-2009)/ Institute of Fundamental Studies; Assi. Professor (Froskar) in Materials Science and Engineering (2004-2005)/KTH (Royal Institute of Technology), Sweden; Doktorander in Materials Science and Engineering (1999-2004)/ KTH (Royal Institute of Technology), Sweden; Fellowship of the International Science Program (1999-2001)/Uppsala University, Sweden. Visiting Assi. Professor (Froskar) in Materials Science and Engineering (2005) /KTH (Royal Institute of Technology), Visiting Scientist in Materials Science and Engineering (2007)/KTH (Royal Institute of Technology), Sweden. **Awards:** Precedential Research Awards; NRC merit awards for scientific publication. Research publications have received 233 citations (December 2017).

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**This project has just completed its first five years, involved with fundamental but target oriented scientific investigations carried out on the following four sub projects.**

### **Development of Sri Lankan graphite for rechargeable battery applications**

The main objective of this sub-project is the very high value addition to Sri Lankan natural vein graphite suitable for extensively used highly demanding Li-ion rechargeable batteries. It is accomplished through upgrading our natural graphite subjecting to a thorough low-cost purification processes and appropriate modifications, to prepare highly valuable “battery grade” graphite.

Already, a number of successful low-cost purification (> 99.9% purity) and surface modification techniques have been invented. Based on that, three local patent applications, which have a high potential for commercialization, have been filled. Already arrangements have been made for R&D and product development work leading to commercialization of lithium batteries.

### **Advanced transition metal semiconductors for energy conversion applications**

Initially, the effect of the precursor on crystal growth in nano particle formation will be investigated under this sub-project in order to develop efficient and low-cost nano particle . This finding was extended to develop performance enhanced novel transition metal semiconductor based cathode material of  $\text{NaNi}_{0.3}\text{Mn}_{0.4}\text{Co}_{0.2}\text{Li}_{0.1}\text{O}_2$  synthesized by Glycine-nitrate combustion method. It successfully resulted the required material with pure hexagonal P- type layered structure.

### **Deriving of nano-materials and composites from Sri Lankan graphite.**

This sub-project involves with deriving nano-materials and nano-entities having diverse characteristics and performance out of our graphite structural varieties. Our preliminary investigations showed the easiness to convert local vein graphite into graphene with higher efficiency. It further revealed some important findings on the effect of the structural variety on the properties and the yield of graphene Our investigations were further extended to graphite based nano composites fabricated with low-cost materials, for new technological applications.In such study, grphene/Ag nano-composite prepared using vein graphite showed an extraordinary behavior as an antimicrobial agent for pathogenic micro-organisms in the environment.



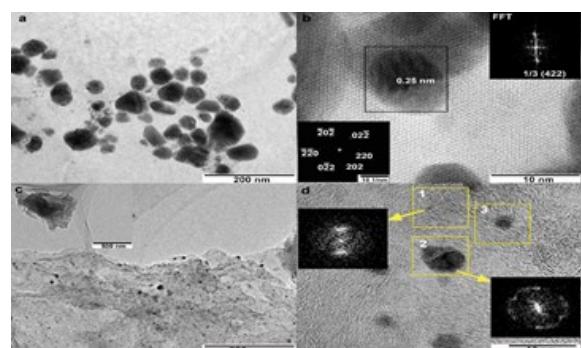
**Battery testing facility developed at NIFS**

This project also involves with development of our graphite for the upcoming novel Na-ion, Mg-ion and related hybrid rechargeable batteries. This is mainly aiming for the growing future market of graphite products for novel rechargeable batteries. So far the work carried out by subjecting graphite into structural modification to facilitate ion intercalation has shown promising outcome.

Further this cathode material revealed a promising cyclability with an initial specific discharge capacity of  $153 \text{ mA h g}^{-1}$  in Na-ion half-cell.



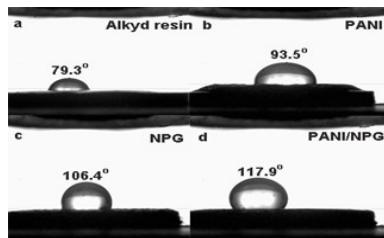
**Battery assembling facility developed at NIFS**



**Transmission electron microscopy images of Ag particles, Ag-graphene composite**

It indicates the possibility to develop potential antimicrobial agents from our vein graphite.

In another study, Polyaniline/vein graphite composites showed a very low corrosion rate of 29 µm per year, and high hydrophobicity on steel surfaces, which can help to prevent the corrosion due to O<sub>2</sub> penetration towards the metal surface. It indicates that this composite can be used as a high potential protective coating material for steel surfaces.



Contact angle measurements of (a) Alkyd resin, (b) PANI, (c) graphite and (d) composite

### Development of materials for efficient water purification using local minerals

Though Sri Lanka possess a variety of minerals capable for water purification, no proper efforts has been put forward for using them in efficient water filtration. This sub-project engages with developing those already identified potential minerals as filter materials, through property enhancement and forming into effective structures. The property enhancement is carried out through purification of materials followed by subjecting to morphological and structural modifications. Presently, a number of local minerals such as clays and sands together with bio materials are under investigation

The ultimate aim is the designing of low-cost water filters with our developed materials to improve the quality of drinking water.



Studying of material properties for water purification

#### Research Students:

M. Phil. : Nimali Rathnayake (Completed)

Sasanka Hewathilake (Thesis under examination)

Niroshan Karunaratne (M. Phil. student)

Heshan Kamalajith (M. Phil. student)

Thilani Senevirathna (M. Phil. student)

Niruba Kanagaratnam (M. Phil. student)

Ajantha Kumara (M. Phil. student)

M. Sc. : Anushka Sajeevani

R.M.N.M.Rathnayake, M.M.M.G.P.G. Mantilaka, Masanori Harac, Hsin-Hui Huang, H.W.M.A.C. Wijayasinghe\*, Masamichi Yoshimura, H.M.T.G.A. Pitawala, Graphite intercalated polyaniline composite with superior anticorrosive and hydrophobic properties, as protective coating material on steel surfaces, *Applied Surface Science*, 410 (2017) 445-453.

T. H. N. G. Amaraweera, Athula Wijayasinghe, B.-E. Mellander and M. A. K. L. Dissanayake, Development of Li(Ni<sub>1/3</sub> Mn<sub>1/3</sub> Co<sub>1/3-x</sub> Na<sub>x</sub>)O<sub>2</sub> cathode materials by synthesizing with glycine nitrate combustion technique for Li-ion rechargeable batteries, *Ionics* 23 (2017) 3001-3011

#### Key Publications:

H.P.T. Sasanka Hewathilake, Niroshan Karunaratne, Athula Wijayasinghe, N.W.B. Balasooriya, and A.K. Arof. Performance of developed natural vein graphite as the anode material of rechargeable lithium ion batteries, *Ionics* 23 (2017):1417-1422.



**From Left:** Dr. N Aththanayake, Mr. GDK Heshan, Ms. T Senevirathna, Dr. G Amaraweera, Dr. A Wijayasinghe,

Mr. WG Jayasekara, Dr. N Balasooriya, Mr. N Karunaratna, Mr. A Kumara, Ms. C Kalubowila, Ms. N Kangarathnam

# Energy & Advanced Material Chemistry

The main objective of the project is to carry out research on renewable energy. Research is mainly focused on chemistry and physics of new materials for the conversion of solar energy into chemical and electrical energies. Extending and adapting current photovoltaic technology mainly dye-sensitized, Q-dot and polymer solar cells to generate electricity directly from solar radiation; Constructing artificial chemical devices mimicking photosynthesis to collect, direct, and apply solar radiation, for example to split water, convert atmospheric carbon dioxide and thus produce various forms of environmentally clean fuels; Chemical, Electrochemical and Photochemical methods for the purification of air and water are the main research topics of the project. Additionally, the project also involves investigation of low cost water and air purification methods for abatement of industrial pollutants by using sunlight. Under the research topics of conversion of solar energy into either electrical or chemical energy mentioned above, the fundamental requirements are; sunlight must absorbed efficiently by light harvesting materials; photoexcited electron and holes must be separated in space to prevent recombination; photoexcited charge must be energetically and kinetically able to perform a chemical transformation and hence we investigate all these factors in our research. Additionally the group is also involved in CKDu research.



Jayasundera Bandara, is a Senior Research Professor at the National Institute of Fundamental Studies, Sri Lanka since 2015 to date. Prior to his current position, he worked as a Research Professor (2009-2015);, Senior Research Fellow (2005-2008) and Research Fellow (1999-2004) at the same institute.

His research is focused on novel materials and nanostructures for improved performance of dye/q-dot sensitized solar cells and solar fuels production. His Other research interests include remediation of environmental pollutants and CKDu. He has published 77 research publications in SCI journals and these research publications have received 4481 citations (December 2017); Google Scholar h-index of 34). He was honored by UNESCO/Japan fellowship (1991-1992), Tokyo Institute of Technology, Japan; Swiss Government Fellowship (1994-1998), EPFL, Switzerland, Postdoctoral Fellow (2000-2001), Tufts University, USA; Visiting Professor (Oct 2004-Feb 2005), EPFL, Switzerland, Geroge Foster Humboldt Fellowship (2007-2008), Bayreuth University, Germany; Visiting Scientist (2009), Bayreuth University, Germany; Humboldt Fellowship (August- Oct 2013), Frie University, Germany; Tubitak Fellowship (August-oct, 2014), Bilkent University, Turkey; Humboldt Fellowship (July-September 2016), Max-Plank institute, Germany. Awards: Young Scientist Award, NASTEC (2005), Presidential Research Awards (2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, 2011, 2014, 2015); NRC Merit Award for Scientific Publication (2012, 2013).CAS president's international fellowship initiative(pifi) award (May,2017-April 2018), Chinese Academy of Science, China.

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## Photocatalytic water splitting

This is considered as one of the most important renewable paths and a reliable hydrogen production system yet to be achieved. In most successful molecular and supramolecular biomimetic hydrogen production methods, a photosensitizer and a catalyst were constructed where photoexcited electron in photosensitizer is transferred either inter- or intramolecularly to the catalytic centre. However, it is challenging to achieve efficient transfer of electrons in supramolecular complexes. Similar to supramolecular complexes in a photocatalytic hydrogen production scheme, here we developed a redox system that contains  $Ti^{3+}/Ti^{2+}$  reduced states in  $TiO_2$  which act as both visible light harvesting component as well as the catalytic site for the catalytic hydrogen production with visible-NIR photons. The  $Ti^{3+}/Ti^{2+}$  states in  $TiO_2$  produce hydrogen from pure water with a solar-to-hydrogen energy conversion efficiency of 1.0% and yield of 43% at 655 nm. In the mechanism of hydrogen production by  $Ti^{3+}/Ti^{2+}$  reduced states in  $TiO_2$ , which involves the initial generation of highly air stable and deeply reduced  $Ti^{3+}$  and  $Ti^{2+}$  states in  $TiO_2$  by the active metal and once  $Ti^{3+}$  and  $Ti^{2+}$  states are generated, these states are continuously self-generated via absorption of visible-NIR radiations where hydrogen is produced by transfer of electrons from  $Ti^{2+}$  to  $H^+$ .

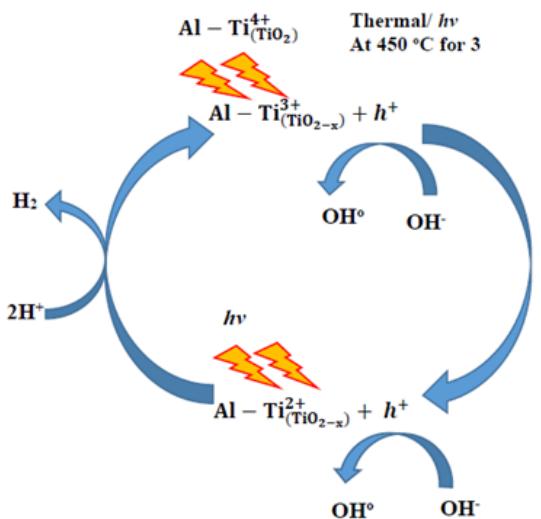


Figure 1: Schematic diagram of the proposed water splitting mechanism

These catalytic systems will be further developed to construct an artificial chemical devices mimicking photosynthesis to collect solar radiation and to produce various forms of environmentally clean fuels by conversion of carbon dioxide and water.

## Photochemical methods for the purification of air and water

Under this project, IR radiation active photocatalyst was further developed for the degradation of airborne pollutants. One-dimensional  $TiO_2$  nanotubes were synthesized by hydrothermal method and silver ( $Ag/Ag_2O$ ) was conformally deposited in 1-D  $TiO_2$  nanotube as shown in Figure 2. IR photon initiated catalytic activity of ( $Ag/Ag_2O$ ) deposited 1-D  $TiO_2$  nanotube was investigated for the degradation of airborne pollutants. The comparison of catalytic activity of ( $Ag/Ag_2O$ ) deposited 1-D  $TiO_2$  nanotubes and  $TiO_2$  nanoparticles revealed that the  $TiO_2$  nanotubes exhibit superior indoor photocatalytic activity than the  $TiO_2$  nanoparticles. The mechanistic investigation of the photocatalytic systems indicated that the enhanced catalytic activity of ( $Ag/Ag_2O$ ) deposited  $TiO_2$  nanotube was due to enhanced carrier density and diminished charge recombination rates of  $TiO_2$  nanotubes based photocatalysts.. As the photodegradation described in this report involves low energy IR photons under ambient indoor conditions, the catalytic system can be applied for the degradation of common airborne pollutants.

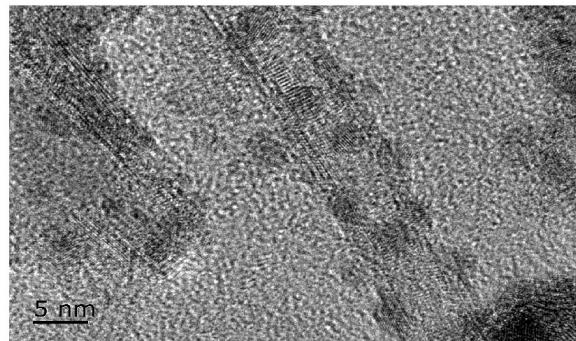


Figure 2: High resolution TEM image of Ag/Ag<sub>2</sub>O coated 1-D  $TiO_2$  nanotubes

A laboratory scale reactor was designed for the removal of waste oil-water discharged from service stations. In this case, mica or  $TiO_2$  nanofibers coated stainless steel mesh was employed as a membrane to remove oil water from water. The  $TiO_2$  nanofibers and mica coated stainless steel membranes exhibit underwater superoleophobic membrane that permit effective separation of contaminated oil-water mixture. . The membrane was fabricated by spray deposition of hydrothermally synthesized  $TiO_2$  nanofibers on stainless steel mesh. The fabricated membrane exhibits superhydrophilicity and superoleophobility properties in air and underwater respectively allowing the separation of oil water efficiently.



**Figure 3:** Physical reactor option 1, oil can be collected from the second compartments and water can be collected from the third compartment and membrane is fixed in the union between 2 and 3

\* Fabrication of multi-layered quantum dot sensitized solar cells, especially q-dot solar cells that contain more than two layers of q-dots as light harvesting materials is a great challenge due to adverse effects of the outer layers of quantum dot on the inner optimized q-dot layer. In this work, multi band gap q-dot semiconductor materials of PbS (Bandgap 1.16 eV), CdS (Bandgap 2.01 eV) and CdSe (Bandgap 1.76 eV) were stacked in different combination on mesoporous TiO<sub>2</sub> layer to enhance the light harvesting ability and the problems associated with stacking of multi layers of q-dots were investigated.

The observed photovoltaic properties of multiband q-dot solar cells with different stacking configurations were then compared with the optical and electronic properties of multi band gap quantum dots.

#### Research Students :

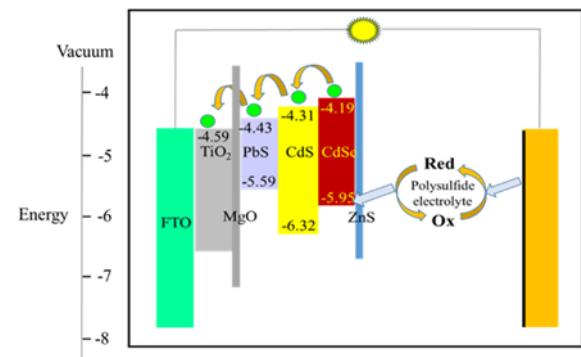
Ph.D. : A Manjeevan.

M.Sc./M.Phil. : KMSDB Kulatunge, KCI Buddika, L Abeykone.

#### Key publications :

A Gannoruwa, B Ariyasinghe, J Bandara, The mechanism and material aspects of a novel Ag<sub>2</sub>O/TiO<sub>2</sub> photocatalyst active in infrared radiation for water splitting, *Catal. Sci. Tech.* 6 (2), 479-487, 2016

The optimized three-layer PbS/CdS/CdSe q-dot solar cell showed a solar cell efficiency of 6.2% while two -layer q-dot solar cells fabricated with PbS/CdS and CdS/CdSe showed solar cell efficiencies of 5.8 and 4.2% respectively. The enhanced solar cell performance of three-layer PbS/CdS/CdSeq-dot solar cell was found to be mainly due to higher light harvesting ability and enhanced charge transport ability and enhanced charge transport ability of such cascade arrangement of three layer arrangement than the two -layer q-dots arrangements



**Figure 4:** Schematic diagram with energy level cascade arrangement of PbS/ CdS/ CdSe QDSSCs with TiCl<sub>4</sub> and MgCl<sub>2</sub> treated TiO<sub>2</sub> photoanode.

UB Gunathilake, J Bandara, Efficient removal of oil from oil contaminated water by superhydrophilic and underwater superoleophobic nano/micro structured TiO<sub>2</sub> nanofibers coated mesh, *Chemosphere* 171, 134-141, 2017

MY Yaman, AS Han, J Bandara, C Karakaya, O Dag, Modifying Titania Using the Molten-Salt-Assisted Self-Assembly Process for Cadmium Selenide–Quantum Dot-Sensitized Photoanodes, *ACS Omega*, 2 (8), 4982-4990.



**From Left:** Mr. KCI Buddika, Mr. KNL de Silva, Mr. UB Gunathilake, Prof. J Bandara, Mr. KMSDB Kulatunge, Mr. AMKL Abeykoon, Ms. D Aluthpatabedi, Ms. DS Dharmagunawardena

# Material Processing and Device Fabrication

Project involves experimentation and basic studies in Material Processing and Device Fabrication with emphasis on graphite, graphite-based devices, carbon super-capacitors, and investigations related to solar cells and other electronic devices based on new materials primarily generated from local minerals.

Work related to graphite will be the exfoliation of graphite and derivation into graphene plates, preparation of graphene thin films and their use in electronic devices. Furthermore, the project plans to conduct research in the area of extremely thin absorber solar cells and developing hole conducting materials to be used in these solar cell devices.

The project also involves the conversion of waste materials, such as coconut shells, to highly porous and electronically conducting activated charcoal for versatile applications in electronic devices such as supercapacitors, counter electrodes of solar cells, in order to develop fast charge stations for latest technology electrical motor vehicles. Expanded graphite derived from Sri Lankan vein graphite are meant to be used in water and air purification and cleaning oil spills on water.

The project ideas stand forefront of current research in the area of Materials Processing and Device Fabrication related to Energy Conversion and Storage and Other Electronic Devices. Theme is nationally relevant and is highly important. It is geared towards utilization of locally available materials with the aim of adding enormous value to local minerals, plant dyes, in order to help improve National Economy through developing cutting edge local industries capable of manufacturing solar cells and other electronic devices locally by utilizing the outcomes of the research.



**G. R. A. Kumara** B. Sc. (1993), University of Peradeniya; M. Phil. (by research) (1997), University of Sri Jayawardenapura; Ph. D, (2001) Shizuoka University, Japan; Research Professor, NIFS Sri Lanka (January 2017 to date); Visiting Professor, JSPS: Toyota Technological University, Japan, 2016; Postdoctoral Research Fellow: Department of Chemistry, University of Peradeniya, (2014-2015); Commissioned Scientist: Toyota Technological University, Japan, (2015); Senior Research Fellow: Department of Chemistry, University of Peradeniya, (2011-2014); Honorable Guest Professor: Research Institute of Electronics, Shizuoka University, Japan, (2009-to date); Senior Scientist: SPD Laboratory, Hamamatsu, Japan (2006-2010); Temporary Senior Lecturer: Department of Chemistry, University of Peradeniya, (2009-2011); Postdoctoral Fellow, JSPS, Shizuoka University, Japan, (2004-2006); Postdoctoral Fellow, JST, Shizuoka University, Japan, (2004); Visiting Researcher: Shizuoka University, Japan, (2003); Assistant Professor: Shizuoka University, Japan (2001-2003); MONBUSHO Japanese Government Fellowship, (1999), JST Japanese Government Fellowship, (2004); JSPS Japanese Government Fellowship, (2004); JSPS Japanese Government Visiting Professor Fellowship (2016). **Awards:** Young Scientist Awards, TWAS-Italy & NARESA, Sri Lanka, (1996); President's Research Award (1999, 2010, 2011, 2012, 2016, 2017); NRC Merit Award, (2013); NSF SUSRED Awards, (2013, 2016); Citations 4353.

Google Scholar h-index: 33

Position: Research Professor NIFS

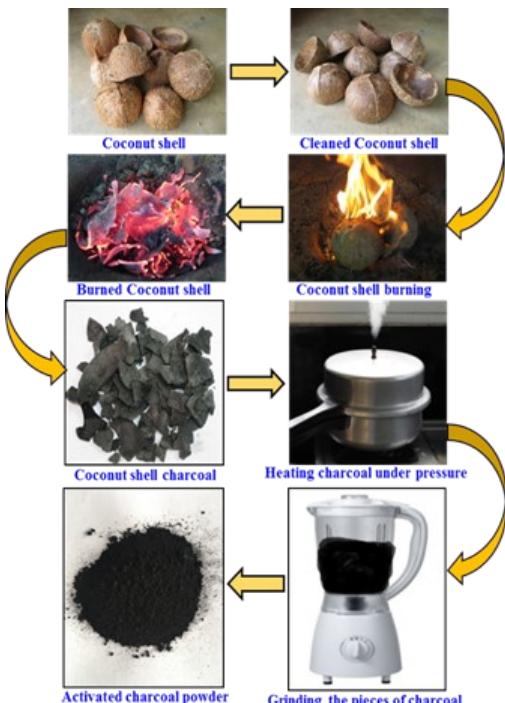
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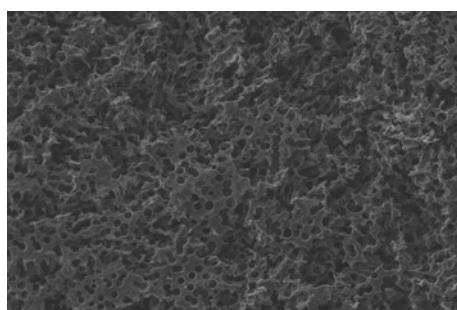
Web site: [www.nifs.ac.lk/?research-project=material-processing-device-fabrication](http://www.nifs.ac.lk/?research-project=material-processing-device-fabrication)

## SUPERCAPACITORS FROM COCONUT SHELLS

Development of supercapacitors attracts a great deal of attention of both academic and industrial communities throughout the world as they are more environmentally friendlier than batteries and admit extraordinarily large number of charge-discharge cycles, without an appreciable decrease in the performance. Besides, supercapacitors can be charged and discharged very quickly compared to batteries and hence they are instrumental in developing fast charging stations for batteries of electrical motor vehicles. These supercapacitors are made with a membrane sandwiched between electrolyte impregnated highly porous and highly electrically conductive electrodes which are made of readily available, low-cost materials. Coconut shell charcoal that we produce in this research fulfills both these requirements since this charcoal is not only highly porous but also highly electrically conducting.



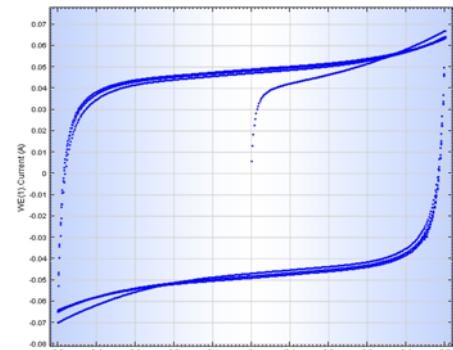
**Fig. 1:** Schematic representation of the steps involved in converting coconut shells to highly porous and electrically conducting activated charcoal



**Fig. 2:** SEM image show the highly porous nature of the activated coconut shell charcoal.



(a)



(b)

**Fig. 3:** (a) A supercapacitor developed in this project (b) Its performance in the form of current-voltage curve

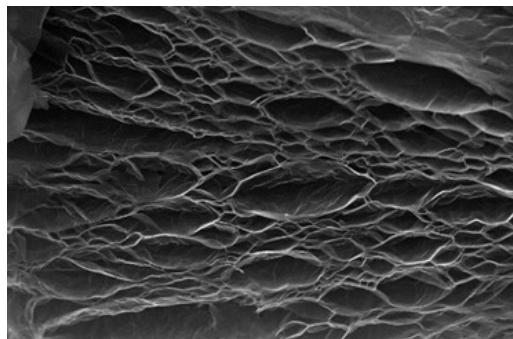
Supercapaciots have to be charged by supplying electrical energy. If the required electrical energy is supplied from the National Grid, then there is always a loss in energy. To circumvent this problem, we propose to use a solar panel to produce electricity and store in the supercapacitors. By this way, supercapaitors are charged from electricity produced freely available solar energy thus not involving any cost for electricity. The solar panels to be used have already been developed and Figure 4 shows a large scale solar panel constructed using a large number of solar cell modules which was developed by the researcher.



**Fig. 4:** Solar Panel constructed by the researcher.

## LOW-COST COUNTER ELECTRODES FOR DYE-SENSITIZED SOLAR CELLS

Dye-sensitized solar cells (DSCs) offer a cheaper and environmentally friendlier approach to electricity generation compared to conventional silicon and other types of solar cells. However, 40% of the cost of DSC is due to platinum used in its counter electrode (CE). This research is devoted to substituting expensive platinum with low-cost catalysts derived from mundane and waste materials such as coconut shells and expanded graphite derived from Sri Lankan natural vein graphite.



**Fig. 5:** SEM image to show the enlarged interlayer spaces.

### Research Students

Ph.D.: KDMSPK Kumarasinghe

M.Sc.: D.N. Liyanage

A.W.M.V. Ekanayake

Table 1. shows the performance of DSCs with Pt-based CE, expanded graphite-based (EG) CE and activated coconut shell charcoal-based (ACSC) CE. Although activated coconut shell charcoal and expanded graphite products are very much cheaper than platinum, performances of the three DSCs are comparable and hence the three DSCs hence the DSCs based on cheaper CEs are more economically viable than conventional DSCs based on platinum CEs.

**Table 1:** Comparison of the DSC performance with different CEs.

CEs	Jsc (mA/cm <sup>2</sup> )	Voc (V)	FF (%)	h (%)
Pt	16.69	0.754	0.74	9.14
EG	15.43	0.730	0.72	8.07
ACSC	15.04	0.691	0.70	7.27

Ranasinghe, C.S.K., Jayaweera, E.N., Kumara, G.R.A., Rajapakse, R.M.G., Bandara, H.M.N., Yoshimura, M. (2015) Low-Cost Dye-Sensitized Solar Cells Based on Interconnected FTO-Activated Carbon Nanoparticulate Counter Electrode Showing High Efficiency, *Journal of Materials Science and Engineering A*, 5,361-368.

### Key Publications:

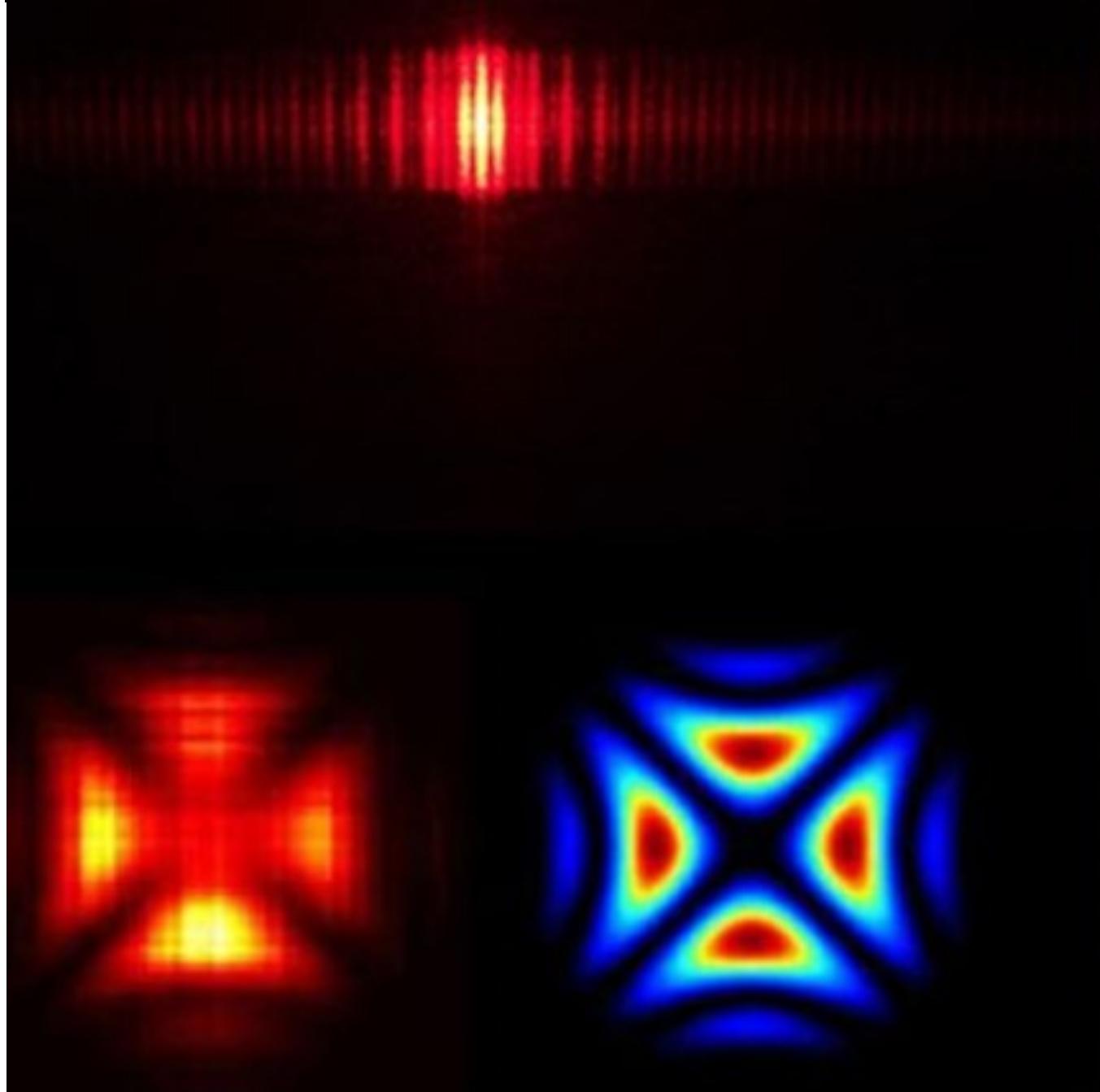
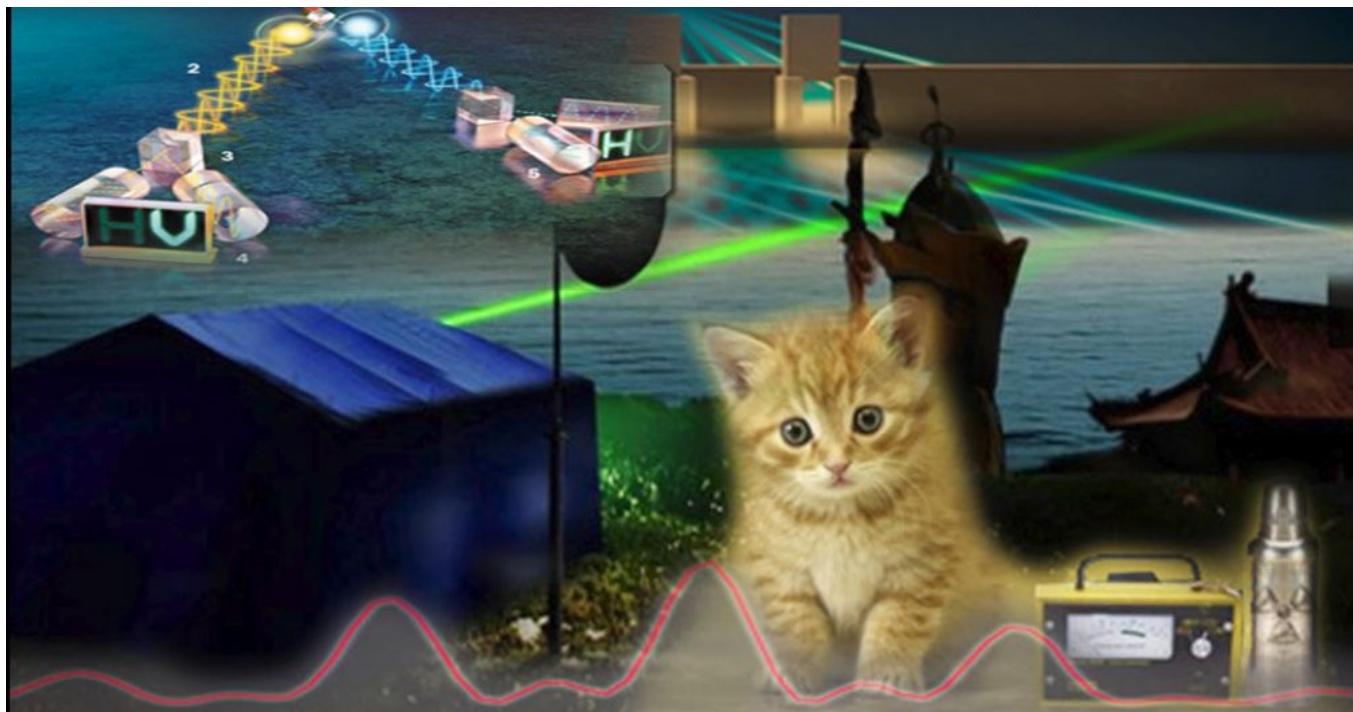
Jayaweera, E.N., Kumara, G.R.A., Pitawala, H.M.G.T.A., Rajapakse, R.M.G., Gunawardhana, N., Bandara, H.M.N., Senarathne, A., Ranasinghe, C.S.K., Hsin-Hui Huang, Yoshimura, M. (2017). Vein graphite-based counter electrodes for dye-sensitized solar cells, *Journal of Photochemistry and Photobiology A: Chemistry*, 344,78-83.

Kumara, G.R.A., Ranasinghe, C.S.K., Jayaweera, E.N., Bandara, H.M.N., Okuya, M., Rajapakse, R.M.G. (2014). Preparation of fluoride-doped tin oxide films on soda-lime glass substrates by atomized spray pyrolysis technique and their subsequent use in dye-sensitized solar cell, *Journal of Physical Chemistry C*, 118,16479-16485.



**From Left:** Ms. KDMSPK Kumarasinghe, Prof. GRA Kumara, Mr. A Abeysekara, Ms. DN Liyanage





# **Theoretical Physics & Computational Studies**

In Theoretical Physics and Computational Studies Research Unit at NIFS, we use the tools of theoretical and computational physics to address, explain and understand the physical world surrounding us. This research unit consists of projects under the areas of foundations of quantum mechanics and Single Bubble sonoluminescence (Mysteries of Energy Focusing Phenomena). Specifically the Quantum Physics research Group is currently engaged in investigating fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.

- **Quantum Physics & Applied Electronics**

# Quantum Physics & Applied Electronics

## Quantum Mechanics

Quantum mechanics, quantum field theory and relativity together form the theoretical foundations of modern physics. Even 100 years after its inception fundamental aspect of quantum mechanics is one of the most dynamic areas of current physics research. In particular, fundamental research on Quantum Non-locality, Quantum Entanglement and Quantum to Classical Transition is not only very important in understanding the true nature of the quantum reality but also their existence has practical consequences, enabling much stronger forms of information processing, communication and quantum computing. Quantum physics research Group at NIFS which was initiated in January 2016 is currently engaged in investigating fundamental aspects of Quantum to Classical Transition, Quantum chaos, Quantum Computing and Quantum non-locality.



**Asiri Nanayakkara** BSc in Mathematics (University of Colombo); MS in Physics (Ohio University USA); PhD in Physics (Iowa State University, USA). He has been a postdoctoral researcher at University of Bristol (UK), Ames laboratory (USA) and Supercomputer computations research institute (USA). He has also worked as a computational Scientist at CRAY Research inc. (USA) before joining NIFS.

## Introduction

One of the unique features of quantum systems is quantum non-locality due to entanglement. On the other hand, the processes of quantum decoherence can provide clues about the mechanism of wave function collapse and quantum to classical transition. Quantum decoherence and entanglement can be investigated both theoretically as well as numerically by means of quantum random walks that are the quantum counterpart of classical random walks. Further quantum walks provide a testing ground for various aspects of decoherence, wave function collapse and quantum to classical transition.

Although single particle one dimensional quantum walk cannot exhibit entanglement within the coin degree of freedom or the position degree of freedom separately, the conditional shift in the evolution operator of a quantum walk generates entanglement between coin and position degrees of freedom. Many investigations have been carried out for generation and utilization of entanglement in multidimensional quantum random walks as well as multiparticle random walks. Even though multidimensional coin operators constructed by taking direct tensor products of one dimensional unitary operators usually preserves entanglement if the initial coin state is entangled, they do not generate entanglement if the initial coin state is a product state.

## Research activities

During 2017 we carried out several investigations regarding quantum and classical correlations and periodic nature of quantum random walks. In the first study, we investigated how the conditions in classical walks manifest in the corresponding quantum walks as correlations by introducing a class of quantum coins which represent classical conditions. It was found that there is a direct link between conditions in the classical walks and the classical correlations in the corresponding quantum walks. When the two particle motion in the classical walk is statistically independent, the corresponding quantum walk has no classical correlations asymptotically. Although in some resent publications by others, the mutual information has been used as a measure of classical correlations in quantum walks, this investigation revealed that it is generally invalid.

Recurrence in classical random walks is well known and the idea has been investigated in quantum walks in many aspects. The probability of returning the walker to its origin is understood as the recurrence in quantum walks rather than full revivals of its state. Under certain conditions the quantum walker will return to the initial state. It has been shown that the four-state Grover walk exhibits localization and full revivals for period of two steps. In this investigation we

introduced another four-state non local coin  $C_N(\theta)$  which shows full revivals with infinitely many periods.

Where;

$$C_N(\theta) = \begin{pmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ \cos\theta & \sin\theta & 0 & 0 \\ \sin\theta & -\cos\theta & 0 & 0 \end{pmatrix}$$

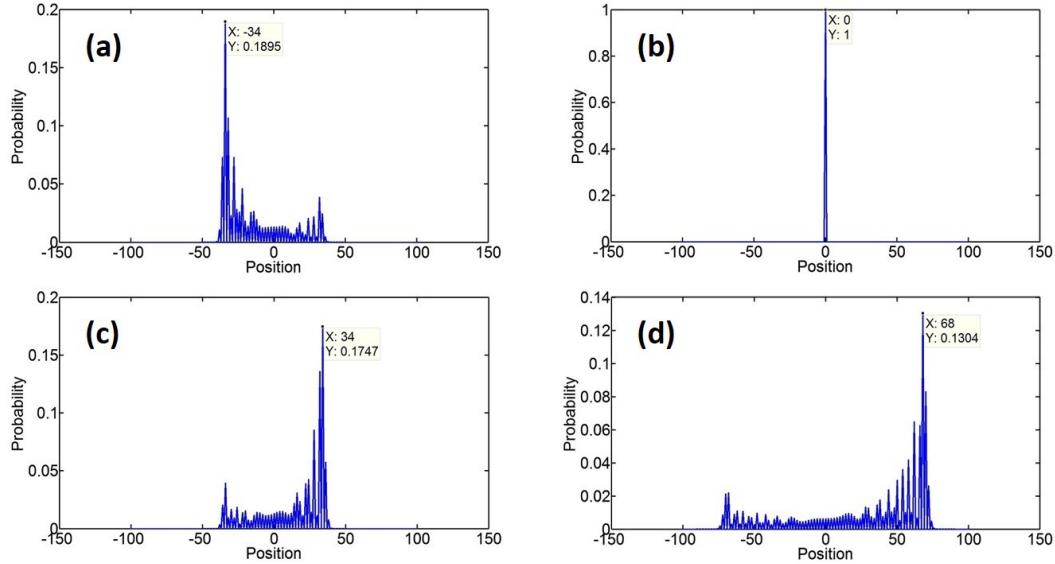
When  $\theta$  has the form and  $\theta = \frac{n}{2m}\pi, n, m \in \mathbb{Z}$   $0 < n \leq 4m$ , then the period is 4m. On the other hand, when  $\theta = \frac{(4n+1)}{2m+1}\pi, n, m \in \mathbb{Z}$  and  $0 < n \leq 2m$ , the period is 4m+2. These solutions indicate that there can be periods longer than 2 for four-state quantum coins and there are infinitely many periods as  $m \rightarrow \infty$ .

Time step (t)	state
$t = 0$	$ \psi(t=0)\rangle = \frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ 1 \\ -1 \\ 0 \end{pmatrix} \otimes  x=0; y=0\rangle$
$t = 1$	$ \psi(t=1)\rangle = \frac{1}{2\sqrt{2}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} \otimes  x=-1; y=-1\rangle - \frac{1}{2} \sqrt{\frac{3}{2}} \begin{pmatrix} 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \otimes  x=-1; y=1\rangle - \frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix} \otimes  x=1; y=1\rangle$
$t = 2$	$ \psi(t=2)\rangle = -\frac{1}{2\sqrt{2}} \begin{pmatrix} \sqrt{3} \\ -1 \\ 1 \\ 0 \end{pmatrix} \otimes  x=0; y=0\rangle + \frac{1}{2} \sqrt{\frac{3}{2}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} \otimes  x=0; y=2\rangle$
$t = 3$	$ \psi(t=3)\rangle = -\frac{1}{2\sqrt{2}} \begin{pmatrix} 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \otimes  x=-1; y=-1\rangle - \frac{1}{2} \sqrt{\frac{3}{2}} \begin{pmatrix} 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \otimes  x=-1; y=1\rangle + \frac{1}{2\sqrt{2}} \begin{pmatrix} \sqrt{3} \\ -1 \\ 0 \\ 0 \end{pmatrix} \otimes  x=1; y=1\rangle$
$t = 4$	$ \psi(t=4)\rangle = -\frac{1}{2\sqrt{2}} \begin{pmatrix} \sqrt{3} \\ 1 \\ -1 \\ 0 \end{pmatrix} \otimes  x=0; y=0\rangle + \frac{1}{2} \sqrt{\frac{3}{2}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} \otimes  x=0; y=2\rangle$
$t = 5$	$ \psi(t=5)\rangle = -\frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix} \otimes  x=-1; y=-1\rangle + \frac{1}{2\sqrt{2}} \begin{pmatrix} \sqrt{3} \\ 1 \\ 0 \\ 0 \end{pmatrix} \otimes  x=1; y=1\rangle$
$t = 6$	$ \psi(t=6)\rangle = -\frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ 1 \\ -1 \\ 0 \end{pmatrix} \otimes  x=0; y=0\rangle$

**Fig. 1:** The first 6 steps of the QW generated by the coin  $C_N\left(\frac{\pi}{6}\right)$  for a Bell state  $|\varphi(t=0)\rangle = \frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ 1 \\ -1 \\ 0 \end{pmatrix} \otimes |x=0; y=0\rangle$  at the origin as the initial state.

Quantum Walks are driven by unitary operators and hence the time reversion of the walk is beyond doubt. The adjoint of an unitary operator that comprises both adjoints of shift and coin operators can generate the reverse evolution of a given quantum walk. In this study we showed an alternative way of achieving the reverse evolution of the position state in one dimensional quantum walks (1DQWs) without employing adjoint operators. We introduced a single intervention only on the coin degree of freedom during the quantum evolution. Position space is not interfered in anyway. With the right choice of temporal parameters of our scheme, quantum walker can be pulled back to the initial position effectively.

For a given initial coin state (product or Bell state) and a fixed number of time steps, our scheme can be used to augment the probability of finding the walker at certain positions. This idea is illustrated in Figure 2.



**Fig. 2:** Probability distributions for Hardmand Walk with and without interventions. Initial state is

$$|\psi_{in}\rangle = |1\rangle_c \otimes |0\rangle_x \quad \text{and} \quad t = 100 \quad \text{time steps (a)}$$

$$(c) \quad t_1 = 75 \quad (d) \quad \text{No intervention}$$

$$|\psi_{in}\rangle = |1\rangle_c \otimes |0\rangle_x$$

The usual ballistic spread of the Hardmand Walk for the initial state  $|\psi_{in}\rangle = |1\rangle_c \otimes |0\rangle_x$  is given in Fig 2 (d). Under this initial state, probability of finding the walker in the negative positon region is comparatively low. However, with the proper choice of temporal parameters, our scheme can increase that probability up to a substantial level (see Fig 2 (a)). When the intervention is introduced in the midst of the evolution, walker returns to the initial position. This is shown in Fig 2 (a).

M.Phil. Students: Mahesh N Jayakody (Quantum Physics), R Dodangodage (Quantum Physics)

#### Key Publications:

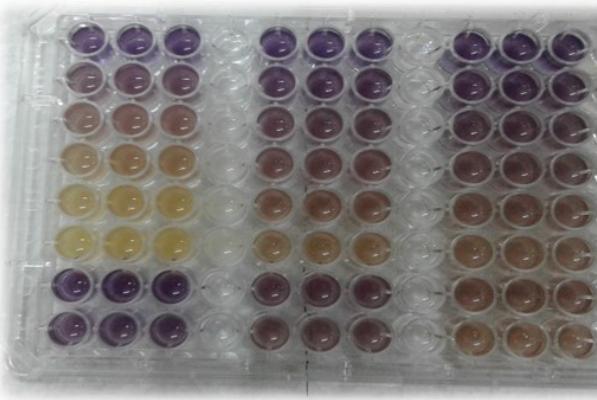
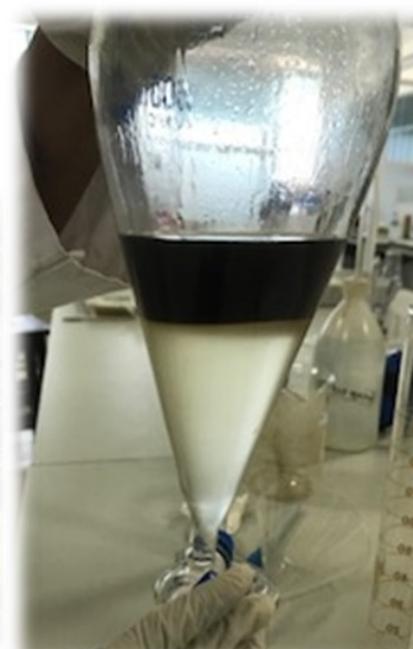
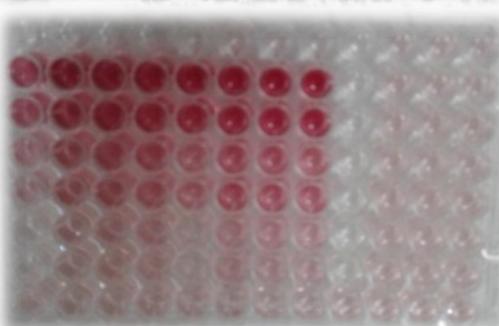
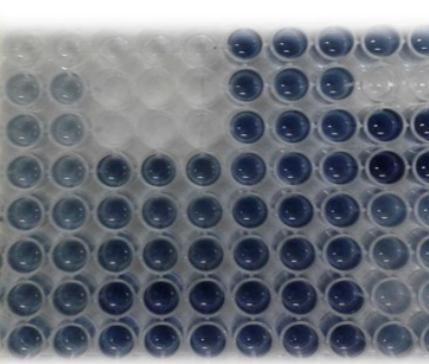
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**From Left:** Mr. MN Jayakody, Mr. R Dodangodage, Prof. A Nanayakkara, Mr. V Bandara



# **Natural Products & Food Chemistry**

Many types of plants, plant products (fruits and vegetables) and microorganisms such as fungi contain bioactive components which are of benefit to humans. These have been consumed as food and some have been used for medicinal purposes for centuries. The natural Products and Food Chemistry unit of the NIFS has practical experience in the study of medicinal plants, natural products and functional food science. Studies are mainly focused on identifying natural products present in plant and fungal extracts, and in medicinal preparations. The preventive/therapeutic effects of these compounds are evaluated against chronic human diseases such as diabetes and cardiovascular diseases. Research work done in this unit involves the isolation and identification of biologically active compounds from natural sources, the development and validation of analytical methods, and the evaluation of their health and crop protection effects through in vitro and in vivo studies. The knowledge gained will eventually be used in the development of novel food products, food supplements and health foods with enhanced nutritional and functional properties. Fungal metabolites with useful bioactive properties will be cultured on large scale for further studies and possible commercial applications.

- **Natural Products**
- **Nutritional Biochemistry**

# Natural Products

Natural Products are compounds produced by plants, fungi, marine organism etc. These compounds can be used to improve the quality of human life. Although there are over 3500 flowering plants inhabiting Sri Lanka, including ~800 endemics, relatively low numbers of plants have been chemically and biologically investigated. Of these 3500 plant species, about 750 are claimed to have uses in the indigenous system of medicine. The fungal flora native to Sri Lanka is around 25,000 and a vast majority of these remains to be studied for the presence of bioactive metabolites. The use of natural products in the management and treatment of disorders and diseases in humans and plants is more acceptable and offers lesser risk than use of synthetic compounds.

The overall objective of the Natural Products Project of the NIFS is the identification of bioactive extracts and compounds from natural sources, as potential resources for control of human and plant diseases. Research activities have been focused on the chemistry and bioactivity of secondary metabolites from plants, fungi (including endophytic fungi) and edible fruits of Sri Lanka. Another area of research has been the identification of polyphenols found in tea, medicinal plants, edible fruits and spices using Liquid Chromatography – Mass Spectrometry (LC-MS) and also studies on the cause and control of postharvest fungal diseases and disorders, including one *hitherto* unknown disorder, of edible and export-oriented fruit crops. These research activities are very wide and represent basic research on the field of natural products chemistry, pharmaceutical research and new materials.

In our studies, the bioactivities of extracts and compounds are assessed using bioassays; [DPPH (2,2'-diphenyl-1-picrylhydrazyl) radical scavenging assay to detect the presence of natural antioxidants; the brine shrimp (*Artemia salina*) lethality assay to detect cytotoxicity; the lettuce (*Lactuca sativa*) seed germination assay to detect the presence of phytotoxic and allelopathic compounds, the TLC bioautography method to detect the presence of antifungal compounds;  $\alpha$ -amylase,  $\alpha$ -glucosidase and lipase enzyme inhibitory activity assays to detect drug targets for the treatment of diabetes, obesity and hyperlipidemia. Bioactive extracts are subjected to activity guided fractionation using chromatographic techniques to isolate bioactive compounds. Structures of isolates are determined by detailed analysis NMR, MS spectral data. Partial syntheses of isolates are carried out to enhance the bioactivity of isolates.



**Lalith Jayasinghe** Senior Research Professor, NIFS, Kandy; Ph.D., University of Peradeniya, 1992; B.Sc. (Chem Sp) Degree, University of Peradeniya; Diploma in Natural Products Chemistry, Tokyo Institute of Technology, Japan in 1994; Alexander von Humboldt Research Fellow, University of Hohenheim, Stuttgart (1999/2000) and Jacobs University Bremen (2011 & 2015) Germany; IPICS Research Fellowship in 1988 to University of Karachi, Pakistan; Kandiah Memorial Award, Institute of Chemistry Ceylon (1992); TWAS-NARESA Young Scientist Award in 1992; UNESCO & Mombusho Research Fellowship in 1993; Visiting Scientist, Tokyo Institute of Technology in 2004; University of Mississippi, USA from 2004-2005 and the University of Milan, Italy, in 2006; Visiting Professor, Tokyo Institute of Technology in 2009; Elected Fellow of the National Academy of Sciences of Sri Lanka 2012; Presidential awards for Scientific Publications (2002, 2003, 2004, 2006, 2007, 2008, 2012 & 2015) Research publications have received 1164 citations (February 2018); H-index of 18; 70 Scientific Publications, 3 Book Chapters; 205 Communications to Learned Societies (Local and foreign); Research grants from NSF and NRC Sri Lanka.

## Visiting Research Professors



**N. Savitri Kumar**, Ph.D. Univ. of London, 1971: Emeritus Prof (UoP) (June 2009); Research Prof. IFS, Kandy (August 2009-2015); Visiting Research Prof NIFS, Kandy (August 2015 to date); Invited Visitor, Rockefeller Foundation, Bellagio Center, Milan, Italy (2007 Sept-Oct); Visiting Prof, Univ. of South Pacific, Suva, Fiji, Feb-June 2006: Head, Dept. of Chemistry UoP, 2001-2004: NSF Research Fellow (2005): Visiting Scientist, IACR, Rothamsted Experimental Station, UK (1998); Research Fellow, Dept/ of Chemistry , UBC, Vancouver, Canada (1986): Research Fellow, Univ. of Stockholm, Sweden 1985-1986; Postdoctoral Research Fellow, York Univ., Ontario, Canada (1977-78): Royal Society Commonwealth Bursary, UK 1977; Elected Fellow SL National Academy of Sciences 1991;

Joint Awardee of the Sri Lanka President's Award for Scientific Achievements to the Natural Products Research Group lead by Prof. MUS Sultanbawa at UoP (1985). Presidential awards for Research 1991, 1995, 1996, 1999, 2005, 2008, 2009, 2015. Research publications have received 887 citations (Feb 2018); H-index 18; Research grants from NSF Sri Lanka and NRC Sri Lanka at the NIFS and UoP; International research awards: joint awardee of Asia-Swedish Research Partnership Program, (1994-2004) and Sida Bilateral Cooperation with Sri Lanka; IPICS, Uppsala, Sweden; Research grants TWAS Trieste, Italy.



**Nimal Adikaram**, PhD. Queen's University of Belfast (1981); BSc. University of Colombo (1974); Professor Emeritus, Visiting Research professor, NIFS (2017– todate), Fellow (Elect), National Academy of Sciences of SL, Honorary Fellow, Indian Mycological Society. Head, Dept. of Botany, Univ. of Peradeniya (1999-2000, 2002 – 2009), Chairman, Board of Study, PGIS (2003 – 2009).Editor-in Chief, Ceylon. J. Science (Bio. Sci.) (1998 –2007). Currently a Member, Editorial Board of CJS, JNSF and J Indian Phytopathology. TWAS Young Scientist Award in Biology (1988), King Baudouin Award, International Foundation for Science (IFS), Sweden (1990), General Research Council (SLAAS) Award(1993), Silver Jubilee Award for research, IFS, Sweden (1997), NSF Merit Award for research in bioactive

lichen substances (2004), CVCD award for research (2012), Presidential Awards for Research (2003–2005, 2007-2009 & 2012). International Consultant in Postharvest Technology for Food & Agriculture Organization, United-Nations in Bangladesh (2003), International Consultant in Plant Health, Asian Development Bank (ADB) in Cambodia in 2015. Published over 84 scientific articles, four books,six book chapters, 125 communications.1014 citations, *h*-index 16, *i10* index 32..



**Yoshinori Fujimoto, Ph.D**, 1978; B.Sc. 1973, Chemistry, Tokyo Institute of Technology, Japan; Postdoctoral Researcher, School of Pharmacy, Univ. of Wisconsin-Madison, USA (May 1979–April 1982); Technical Staff of Education and Assistant Professor (May 1982– Feb 1990), ChemDept, Tokyo Inst Tech; Associate Professor of the same (Mar 1990–Sep 1996); Professor (Oct 1996–Mar 2015), Department of Chemistry and Materials Science, and also ChemDept; Retired as Emeritus Professor from Tokyo Inst Tech (Mar 2015); Visiting Research Professor, NIFS Kandy, Sri Lanka (May 2015–to date); Visiting Professor, School of Agriculture/Organization for the Strategic Coordination of Research and Intellectual Properties, Meiji University, Japan (Jun 2015–to date); Research interests are in natural product chemistry, particularly, steroidal and terpenoidal compounds from plants, insects, microorganisms and marine invertebrates. Research publications received 6,414 citations (Jan 2018); H-index of 29; Published 276 research papers; Author of 14 book chapters and books, and 11 patent applications.



**Nikolai Kuhnert** obtained his PhD in Inorganic chemistry and pharmaceutical biology. Following postdoctoral stays at the Universities of Cambridge and Oxford, he accepted a position in Organic Chemistry at the University of Surrey. In 2006 he moved to Jacobs University Bremen, where he is now a Full Professor in Analytical and Organic Chemistry. He has been visiting Professor at several Universities including Saarbrücken, Regensburg, Bremen, CSIC Rocasolano in Madrid, CEBAS in Murcia and KAUST, NIFS Kandy, Sri Lanka. His research interests are focused on the application of mass spectrometry in the analysis and structure elucidation of phenolic natural products from dietary and medicinal plants and the analysis of food processing products such as black tea, roasted coffee, Maillard reaction products and chocolate. (<http://www.jacobs-university.de/ses/nkuhnert>). Research publications received 5447 citations (January 2018); H-index of 38.

## Research activities of the Natural Products Project of the NIFS are mainly on the following three areas.

- Investigation of extracts from plant sources and, epiphytic and endophytic fungi, for use in agriculture and human health.
- Chemistry and bioactivity of edible fruits.
- Plant secondary metabolites and LC-MS profiling of bioactive extracts.
- Cause and control of postharvest fungal diseases and disorders of edible and export-oriented fruits.

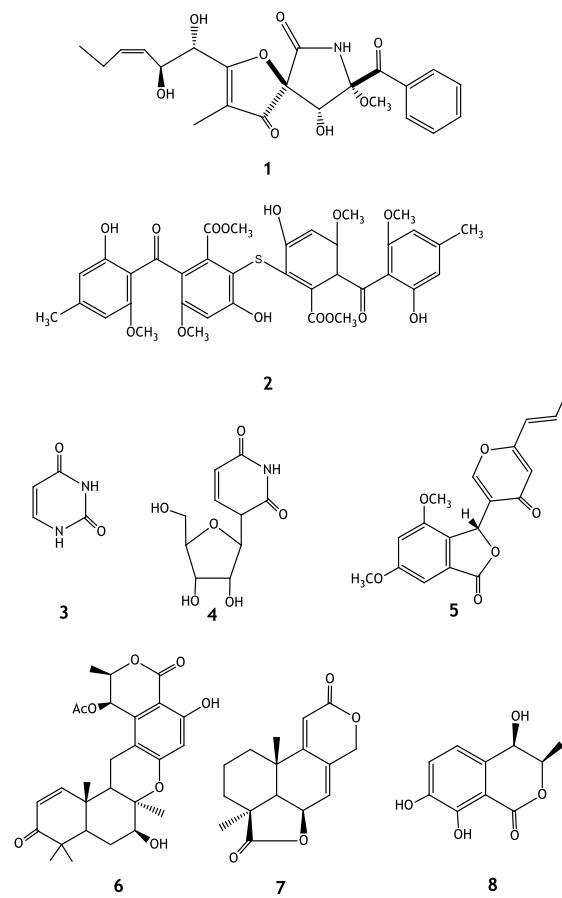
### Chemistry and bioactivity of fungi associated with medicinal plants, edible fruits

Fungi can be mainly categorized as endophytic and epiphytic fungi. Endophytes are found in the inner tissues or even in the cells of their host while epiphytic fungi grow on the surface of the host. Endophytes are considered to be a rich source of secondary metabolites with novel structures and interesting bioactivities. These metabolites have found extensive applications as agrochemicals, antibiotics, antiparasitic immunosuppressants, and anticancer agents.

Some endophytic fungal strains produce natural products that are either identical or closely related to those produced by the host plant. A well-known example is the production of Taxol, an anti-cancer drug obtained from the Pacific Yew tree *Taxus brevifolia*, which was also produced by the endophytic fungus *Taxomyces andreanae* isolated from the bark of *T. brevifolia*. Currently we are studying the chemistry and bioactivity of secondary metabolites produced by the endophytic fungi isolated from some medicinal plants. Several secondary metabolites with interesting structural features and some useful bioactivities have been isolated. Structures of some selected compounds are given below. Pseurotin A (**1**) {*Aspergillus fumigatus* from *Solanum insanum*}; guignasulfide (**2**) {*Aspergillus fumigatus* from *Solanum insanum*}; uridine (**3**), uracil (**4**) {*Phialemonium curvatum* from *Manilkara zapota*}; vermistatin (**5**), chrodrimanan B (**6**) {*Penicillium verruculosum* from *Murraya koenigii*}, derivative of yukonin (**7**), 4,7 dihydroxymellein (**8**) *Neofusicoccum parvum* from *Elaeocarpus serratus*.

### Fungi from insects as a source of bioactive Compounds

Insects such as attinine ants, macrotermitine termites, wood wasps and ambrosia beetles have cultivated fungi as a food source for millions of years. Some compounds produced by these fungi affect the growth and development of other fungi thereby protecting the fungal crop of insects. The tea shot hole borer beetle (*Euwallacea fornicates*, TSHB) lives symbiotically with the fungus *Monacrosporium ambrosium* (syn. *Fusarium ambrosium*) in galleries made by TSHB in tea stems. EtOAC extract of liquid cultures of *M. ambrosium* isolated from the TSHB beetles was found by TLC bioautography method to show antifungal activity against a plant pathogen *Cladosporium cladosporioides*. Chromato graphic separation of the extract yielded twelve naphthoquinones, eight of which showed antifungal activity against *C. cladosporioides* at a concentration of 64 µg/spot and all at 128 µg/spot. Bio-inhibitory effect of *M. ambrosium* on the growth of three endophytic fungi isolated from tea stems was studies.



*M. ambrosium* was found to show slight inhibitory effects on the growth of these three endophytic fungi by dual culture assay. The antifungal nature of the naphthoquinones produced by *M. ambrosium* suggests its ability to prevent/inhibit the growth of other fungi in TSHB galleries thus protecting the habitat of TSHB beetles.

Caffeine is the major alkaloid found in tea. It is toxic to a variety of insects and fungi, and is known to be pesticidal at the concentrations found in plants. Caffeine shows in vitro inhibitory activity against TSHB beetles. However, TSHB beetles continue to infest tea stems despite the high concentration of caffeine found in tea stems. Study were conducted to investigate whether *M. ambrosium* is able to transform/degrade caffeine in liquid culture media to theophylline and/or theobromine, known to be less fungicidal. Both TLC and HPLC studies showed that caffeine was unchanged, and that caffeine is not converted to theophylline and/or theobromine in culture media.

## **Study of some postharvest diseases and disorders adversely affecting the export potential of fruits of mango var. TomEJC, and their management.**

This project will investigate the cause of some disorders and fungal diseases of fruits of mango var. TomEJC, that adversely affect the fruit exportation, and develop appropriate management practices. National Research Council (NRC) has awarded a Public-Private Partnership (PPP) research grant to investigate in to these diseases and disorders. Two postgraduate research students are currently working on this project.

Fruit pitting and Lenticel Browning are two disorders reported in certain fruit species including mangoes. However, these have not been studied with respect to Sri Lankan mango varieties and conditions, e.g. weather, prevailing in the country. Fruit pitting is believed to be resulted from calcium and/or boron deficiency but the exact cause/s and the mechanism of pitting is not well understood. Fruits showing symptoms of Lenticel Darkening or Fruit Pitting do not have a place in the export market.

### **Research Students:**

CL Kehelpannala (M.Phil.)  
D Thanabalasingam (M.Phil.)  
GRN Rathnayake (M.Phil.)  
MVK Munasinghe (NSF) ( M.Phil.)  
MM Qader (Reg. for Ph.D.)  
DMMD Dissanayake (Reg. for M.Phil.)  
CB Gunawardhana(NRC) (Reg. for M.Phil.)  
S Sathya (NSF) (Reg. for M.Phil.)  
LN Manawadu (NRC) (Reg. for M.Phil.)  
CP Amarasinghe (NRC) (Reg. for M.Phil.)

### **Chief Technical Officer:**

DS Jayaweera (M.Phil.)

### **Key Publications:**

Gunawardena et al., (2015) Phytotoxic Constituents from the fruits of *Averrhoa carambola*, *Chemistry of Natural Compounds*, **51**, 532-533.

Internal Pulp Browning (IPB) is a new and *hitherto* unknown disorder, observed for the first time in harvested, ripe fruits of the var. TomEJC. In IPB, the pulp just outside the seed, turns brown colour and the condition cannot be detected without cutting the fruit and exposing the pulp tissue. Once disorders occur, the damage caused to the fruit cannot be reverted. The only way of overcoming them is by prevention of their occurrence.

Among the fungal diseases, the stem-end browning is a new disease affecting the marketing of fruits ripe mangoes of the variety TomEJC adversely, at both the local and export market. The other fungal diseases that are being studied include the mango scab and the *Pestalotiopsis* spot.

Mango var. TomEJC is presently cultivated in the dry and arid zones of Sri Lanka and with the current expansion programmes of cultivation, the future fruit production, therefore the fruit exportation also, is expected to be doubled by 2020. Development of proper management practices to combat these disorders and diseases is important to sustain the availability of good quality fruits of this variety for exportation.

Padmathilake et al., (2017). Furanone analog of Talaroconvolutin A, a new alkaloid from the endophytic *Talaromyces purpurogenus* from *Pouteria campechiana* seeds *Natural Products Communications*, **12**, 489-490.

Alakolanga et al., (2015), Antioxidant property and a-amylase, a-glucosidase and lipase inhibiting activities of *Flacourtie inermis* fruits: Characterization of malic acid as an inhibitor of the enzymes, *Journal of Food Science and Technology*, **52**, 8383-8388 (2015).

Kehelpannala et al., (2018). Naphthoquinone metabolites produced by *Monocrotophorum ambrosium*, the ectosymbiotic fungus of tea shot-hole borer, Euwallacea, in stems of tea, *Camellia sinensis*. *Journal of Chemical Ecology* (in press).



**From Left:** Mr. C Mullegama, Ms. S Sathya, Prof. NS Kumar, Prof. L Jayasinghe, Prof. NKB Adikaram, Ms. VK Munasinghe, Ms. CP Amarasinghe, Ms. DMMD Dissanayake, Ms. LN Manawadu, Ms. CL Kehelpannala, Mr. S Jayaweera

# Nutritional Biochemistry

Nutritional Biochemistry project focuses on various aspects of functional and nutritional properties of foods and cover a wide area like functional and nutritional properties of food, food safety, and bioavailability of food to improve health and well-being of people.

**Functional and nutritional properties of food:** Under this research theme, studies are done to assess the antioxidant, enzyme inhibition, radical induced DNA damage prevention and identification of active compounds.

**Bioavailability of food:** Bioavailability is the degree to which food nutrients are available for absorption and utilization in the body. It is a critical issue for many nutritional concerns. In this study, bioavailability of nutrients and antioxidant compounds in legumes are studied. Further, the effect of boiling and simulated digestion on prebiotic activity of legumes was studied.

**Food Safety:** Heavy metals are trace elements that cause negative impacts on human health, even at very low concentrations. In this study Heavy metal residues and trace elements in milk powder, poultry meat available in the market and seaweeds collected from coastal areas are analyzed.

**Interaction of glucose oxidase with other sugars -** Glucose oxidase (GOx) was found to show significant interaction with other sugars. Thus, the primary aim of the present work was to study the interaction of GOx with other sugars which could pose a significant clinical implications.



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## **Functional and Nutritional Properties of food:**

During the last few years there has been a tremendous growth in the field of herbal medicine. Herbal medicine is gaining popularity both in the developing and developed world because of their natural origin and less side effects. As a result, the general public has turned towards medicinal plants for the treatment of diabetes. Identification of the active component and their molecular interaction is essential to analyze therapeutic efficacy of the product and also to standardize the product. Though, over 400 traditional plant treatments for diabetes have been reported, only a small number of these have received scientific and medical evaluation to assess their efficacy. Thus the present study aims to screen popular Sri Lankan Ayurvedic plants for their anti-diabetic property and identify the active ingredients responsible for these effects. Out of the 10 studied plants, three plants have been identified with high anti-diabetic properties and further studied are being carried out to identify active compounds in those plants.

## **Bioavailability of antioxidant compounds and nutrients in legumes after *in vitro* digestion:**

To better understand the bioavailability of antioxidant compounds in legumes; a study was conducted to assess the phenolic content and antioxidant capacity of five legumes; cowpea (Dhawala and Waruni), Mung bean (MI 6), Horse gram (brown) and chickpea (Desi) after boiling and simulated digestion with porcine gastric and intestinal juices. The results represented higher antioxidant activity in undigested samples than in digested samples. Moreover, boiling reduced ( $P < 0.05$ ) antioxidant activity in legumes except in Horse gram by ABTS assay. Boiling induced ( $P < 0.05$ ) the total flavonoid content in all the legumes. Antioxidants were reduced by digestion ( $P < 0.05$ ) except in boiled Waruni (TPC assay) and Dhawala (ABTS assay) legume samples. DPPH assay showed significant enhancement in antioxidant activities after digestion. Further the results showed that boiling reduced the crude fat content in all the samples. Crude protein content decreased in Chickpea and Horse gram legumes. Therefore, the present study confirmed that, boiling and simulated digestion modulated the bioavailability of antioxidant compounds and nutrients.

## **Prebiotic activity of legumes after *in vitro* digestion:**

It is important to study the effect of boiling and *in vitro* digestion on prebiotic activity of legumes. In this study fermentative properties of raw and boiled legumes before and after simulated digestion were studied. Boiling and *In-vitro* digestion showed differential effect on the growth of colonic bacteria depending on the legume.

Among the tested samples, chickpea significantly enhanced the growth of *Bifidobacterium*, *Lactobacillus* and suppressed the growth of Coliform whereas Dhawala, Waruni and Horse gram did not show a significant effect on the growth of beneficial bacteria. An inverse relationship was observed between digestion and fermentative properties of legumes. *In-vitro* digestion significantly increased the final pH of the fermented solution compared to undigested samples. Thus, this study shows that simulated digestion modulated the fermentative properties of legumes and chickpea showed the highest fermentative properties compared to other legumes used in this study.



## **Food Safety:**

Heavy metals are trace elements that cause negative impacts on human health, even at very low concentrations. Chicken and milk powder are main sources of protein in Sri Lankan diet but if contaminated by toxic heavy metals will cause a harmful effect on human health. In this study the heavy metal concentration in broiler tissues (3 brands), broiler feed (3 brands) were analyzed by microwave digestion followed by ICPOES. From the results it was found that inorganic AS concentration in liver samples from one brand was higher than the permissible level. As the results were alarming more comprehensive study will be conducted in the future. Heavy metal analysis in milk powder is not completed yet.

## **Interaction of glucose oxidase with other sugars and its implications in blood glucose monitoring:**

Blood glucose monitoring is considered as a valuable tool in the management of diabetes mellitus. As a result of this, several glucose monitoring systems with different enzymes have been developed and are available in the market. Glucose oxidase (GOx) is one of the most widely used and highly recommended enzymes for glucose monitoring systems owing to its high specificity for glucose compared to other enzymes such as glucose oxidoreductases and glucose dehydrogenase-pyrroloquinone, which are reported to show significant interaction with other simple sugars. However, from our preliminary work, glucose assay kit comprising of GOx was found to show significant interaction with other sugars

Thus, the primary aim of the present work was to study the interaction of GOx with other sugars which could pose a significant clinical implication. According to the results, other than glucose, maltose, mannose, galactose, xylose, and sorbitol acted as substrates for GOx. Among these sugars, the interaction of galactose, maltose, and xylose can be considered clinically critical. In some special cases, these sugars are found in high concentration in the circulation which can be misinterpreted as glucose. Administration of insulin in these conditions may lead to hypoglycemia and in severe cases can lead to death. Thus, though the interaction of other sugars with GOx is not significant as glucose, clinicians should be aware of the potential interaction of these sugars with GOx and should take careful measures to prevent possible harm to their patients

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### Research Students:

M.Sc. : Rukshila Bangamuwage

Dhanushki Wickramarachchi

Pathumi Ariyarathne

Uditha Premarathne

M.Phil. : Oshini Perera-(Completed)

Rizliya Visvanathan

Afka Deen

### Key Publications:

R. Liyanage, C. Kiramage, R. Visvanathan, C. Jayathilake, P. Weththasinghe R. Bangamuwage, B.C. Jayawardana, J. Vidanarachchhi, Hypolipidemic and hypoglycemic potential of raw, boiled, and sprouted mung beans (*Vigna radiata* L. Wilczek) in rats. *J. Food . Biochem.* e12457, 2017.

R. Visvanathan, C. Jayathilake, R. Liyanage. A simple microplate-based method for the determination of  $\alpha$ -amylase activity using the glucose assay kit (GOD method), *Food. Chem.* 211, 853–859, 2016.

B. Jayawardana, R. Liyanage, N. Lalantha, S. Iddamalgoda, P. Weththasinghe, Antioxidant and antimicrobial activity of Drumstick (*Moringa oleifera*) leaves in herbal chicken sausages *LWT - Food Sci. Technol.* 64,1204-1208,2015.



**From Left:** (1st row ) Ms. UK Herath, Ms. MNF Amriya, Ms. R Bangamuwage, Ms. UO Premarathna, Ms. IWDN Wikramaarachchvchi,  
(2nd row ) Ms. FA Deen, Dr R Liyanage, Ms. V Rizliya, Ms. RHWMIC Rathnayaka





# **Microbiology & Carbon Sequestration**

In the evolution of the Earth, formation of the lithosphere preceded that of the biosphere and even today the existence of plants depends largely upon soil which provides the substrate for anchorage and most of their nutrients. Soil nutrient supply is sustained by cycling of water, carbon, nitrogen, sulfur etc and these processes are mediated by soil microorganisms. Studies carried out by this cluster are aimed at sustaining and improving soil fertility by manipulating the role of microorganisms in nitrogen fixation, carbon sequestration and enhancing root growth and nutrient uptake through the introduction of beneficial microbial communities in biofilm mode. Research work is also directed towards microbial generation of bio-energy to circumvent the use of environmentally damaging fossil fuels.

- **Microbial Biotechnology**
- **Bioenergy & Soil Ecosystems**

# Microbial Biotechnology

The research program focuses on investigations of the role of developed microbial biofilms in agriculture, plantations and the environment. With the invention of development of microbial biofilms [fungal-bacterial biofilms (FBBs) in particular] in vitro in 2002, several basic research studies were conducted to evaluate their potential as microbial ameliorators in the soil and also in the environment. The studies yielded very promising results. Consequently, biofilm-based Bio-fertilizers called Biofilm Bio-fertilizers (BFBFs) were developed for agriculture and plantation crops (especially non-legumes, e.g. tea, rice, vegetables etc.), tested extensively under field conditions, and were commercialized in 2014. So far, BFBFs have been used in over 30,000 acres in the country with a chemical fertilizers (all NPK) cut down up to 50%, and also in organic agriculture. Research on BFBFs have also been started in India, Indonesia and Brazil.

Current studies are centered on agriculture, health and environmental benefits of the use of BFBFs, and also industrial applications of FBBs.



B. Sc. (1984), Ph.D, University of Peradeniya, Sri Lanka, (1993); Senior Research Professor, National Institute of Fundamental Studies; Postdoctoral Fellow, Katholieke Universiteit Leuven, Belgium (1994); Visiting Collaborative Research Fellow, University of Sydney, Australia (April-June 2007); Visiting Professor, University of Sydney, Australia (January-May 2009); Member, Soil Science Society of America/American Society of Agronomy; Member, American Society for Microbiology; Associate Editor, Agriculture, Ecosystems & Environment (Elsevier); Research publications have received 1396 citations (December 2017); Google Scholar h-index of 21; Elected Fellow of the National Academy of Sciences (2011 to date). **Awards:** Presidential Research Awards (1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006); Listed as a top researcher in Sri Lanka by the University Grant Commission (UGC), Sri Lanka& one of the most productive scientists in Sri Lanka in the Third World Academy of Sciences, Italy.

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## Field experiments with Biofilm Bio-fertilizer

Rice (*Oryza sativa*) is the staple food crop in Sri Lanka. Hence, its yield must be increased annually to meet the growing demand. However, this should be achieved with the minimal use of chemical inputs to minimize environmental pollution. Incorporation of Biofilm Bio-fertilizer (BFBF) is a better strategy to reduce the use of Chemical Fertilizers (CF) and increase productivity of paddy lands. BFBFs influence positively on soil fertility and plant-microbe interactions.

Multi-location trials in 14 sites were conducted during this year to systematically investigate rice crop response to BFBF under different soil and climatic conditions.

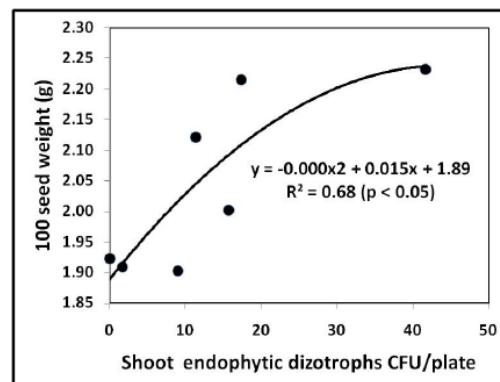
Two field experiments were conducted during Yala 2017 season in Mahaweli Thoda farm at Dehiaththakandiya, and Rice Research and Development Institute, Bathalagoda to determine the fertilizer replacement value of BFBF under the new CF recommendation of the Department of Agriculture for rice(2013). The experiment had six treatments, namely 100% CF, 80% CF, 80% CF + BFBF, 65% CF, 65% CF + BFBF and Control, in a RCBD with 4 replicates. Their effects on soil nitrogen (N), phosphorous (P), potassium (K) and carbon (C) and growth and yield parameters of rice were studied. The treatment 65% CF + BFBF application resulted in a significant increase in total soil N, P and C compared to the recommended level of CF application. It also resulted in the lowest soil  $\text{NO}_3^-$  level due probably to more efficient uptake/scavenging of soil  $\text{NO}_3^-$  facilitated by BFBF. In both locations, BFBF produced dry matter and grain yields comparable to those obtained when the recommended level of CF applied. Therefore, there is a possibility of replacing about 35% of the current CF recommendation for rice with BFBF without affecting yield when grown under the two field conditions.

**Rice grain yield at Mahaweli Thoda farm, Dehiaththakandiya.**

Treatment	Grain yield (kg/ha)
100%CF	5632 ab
80%CF	5278 ab
80%CF+BF	6619 a
65%CF	4249 b
65%CF+BF	6969 a
Control	1946 c
Pooled SD	498
P value	0.000

Another field experiment was conducted in a selected field of the Rice Research Institute, Ambalanthota with the same five treatments and a control in the same experimental design.

The results revealed that root endophytic diazotrophs and total bacterial communities determined tillering and panicle formation of rice plants. There was a significant positive relationship between the count of total bacterial community (x) and tillering (y); ( $y = 0.004x + 2.180$ ;  $R^2 = 0.70$ ,  $p < 0.05$ ). Further, the count of root endophytic diazotrophs (x) was significantly related to grain filling, as reflected by 100 seed weight (y); ( $y = -0.000x^2 + 0.015x + 1.89$ ;  $R^2 = 0.68$ ,  $p < 0.05$ ). Similarly, root growth and grain filling showed a positive relationship ( $y = 0.088x + 1.9$ ;  $R^2 = 0.54$ ,  $p < 0.05$ ). Treatments with the application of BFBF showed increasing trends of tillering, panicle formation and grain filling, because BFBF increases the soil and plant microbial communities and their functions. However, further studies under the same field conditions and the recommended practices are required to confirm the effects of microbial activities in rice plants with the intervention of BFBF.



**Relationship between rice shoot endophytic diazotrophs and 100 seed weight at Rice Research Institute, Ambalanthota.**

Another experiment was conducted in a selected field at FCRDI, Maha-Iluppallama with the same five treatments and a control in the same experimental design. Results showed that BFBF significantly increased both vegetative and reproductive parameters of rice plants with increasing trends of total and diazotrophic endophytic bacterial counts, compared to CF application alone. The treatment 65% CF + BFBF showed the greatest significant improvement of growth, rhizosphere soil total nutrients (N, P and K) and 100 seed weight compared to 100% CF.

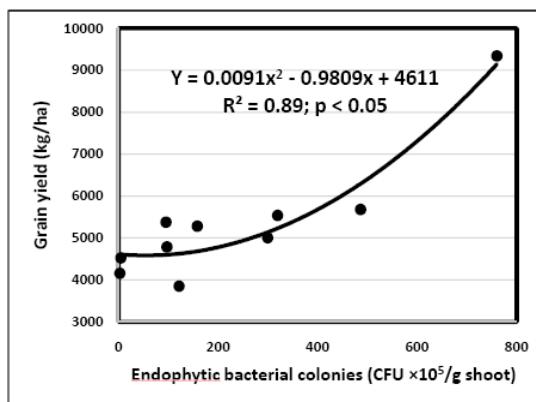
The BFBF treatment also resulted in prolonged photosynthesis with delayed senescence even under water deficit conditions to plants. This study indicates the importance of microbial community-based biofilms in increasing soil and plant parameters to ensure higher yields, and also in reinstating sustainability of rice agroecosystems, depleted due to conventional agricultural practices.



Rice plants from treatments, 65% CF + BFBF (left) and 100% CF (right) after subjecting to 5 days water stress condition at tillering stage at FCRDI, Mahalluppallama. Note the level of wilting.

Another study was carried out to evaluate mainly the effect of rice endophytic bacteria on grain yield under real farmer field conditions with the intervention of BFBFs. Field experiments were conducted in ten randomly selected farmer fields at Dehiattakandiya in Mahaweli System C.

Two treatments were applied farmers' chemical fertilizers practice (CF), and 50% of the CF with BFBF application (BF). Microbial, soil and plant parameters were recorded and analysed to find out the relationship between grain yield and measured parameters. Results revealed that shoot endophytic bacterial colony count increased by about 10% with a marginal yield increase in BF compared to CF. colony count increased by about 10% with a marginal yield increase in BF compared to CF. Mode of action of BFBF is the activation of dormant soil microbes and increasing soil microbial diversity and their functions. Possibly, the same scenario may have been applied to the action of shoot endophytic bacterial community, which leads to improve the grain yield.



Positive significant relationship between shoot endophytic bacterial count and rice grain yield in the ten farmers' fields, observed only with BF application, but not with CF application at Dehiattakandiya in Mahaweli System C.

#### Research Students:

Ph.D. : T Perera, RDA Gunasekara

M.Sc./M.Phil. : P Wijepala, S Gunaratne

#### Key publications:

J.S. Singh, G. Seneviratne, Agro-Environmental Sustainability, Vol. 1: Managing Crop Health, Springer Nature, Switzerland, 316 pp, 2017.

J.S. Singh, G. Seneviratne, Agro-Environmental Sustainability, Vol. 2: Managing Environmental Pollution. Springer Nature, Switzerland, 257 pp, 2017.

G. Seneviratne, Signal transduction in edaphic ecosystems governs sustainability, *Agric. Ecosys. Environ.*, 210, 47–49, 2015.



From Left: Ms. WMDM Wicramasinghe, Ms SW Meepagamage, Ms. HKSNS Gunarathne, Prof. G Seneviratne, Mr. A Pathirana, Ms. RKC Karunarathne

# Bioenergy & Soil Ecosystems

Main research areas under investigation are Bio energy and soil C sequestration with sub projects in each category. A fair amount of studies have been reported and some data are available on the above ground C-sequestrations in the major vegetation types of Sri Lanka. However, very little or no information is available on the below ground or soil C sequestration. In consideration of the importance as well as the long term stability of soil C, it is essential to fill the gap of knowledge on soil C in Sri Lanka. Therefore the project on soil C sequestration and management was initiated in 2010 at the National Institute of Fundamental Studies. This project targets to determine soil C sequestration potential, its dynamics and the method of improvement in different major vegetation types of Sri Lanka such as natural and plantation forests, agricultural plantations, farm lands, home gardens and small holder cultivations etc. The studies conducted by our group are among the few studies reported so far on soil C sequestration in Sri Lanka. We published the first digital soil map for Sri Lanka.

The aim of the Bioenergy research project is to explore the microbial flora of Sri Lanka for cellulase production and their applications. Microbial cellulases have shown potential application in a wide range of industries including biofuel production, pulp and paper, textile, laundry, food and feed industry, agriculture etc. The present project also aims to study possible enhancement of enzyme production by formation of co-cultures or biofilm. The possibility of using cyanobacteria and other algal species available in fresh water bodies of Sri Lanka for value added products and processes is also under investigation. Higher photosynthetic ability, rapid growth, low space and nutrient requirement together with low production cost make cyanobacteria a promising candidate for food supplements. Therefore, as a continuation of the project on Biodiesel production using cyanobacteria for value addition to the treated biomass is currently under investigation. The nitrate removal in groundwater is of great interest due to excessive amount of nitrate in groundwater a growing problem globally including Sri Lanka. In the Jaffna peninsula, the population entirely depends on groundwater for all purposes. A significant increase in nitrate contamination in well water was detected recently in the Jaffna District. Studies are continuing to find out the possibility of utilizing denitrifying bacteria for nitrate removal from well water of Jaffna District.



Dr. Renuka Ratnayake, Senior Research Fellow at NIFS, obtained her B.Sc. (Sp) Botany (1992), M.Phil. (by research) (1997) and Ph.D.(2006) from the University of Peradeniya and joined the NIFS in 2009. She was a Postdoctoral researcher at the World Forestry Center, USA and Murdoch University, Australia. Renuka is a recipient of Endeavour Research Fellowship, Presidential Research Awards and SUSRED award for post graduate supervision. She has worked as a lecturer in the Faculty of Applied Sciences at the Rajarata University of Sri Lanka before joining the NIFS.

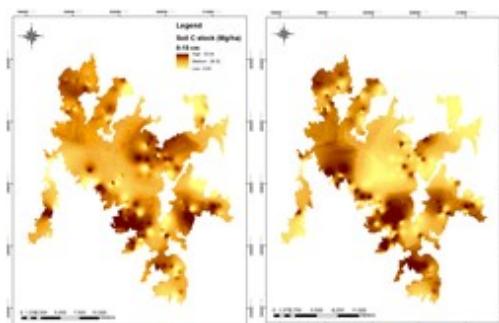
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## Assessment and Mapping of Soil C Stocks in Knuckles Forest Region of Sri Lanka

Knuckles Forest Region (KFR), a Man and Biosphere Reserve, is consisted of a variety of climatic conditions and forest types. This tropical forest ecosystem, located in the central massif of Sri Lanka, provides a catchment area for 6 major rivers, their tributaries and major reservoirs. The conservation of KFR is of utmost importance to protect these water bodies. This study aimed at assessing and mapping the SOC stocks under major vegetation types of KFR. Soil samples were collected from montane forest (MF), sub-montane forest (SMF), moist monsoon forest (MMF), open and sparse forest (OSF), grassland (GL) and forest plantation (FP). Total organic carbon, microbial biomass carbon, KMnO<sub>4</sub> - oxidizable carbon, water soluble carbon, available macro (N, P, K, Ca, Mg) and micro nutrients (Fe, Mn, Cu, Zn) were estimated. Soil carbon stocks were digitally mapped using GIS (ArcMap 10).



**Fig. 1:** Soil C stocks (Mg/ha) in Knuckles Forest Region (a) 0-15 cm (b) 15-30 cm

The results concluded that the MF soils showed higher C stocks, indicating their critical place in the local and global C cycles. The maps of SOC stocks for two depth levels and the availability of other nutrients in KFR will provide useful information in future conservation and management activities of forest and climate change mitigation programs in Sri Lanka. These baseline data could provide valuable information to fill the knowledge gap in related to below-ground carbon estimates of tropical forest ecosystems in the region of South Asia.

### Microbial Cellulases: The Application in Biofuel production and other value added products and processes.

The aim of this project is to study the possible applications of microbial cellulases obtained from locally isolated microorganisms. Further the effect of co-culturing on cellulase production has also been studied. Cellulase enzyme extracts have been studied for the application in bio stone washing of denim fabrics in comparison with commercial cellulase and found that the strains were efficient in removing denim dye. Furthermore, crude cellulase was studied in suppressing the causal agents of damping off disease in tomato.

The growth of *Phytophthora*, which is a common causative agent of damping off disease was inhibited by cellulases extracted from *Trichoderma* sp.

Furthermore, the initiatives have also been taken to study the fermentation ability of locally isolated yeast strains for bioethanol production using sugars released by cellulolytic fungi through cellulose degradation.



**Fig. 2:** Inhibitory effect of crude enzyme extract of *Trichoderma* sp on *Phytophthora* sp.

### Value addition to treated cyanobacteria; Morphological, Molecular and Taxonomical Identification of most efficient and abundant cyanobacteria in freshwater bodies of Sri Lanka

Cyanobacteria are biologically important group of photosynthetic organisms rich with nutrients. Therefore, value addition to the treated biomass (after biofuel production) was carried out by analyzing nutrients such as carbohydrate, protein content, fatty acids, different sugar types, macro elements, micro elements and Vitamin C. We found that there is a great possibility of using locally isolated cyanobacteria as a food supplement, biofertilizer and compost enhancer in agriculture. A culture collection of 75 freshwater cyanobacteria with potential industrial applications has been established & maintained under laboratory conditions with regular sub culturing and cryopreservation. Experiments have been initiated for taxonomical identification of these freshwater cyanobacteria strains depending on their morphological and molecular characterization with the collaboration of Prof. Deepthi Yakandawala, Dept. of Botany, UOP.

### Potential to use wastewater as a low cost growing medium for cyanobacteria.

Commercial scale culturing of cyanobacteria involves high cost. The possibility of using waste waters as a medium for mass culturing of cyanobacteria was tested. The effect of nutrient stress on the growth of cyanobacterial strains was assessed. The nutrient levels of wastewaters before and after cyanobacteria culturing were also tested to assess the potential of the selected cyanobacteria to be used in wastewater treatment.



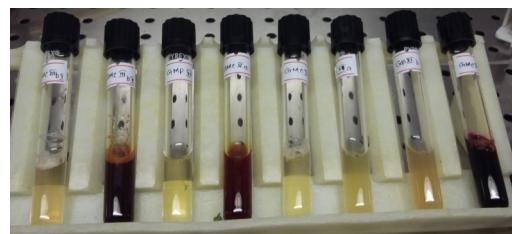
**Fig. 3:** Collection of cyanobacteria

## **Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal of Well water of Jaffna District**

The nitrate removal in groundwater is a great interest due to excessive nitrate in groundwater. Excessive consumption above 50 mg/l of nitrate (WHO limit) can cause deleterious health effects in human especially methaemoglobinemia in bottle fed infants.

In Jaffna peninsula population is entirely depend on the groundwater for all purposes. In agricultural areas of Jaffna well water contains about 20 – 50 mg/l of nitrate nitrogen. Thus it is necessary to remove nitrate from groundwater to reduce its harm to the environment. Methods available for remediation of nitrate contaminated water; are expensive and less applicable to Sri Lankan economy. Therefore, the goal of present study is to develop a biological method using denitrifying bacteria isolated from environment and evaluate their

potential use in nitrate removal of well water of Jaffna district. So far 70 bacterial strains isolated as nitrate reducers in the primary medium and they were narrowed down to five efficient strains through the several screening processes and biochemical tests. Possibly few of them could be potentially used for nitrate removal from contaminated water. In addition, 27 Cyanobacterial strains were isolated and they were screened for nitrate reduction capability.



**Fig. 4:** Formation of nitrite intermediate during nitrate reduction processes

### **Research Students:**

Ph.D. : K Mohanan, Md. Fuad Hossain

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Abhiramy Thureirajah, Tharangika Bowange

M.Sc. : Samadhi Jayalath, Shyama Malika

### **Key publications:**

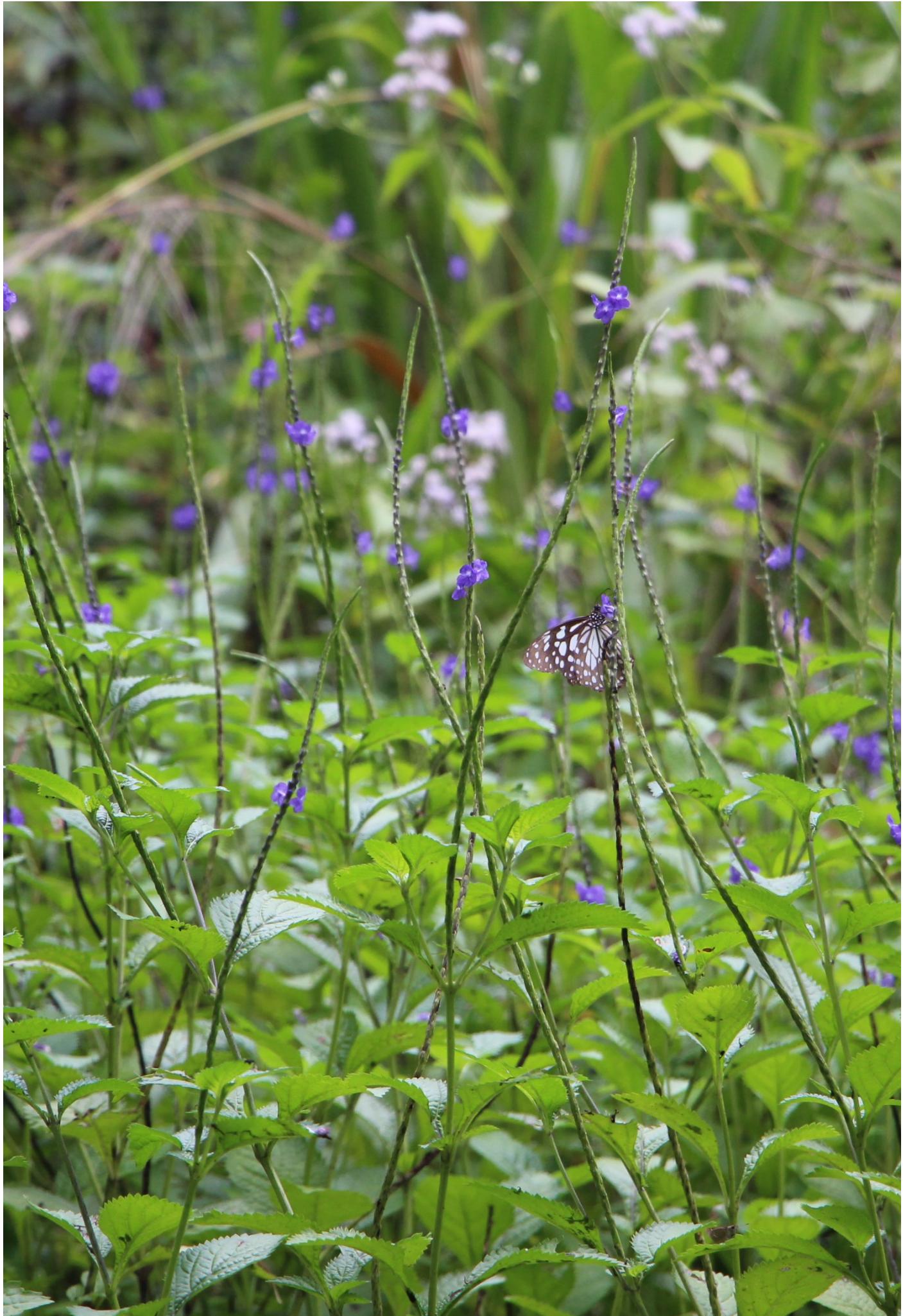
Ratnayake, R.R., Perera, B.M.A.C.A., Rajapaksha, R.P.S.K., Ekanayake, E.M.H.G.S., Gunaratne, H.M.A.C. (2017). Soil carbon sequestration and nutrient status of tropical rice based cropping systems in Sri Lanka, *Catena*, 150: 17–23.

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M.F Hossain, R.R. Ratnayake, K. Meerajini, K.L.W Kumar “Antioxidant properties of some selected cyanobacteria isolated from fresh water bodies of Sri Lanka.” *Food Science & Nutrition* (2016).



**From Left:** (Standing) Ms. P Balasubramaniam, Ms. N Sivappiragasam, Ms. P Attanayake, Ms. D Premalal, Ms. A Thurairajah, Ms. T Bowange, Ms. S Karunaratna, Ms. D Karunaratna  
(Sitting): Ms. K Rajapaksha, Dr. RR Ratnayake, Ms. S Jayasekara



# **Earth, Environment & Biodiversity**

Sri Lanka is blessed with a bounteous amount of biotic and abiotic natural resources. Discovering, evaluating, and development of the islands natural resources is the main focus of research in this unit. Origin of Sri Lankan rocks using their mineralogy and petrology is also studied. Improving efficiency of existing systems by energy scavenging and co-generation is an important step in conservation of energy. Research activities are focussed on thermoelectricity and maintaining a cleaner environment through efficient use of existing resources.

A team of scientists in this unit work on monitoring and modelling of atmospheric, terrestrial and aquatic systems that provide scientific support for restoration and management. They conduct laboratory and field experiments on monitoring toxic metal release from atmospheric deposition, soil and water, enable measurements of concentrations and reaction rates in environmental samples for key/emerging pollutants in the environment in order to assess their fate and transport to discover solutions to remediate those using different geo/bio/nano materials.

Investigating the degradation of our forests and their restoration through natural regeneration, particularly in the dry zone of Sri Lanka, is another line of research in this unit. Biogeography, factors affecting biodiversity, such as invasive alien plants, and conservation status of flora of Sri Lanka are also studied.

Understanding how ecosystems are modified by the loss of biodiversity is the focus of another group of scientists. These studies are based on plants and animals in terrestrial and aquatic ecosystems with a special focus on the Western Ghats – Sri Lanka biodiversity hotspot. Taxonomic and ecological studies conducted by the scientists of this unit range from arthropods such as spiders and scorpions to primates and higher plants.

- **Natural Resources & Renewable Energy**
- **Environmental Chemo-dynamic**
- **Ecology & Environmental Biology**
- **Plant & Environmental Sciences**
- **Plant Taxonomy & Conservation**
- **Primate Biology**

# Earth Resources & Renewable Energy

Finding new energy sources as well as better utilising the existing resources are of utmost importance in the face of escalating energy needs. Several research projects have been designed with the above objective in mind. This concept has not been limited to the energy sources, but also extended to other earth resources including mineral and geothermal resources.

Geothermal energy is one of the underutilised energy resources in Sri Lanka. A project on geothermal resources of Sri Lanka aims to evaluate these resources with a view to utilise them for national development. A combination of geophysical, geochemical and geological techniques were used to evaluate these resources.

Despite its size, Sri Lanka has a considerable number of economic mineral deposits, and may have many undiscovered resources as well. Understanding basic principles on origin of minerals is as important as employing modern techniques, to identify the new resources. They also help to understand the origins of lithological complexes in Sri Lanka and thus improve the advanced knowledge of the subject.

A pioneering project on radon mapping is being conducted jointly with the Atomic Energy Board, Sri Lanka to establish the baseline of the background radiation levels and to find mineral resources.

The pioneering research project on thermoelectricity was initiated to introduce this new area of research to Sri Lanka. Thermoelectric generators produce electricity directly from heat energy using “*Seebeck Effect*”. Thermoelectricity can increase the overall efficiency of an existing system by ‘scavenging’ and converting waste heat to electricity and can be operated with any heat source and in any temperature range.



N. Deepal Subasinghe, Associate Research Professor at NIFS, earned his BSc and MPhil degrees from the University of Peradeniya, Sri Lanka. He studied at Macquarie University, Australia and University of Reading, England, completing his Ph.D. in 1999. He worked as a Senior Lecturer in Physics at the Open University of Sri Lanka from 2000-2003 and established geology and geophysics courses there. He was a Postdoctoral researcher at the RMIT University, Australia from 2003 to 2009. He has worked as a visiting lecturer at University of Kelaniya, University of Peradeniya, Macquarie University, Sydney, RMIT University, Melbourne, and Geoscience Teaching Unit, University of Reading, England, during his career. He has also worked for exploration giants such as BHP Billiton (Australia) and British Petroleum (UK).

## Merit Awards:

ODCSS (Overseas Develop. Corporation Schol. Scheme) - Australia

Faculty merit scholarship - Faculty of Science, University of Reading

ORS - Overseas Research Students Scholarship, (CVCP), UK

Australian Research Council (ARC) fellowship, RMIT University

Presidents Awards for scientific publication (every year since 2013).

**President** - Geological Society of Sri Lanka (GSSL), Member of British Sedimentological Research Group (BSRG) 1995-1999; British Parachute Association, American Physical Society. Life member of Geol Soc. SL and SLAAS. Member of Energy Expert Group, Ministry of ST&R, Elected Member Board of Earth Sciences, Postgraduate Inst. of Science, Univ. Peradeniya, Chief Editor, JGSSL 2013-14.

## Mapping of Geothermal Resources in Sri Lanka

Although not located on a highly active geothermal region, Sri Lanka still has geothermal resources which may have a potential of generating electricity and contributing to the energy needs of the country. Developing our own renewable energy sources will not only reduce our dependence on imported fossil fuel, it will also help to reduce the pollution.

The National Institute of Fundamental Studies (NIFS) initiated a project on mapping geothermal resources in Sri Lanka, in 2009.

NIFS, in collaboration with few other institutes, conducted the first ever comprehensive geophysical survey in Sri Lanka. In this survey, passive and active geophysical techniques were employed to investigate the near-surface as well as deep structures of the earth. One of the non-invasive, passive geophysical techniques used in the survey was Magneto-Telluric (MT) technique.

Time-Domain Electromagnetic (TDEM) is an active technique used in the survey. Without the need for drilling, above two techniques can provide information on geological structures, heat sources and water resources hidden under several meters to several kilometers of the earth, if necessary. Processed data is used to produce resistivity profiles that represent the sub-surface structures. Recently, the focus was on the geochemical, petrological and mineralogical aspects of the areas around the geothermal belt.



**Fig. 1:** Collecting water samples from a thermal spring  
Trincomalee area

## Studies on Mineralogy & Economic geology

Employing modern geophysical, geochemical and mineralogical techniques help to find new economic mineral resources, evaluate existing resources and improve the understanding of the fundamental processes of nature. Estimating of the remaining reserve of ore deposits, evaluating the potential of new mineral ores are currently being carried out.

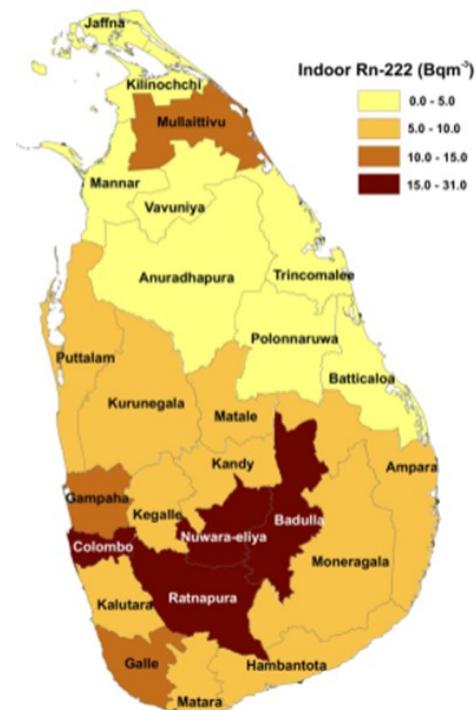


**Fig. 2:** Naturally occurring radioactive minerals found at a pegmatite intrusion in Randenigala area .

## Developing a Radon Map of Sri Lanka

Radon is a naturally occurring radioactive gas generated by radioactive decay of uranium and thorium in rocks and minerals. It is responsible for the largest dose of natural radiation on earth. Level of radon in the atmosphere changes due to many factors. In health perspectives, it is important to monitor the indoor radon levels.

In collaboration with the Atomic Energy Board of Sri Lanka, NIFS is conducting a radon monitoring programme with a view to produce a radon map of the country. Passive and active methods are used in this exercise. Indoor and outdoor radon levels are mapped around the country. Distribution of indoor radon levels, mapped using passive radon detectors for a period over 3 months, is shown in Fig. 3



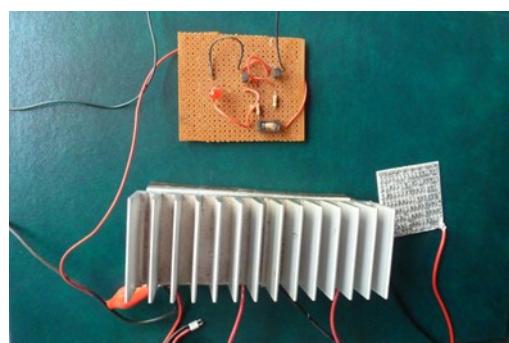
**Fig. 3:** Distribution of indoor radon levels around the country, mapped using passive radon detectors.

## Research on Thermoelectricity

Research work on thermoelectricity (TE) at the NIFS is a pioneering work, since this area of research was new to Sri Lanka, despite the fact that it is a fast growing area globally. While TE can be considered as a source of renewable energy, the main advantage is its ability to improve the overall energy efficiency of existing systems by energy scavenging and co-generation. In thermoelectricity, heat is directly converted to electricity using thermoelectric effect, known as the *Seebeck* effect. Unlike other methods, TE can utilise heat energy from any source, for example, solar energy, geothermal energy, waste heat from cooking, baking, factories, or from automobile engines.

Some other advantages of thermoelectric generators (TEGs) are the scalability (from a large plant to nano-scale module), reliability and durability due to no moving parts.

**This project is partially funded by the NRC Grant 15-119**



### Research Students:

PhD : NB Suriyaarachchi

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KVGS Perera

WMHS Wijekoon (NRC)

SA Samaranayke

MSc. : KUK Hapuhinna

KPVB Kobbekaduwa

### Key publications :

Dharmapriya. P., Malaviarachchi, S. Kriegsman, L., Krishnan. S., Galli, A. Osanai, Y., Subasinghe, N.D. and Dissanayake, C.B. (2017) Distinct metamorphic evolution of alternating silica-saturated and silica-deficient microdomains within garnet in ultrahigh-temperature granulites: an example from Sri Lanka. *Geoscience Frontiers*, 8(5), 1115-1133.

Jayathilaka, P.B., Hapuhinna, K.U.K, Bandara, A., Nanayakkara, A. and Subasinghe, N.D. (2017) Phenol contaminated water treatment on several modified dimensionally stable anodes. *Water Environment Research* Vol. 89 (8) 687-693.

Kobbekaduwa, K.P.V.B. and Subasinghe, N.D. (2015) Thermoelectric Generation Using Industrial Grade Low-Cost Materials. *Advances in Engineering Research* 14, 12-15.



**From Left:** Ms. DRTL Harischandra, Mr. S Opatha, Mr. KPVB Kobbekaduwa, Prof. ND Subasinghe, Mr. WMHS Wijekoon, Mr. HMDAH Bandara, Mr. KVGS Perera, Mr. NB Sooriyarachchi

# Environmental Chemo-dynamics



Dr. Meththika Vithanage served as a Senior Research Fellow at the National Institute of Fundamental Studies, Kandy until mid June 2017 and an Adjunct Associate Research Professor at the University of Southern Queensland, Australia. Currently, she is a Senior Lecturer, University of Sri Jayewardenepura, Nugegoda. Her work has yielded important findings for successful application in the fields of agriculture, solid waste management, and environmental pollution remediation. Dr. Vithanage has contributed more than 80 journal articles and 25 book chapters.

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Environmental chemodynamics group is focused on monitoring, modeling and research of water and soil systems to provide scientific support for restoration and regeneration of the environment. Environmental pollution is one of the major results of modern development. Remediation of pollutant materials from water, soil and air is the most focused. Monitoring and understanding of the basic and fundamental mechanism of the pollutant materials in nature is much more important.

Advanced materials such as nanomaterials and composite materials play vital role in various applications. Synthesis of advanced materials using locally available materials such as zeolite from kaolin, contribute the national development. Nano and composite materials show higher efficiency in remediation of pollutant in environment.

## Major Fields

Nanotechnology: Synthesis of nanomaterials and advanced materials, characterization and application

Water treatment: Adsorption study of heavy metals, organic materials, pesticides

Water filter systems designing and development

Molecular modeling, solid state calculation and simulation

## **Introduction**

The Environmental Chemodynamics research group is engaged in monitoring, understanding, and modeling the flow, transport, and chemical processes in water, wastewater, atmosphere and soil systems as well as the pollution remediation aspects in order to find feasible solutions for human benefit. To accomplish this, the Environmental Chemodynamics group is carrying out monitoring environment for key pollutants which is essential to understand the fundamental mechanisms behind the release or removal in order to formulate a better remediation technique and/or a mitigation strategy, laboratory and field experiments on toxic metal release from soil and water, their removal using low cost materials such as biochar and nano-materials, and modeling pollutant plume dynamics. Moreover, for the purpose of enhancing the capability of these low cost materials to removal of particular pollutants, the research group is engaged in development of different composites by using different geo materials with biochar and nano substances. The outcomes of the research finding in this group lay good foundation to identification of current threats to the environment in the means of solid waste, water pollution and atmospheric pollution and suggest the remedial measures and transform the gained knowledge to the scientific society as well as to the general public.

## **Research activities**

During 2017 the Environmental Chemodynamics research group has engaged with different research activities that basically related to environmental pollutant monitoring, modeling, removal and remedial measures and those are,

### **Biochar research**

#### **Biochar for the removal of carcinogenic volatile organic compounds from municipal solid waste dumpsite in the landfill leachate**

Our recent attempts with biochar were focused on production of biochar from the organic portion of municipal solid waste and seek the potential for the removal of carcinogenic volatile organic compounds from municipal solid waste dumpsite in the landfill leachate. The indication of aromaticity and polarity of the BC can be identified by respective atomic ratios of H/C and  $[(O+N)/C]$ . Furthermore, lower value of H/C and polarity index ratios of MSW-BC recognize highly carbonized high temperature derived biochar. The pH dependence in aqueous media of benzene and toluene can be considered as prominent factor and dynamic adsorption pattern was recorded with same sample at different pH. For, toluene at pH 8.3 and for benzene at pH 9 was favorable for adsorption study.

Toluene adsorption capacity was higher than that of the benzene for MSW-BC and 80% removal obtained for 300  $\mu\text{g/L}$  solution in 24 h time period

Freundlich was the best fitted Isotherm model for benzene and toluene suggesting a heterogeneous adsorption. Kinetic modeling postulated that the rate-controlling step is physisorption. It can be concluded that the MSW-BC can be potentially used for eliminate BTEX such as benzene and toluene from aqueous media however, with a change in the environmental conditions the VOCs can be desorbed as the sorption is via physical attraction. However, still MSW can be recycle and reuse to remediate its own pollutants while reducing the volume of waste by producing MSW-BC. This project was granted by National Research Council.

## **Environmental monitoring**

### **Monitor atmospheric deposition for heavy metals and hydrocarbons**

Dry and bulk atmospheric deposition in Kandy City, Sri Lanka, were analysed for a range of heavy metals and dry deposition for polycyclic aromatic hydrocarbons. As for heavy metals Al and Fe, from geogenic sources, were found to be in significantly higher concentrations in deposition loads compared to the other heavy metals. The other heavy metals investigated, namely, Cr, Mn, Ni, Cu, Zn, Cd and Pb, were attributed to being primarily originating from anthropogenic sources, mainly from traffic activities as confirmed by the PCA analysis undertaken. The trans-boundary pollution may have some influence on low concentrated heavy metals in Kandy area. The metal deposition in lichen also has been able to confirm and describe the metal contents in Kandy atmosphere. Regarding the health risk assessment for heavy metals, the major exposure pathway of HMs for both children and adults is ingestion. The hazard quotient for the pathways investigated in this study was in the order of ingestion > dermal contact > inhalation. Both hazard quotient and hazard index were lower than 1. The ecological risk imposed by Cd and Pb are much significant in Kandy area.

Other than Al and Fe, all other heavy metals also have ecological health impacts though those are not as much as Cd and Pb. Only five polycyclic aromatic hydrocarbons namely; Phenanthrene, Anthracene, Fluoranthene, Pyrene and Napthalene, were found in atmospheric deposition. The Trinity College site found with four out of above five polycyclic aromatic hydrocarbons. Regarding the cancer risk by polycyclic aromatic hydrocarbons, the risk is in above the acceptable levels. Children in Kandy area are much sensitive to carcinogenic impacts than that for adults. This project was granted by National Foundation and ended in 2017.

## **Material synthesis**

### **Synthesis of zeolite using natural resources for various applications**

Zeolites are porous crystalline aluminosilicate, which have a highly regular and open structure formed by a three-dimensional network of  $\text{SiO}_4$  and  $\text{AlO}_4$  tetrahedra. The tetrahedra are linked together by oxygen bridge to give cages connected by pore openings of defined size. The pore sizes range from approximately 0.3 -1.0 nm. Zeolite is also known as molecular sieves with unique pore and channel systems in the molecular size range. These features are the basis of their important contribution in ion exchange, separation and catalysis.

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#### **Research Students :**

Ph.D. : MME Munasinghe

M.Phil.: BAYB Jayawardane

WMLS Weerasundara

M.Sc. : AI Abeywansha

RMVN Gunarathne

Aashiq AR Ahmed

#### **Key Publications :**

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**From Left:** Mr. V Gunarathne, Ms. L Weerasundara, Dr. M Vithanage, Mr. A Ahmed, Mr.Y Jayawardhana,



**From Left:** Ms. L Weerasundara, Mr. Y Jayawardhana, Ms. E Munasinghe, Dr. L Jayarathna, Ms. I Abeywansha, Mr. V Gunarathne

# Ecology and Environmental Biology

Basic research in biodiversity covers every aspect of ecosystem function. Research in my laboratory focuses on understanding how ecosystems are modified by the loss of biodiversity. Ecosystems sustain human lives and diversity of species is fundamental to healthy ecosystems. We believe that biodiversity loss is the single most significant challenge facing not only Sri Lanka but also the entire planet. Biodiversity loss is also a hindrance to achieving sustainable development.

Studies in my lab are currently on plants and animals in terrestrial and freshwater ecosystems worldwide, with a special focus on the Western Ghats-Sri Lanka biodiversity hotspot. The primary focus however is the largely unchartered fields of invertebrate and small plant biodiversity. The invertebrate fauna of our country remains largely unexplored, with most studies originating during the colonial period.

Arthropod diversity estimates can be useful as indirect assays of ecosystem function or productivity or as direct estimators of ecosystem responses to human induced change. The groups of our focus are pseudoscorpions, spiders, bees and orchid, groups of high conservation necessity. These findings are then shared through papers published in peer reviewed journals.



Suresh Benjamin obtained his Ph.D. from the University of Basel, Switzerland and prior to joined the NIFS was a Postdoctoral researcher at the University of California (Berkeley), The George Washington University and Smithsonian Institution (both in Washington, DC). He is also an Alexander von Humboldt Research Fellow.

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## Molecular Phylogeny of Goblin Spiders with a Revision of Selected Genera (Araneae: Oonopidae) of Sri Lanka

The Oonopidae or goblin spiders is a midsize family (1787 species) of minute spiders that mostly inhabit on leaf litter or the canopy of forests worldwide. The aims of the project “Sri Lankan Oonopidae” were to undertake a taxonomic revision of selected Oonopidae genera in Sri Lanka and to include Sri Lankan representatives of the family in a worldwide molecular analysis.

During this study, ten new species were described from the genera *Aprusia*, *Brignolia* and *Xestaspis*. Identification keys and distribution maps were provided for all Sri Lankan species of the above genera. New members were found of the genera *Grymeus* and *Cavisternum*, which were previously believed to be Australian endemics, as well as seven new species of *Silhouettella*, *Pelcininus*, *Ischnothyreus* and *Opopaea*. The study revealed the presence of 46 Oonopidae species (41 endemics) belonging to 13 genera in Sri Lanka.

Phylogenetic evidence from two nuclear ribosomal loci showing the relationships of Sri Lankan taxa to the remaining global goblin spider fauna was analyzed. The study inferred the phylogenetic relationship of the family Oonopidae including 154 taxa representing 140 oonopids belonging to 40 genera. All generated sequences were submitted to the Genbank.

The species of *Brignolia* are narrow endemics with very restricted distributions. Therefore, our hypothesis is that most of this diversity is derived within island speciation. To confirm this hypothesis, a biogeographic study using *16S*, *28S* and *COI* sequence data for these short range endemics is ongoing.



*Xestaspis kandy* in live from Ethagala FR and NIFS-Sam Popham Arboretum

## Molecular Phylogeny and Systematics of Jumping spiders (Araneae: Salticidae) from Sri Lanka

The jumping spider (family Salticidae) is the most speciose spider family in the Araneae with 6010 described species categorized under 634 genera (World Spider Catalog, 2018) representing about 13% of global spider diversity. Sri Lanka possesses a relatively large jumping spider fauna of 86 species, placed in 50 genera, with a large endemic component. However, this might be only a small fraction of its true diversity. The aim of the project is to identify and document the jumping spider diversity of the island as well as the inclusion of them in the global molecular phylogeny of Salticidae.

Spiders were collected by leaf litter sifting, general hand collecting, sweeping and beating off bushes and trees. All materials were preserved in either 70% or 100% ethanol for morphological and molecular analysis respectively.

To date, nearly 1055 specimens have been identified up to genus and/or species level. Three new genera and several new species to science and new records of the genera *Ha-brocestum*, *Synagelides*, *Phintella*, *Carrhotus*, *Cosmophasis*, *Evarcha*, *Curubis*, *Telamonia*, *Onomastus*, *Menemerus*, *Ballus*, *Marengo*, *Rhene*, *Colaxes*, *Hyllus*, *Flacillula*, *Ptocasius*, *Plexippus*, *Epidelaxia*, *Bianor*, *Harmochirus*, *Cyrba*, *Siler*, *Simaetha*, *Stenaelurillus*, *Hispo*, *Thyene*, *Tamigalesus*, *Thiania*, *Hasarius*, *Phausina*, *Irura*, *Epocilla*, *Phaeacius* have been diagnosed.

During 2017, three new genera and sixteen new species including *Bavirecta* sp., *Schenkelia* sp., *Brancus* sp. were diagnosed. Four new combinations were proposed

In addition, molecular phylogeny of Tribe Chrysillini

was undertaken to elucidate the interrelationships

within their global molecular phylogeny. Genus

*Evarcha* was revised with the description of seven new

species and taxonomic key.



*Myrmarachne dishani* Benjamin, 2015 an endemic jumping spiders from Sri Lanka

## **MOLECULAR PHYLOGENETIC RELATIONSHIPS OF SELECTED CRAB SPIDER GENERA (ARANEAE: THOMISIDAE) WITH NOTES ON NEW SPECIES FROM SRI LANKA**

Crab spiders of the family Thomisidae are medium sized, cryptic dwellers in habitats ranging from foliage, flowers, tree barks to soil. They possess a variety of morphological, behavioural and ecological traits which make them special. Thomisidae is the sixth largest family of spiders and currently includes 2158 species placed in 175 genera distributed worldwide. Majority of thomisid genera lack proper descriptions and revisions, and molecular data. Still more important to us, phylogenetic relationships of Sri Lankan crab spiders are still unknown due to lack of morphological and molecular studies.

The objectives of the current study are to provide taxonomic description of the currently monotypic crab spider genus *Peritraeus*, re-circumscribe it in phylogenetic terms and placement of the genus in the thomisid tree of life, description of new species of *Tmarus* and assessment of its relationship to *Peritraeus* and phylogenetic placement and taxonomic revision of the crab spider genera *Diaeae*, *Massuria* and *Tarrocanus* with provisional descriptions of new species and notes on their distribution.

Molecular phylogeny of the selected crab spider genera was based on combined molecular data of H3+CO1+28S+16S-ND1 fragments.

All members of the selected crab spider genera are described based on materials from Sri Lanka. Among the ten species described, nine were endemic to Sri Lanka *Diaeae subdola*. *Tmarus hystrix*, *Diaeae subdola* and *Tarrocatus capra* were re-described. Three species of *Tmarus*, one species of *Diaeae*, one species of *Massuria* and one species of *Tarrocatus* will be described as species new to science in the near future. These species are named here as morph-species (A, B, C) until then. DNA barcodes for 47 Sri Lankan taxa were generated and these sequences will be submitted to Genbank. The presence of the endemic species and their restricted distribution highlights their diversity and the necessity of conserving their habitats.

### **Research Students:**

M.Phil : Nilani Kanesharatnam, Sasanka Ranasinghe, Ilesha Sandunika Illeperuma Arachchi, Dilini Bopearachchi

Post-doc: Dr. Crisenthiya I Clayton

### **Key Publications:**

Benjamin SP. 2011V. Phylogenetics and comparative morphology of crab spiders (Araneae: Dionycha, Thomisidae). *Zootaxa* 3080: 1-108.

Benjamin SP. 2015. Model mimics: antlike jumping spiders of the genus *Myrmarachne* from Sri Lanka. *Journal of Natural History* 49: 2609-2666.

Wheeler et. al. 2016. The spider tree of life: phylogeny of Araneae based on target-gene analyses from an extensive taxon sampling. *Cladistics* 33: 574-616.



**From left:** Ms. SL Ranasingha, Mr. R Rathnasiri, Prof. SP Benjamin, Mr. NL Athukorala, Ms. DP Bopearachchi, Ms. N Kanessharatham

# Plant and Environmental Sciences

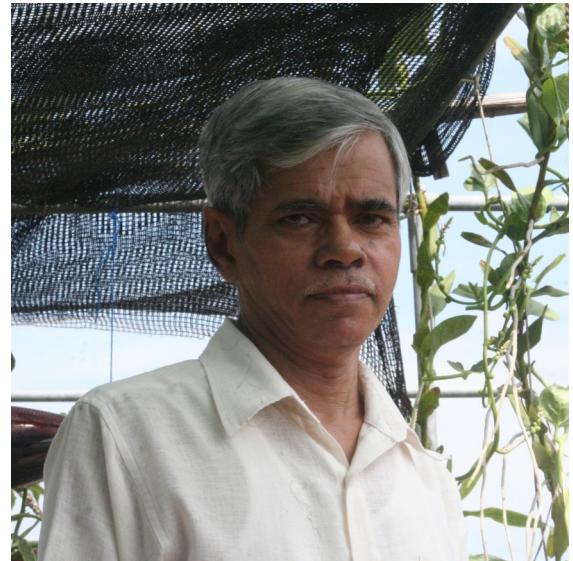
The major areas of focus of our project are: (i) Environmental remediation of pollutants using plants and plant biomass, (ii) restoration of degraded dry forests, (iii) flora growing on serpentine soil, and (iv) impact of climate and socio-economic factors on the spread of the dengue virus.

Environmental remediation is the removal of pollutants or contaminants from water and soil to ensure the protection of the environment and human health. Of the existing remediation technologies, bioremediation is cost effective, easy to operate and eco-friendly. Our research interests are focused on phytoremediation and biosorption. Our major interests are the removal of textile dyes, heavy metals, phosphate and nitrate from water bodies.

Forest degradation is a permanent and ongoing issue since forests are regarded as a freely available natural resource by subsistence farmers and those living around the forests. In this context it is necessary to assist in the restoration of our dry forests. We assessed the degree of forest degradation in the Hurulu Forest Reserve by determining the distribution of tree species, their structure and the influence of communities living adjacent to forests to find viable solutions to arrest forest degradation.

Our studies on plant species living on the harsh environment of serpentine soils provides an insight into how plants adapt to harsh environments and their possible utilization for bioremediation of heavy metals.

Climate and climate change are significantly responsible for the transmission of the dengue virus, further aided by socio-economic factors. To understand this transmission, we studied a low risk population to characterize their household related, demographic, and knowledge, attitude and practices (KAPs) in five selected dengue free communities in Kandy. This provides insights for measures to be taken by high risk communities, to reduce or prevent the incidence of dengue.



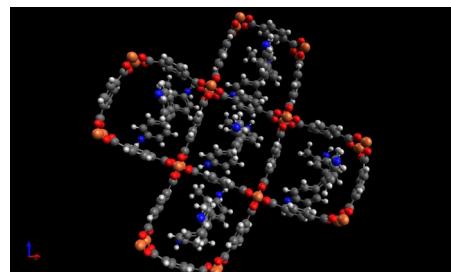
**M.C.M. Iqbal** graduated with a B.Sc (Agric.) from the University of Peradeniya in 1980 and joined the Eastern University of Sri Lanka as an Assistant Lecturer in Agriculture Biology and later served as a Senior Lecturer in Agronomy. He completed his Master's degree at the Swiss Federal Institute of Technology (ETH) in Zurich. He received a Freedom from Hunger Award from the Rotary International to read for his PhD from the University of Göttingen, Germany in 1990. He joined the IFS in 1996 and is now an Associate Research Professor. He has received Research Fellowships from the German Academic Exchange Service and the Erasmus – Mundus programme of the EU. He has received Presidential Research Awards (2000, 2002, 2003, 2004, 2007, 2013) and NRC Merit Award for Scientific Publication (2011). He was a council member of the Royal Asiatic Society of Sri Lanka and the Institute of Biology, and Chairman of the General research Committee of the SLAAS.

## Reusable biosorbents to remove textile dyes from water effluents

The development of a reusable biosorbent is a challenging task since the plant materials used in biosorption can easily biodegrade. As an alternative, we have synthesized a composite material incorporating inorganic kaolinite to give structure to the composite material. Composites were developed using alginate (anionic) and chitosan (cationic), extracted from biological sources. The biosorption process was optimized to have a favourable time to reach equilibrium, by varying the speed of shaking the dye solution with the biosorbent and measuring the residual dye concentration at different time interval. Other parameters to optimize the equilibrium time were, pH of the solution, amount of biosorbent used, and the maximum dye concentration permissible. Data obtained from kinetics and isotherm studies were further analyzed to understand the mechanism of biosorption.

Metal Organic Frameworks (MOFs) are novel synthetic materials that are used for gas adsorption and separation. They are crystalline materials with coordination bonds linking transition

They are synthesized by hydrothermal and mechano-chemical methods. In our laboratory, we are using hydrothermal synthesis using microwaves, which is considered a green technological method. We intend to coat thin films of MOFs on commonly available minerals in Sri Lanka to act as adsorbents for dyes. This is supplemented with the application of molecular beams, whose scattering from the adsorbent surface will be used to determine if the biosorption process is a physisorption or chemisorption process.



Schematic of a metal organic framework

## Remediation of Phosphate and Nitrate

### A bio-composite and *Salvinia* in tandem can absorb up to 80% of phosphates

Phosphates are essential for life on earth – they are the backbone of the DNA and RNA molecule and critical for cellular metabolism. The indiscriminate use of phosphate fertilisers and effluents from industries has increased the environmental load of phosphates causing eutrophication of water bodies stimulating the growth of cyano-bacterial blooms and aquatic plants.

The biopolymers are rich in functional groups such as carboxylic groups, hydroxyls, and aldehydes whose adsorption ability is enhanced by crosslinking link the polymer and the composite with metal ions. External parameters such as contact time, pH of the anion solution, initial anion concentration and the dose of the adsorbent were optimized. The composite was prepared with Feldspar and Flyash with Alginate cross linked with Cu<sup>2+</sup> adsorbed 82.5% after 360 minutes at an optimum pH of 3-7.

The kinetic data agreed with pseudo 2<sup>nd</sup> order and intra particle diffusion models. The isotherm model that describes the adsorption was Freundlich, Dubinin-Radushkevich and Langmuir-Freundlich combined models.

A model for application was prepared using a composite and the aquatic plant *Salvinia molesta*. The phosphates from a synthetic waste solution was applied to *S. molesta* in a basin followed in tandem by the composite: 86.5% of the phosphates were removed in 50 h.



Water body is covered with *Eichhornia crassipes*

## Forest degradation and restoration

### Empowering villagers to be gainfully employed can mitigate forest degradation

In Sri Lankan, over 50% of our natural forest cover belongs to dry forests. Unlike rain forests they are heavily utilized by humans and the potential for disturbance and degradation is high. In the Hurulu Forest Reserve, a dry forest in north-central Sri Lanka, disturbance was classified into three levels based on forest structure and tree species composition to understand the drivers of degradation. The major contributors were slash and burn agriculture and hunting; timber harvesting was not a major issue. Forest exploitation activities were primarily due to the economic necessity of the people. Thus an improvement of their economic status would directly contribute to a decline in forest degradation. This was evident from our survey where programs conducted by the state custodians of the national forest cover, the Forest Department and the Department of Wildlife Conservation of Sri Lanka, had led to a decline in degradation. Small scale projects had a lasting impact.

The absence of demarcation of boundaries between the forest and the homesteads of the villagers was a cause of conflict between the villagers and the state agencies. The absence of legal entitlement to their lands denied them opportunities to seek loans from banks to begin an enterprise. The small scale enterprises done by the villagers, included cottage industries on dairy, vegetable farming, organic fertilisers and poultry farming (this reduced the hunting activities in the forest). Thus an intervention by the state through its agencies to alleviate poverty of the villagers would mitigate forest degradation.



Forest in the dry zone

## **What characterizes a dengue free community?**

### **Know-how of the vector, and practice of attitudes to prevent its breeding**

Socio-economic, demographic factors and Knowledge Attitude Practices (KAPs) are recognized as critical factors that influence the incidence and transmission of dengue epidemics. However, studies that characterize these features in a low risk population are rare. This study was conducted to characterize the household related, demographic, socio-economic factors and KAPs status of five selected dengue free communities. An analytical cross-sectional survey was conducted on selected demographic, socio-economic, household related and KAPs in five selected dengue free communities living in dengue risk areas within the Kandy District. Household heads of 1000 randomly selected houses were interviewed in this study.

Chi-square test for independence, cluster analysis and Principal Coordinates (PCO) analysis were used for data analysis. Knowledge and awareness regarding dengue, (prevention of the vector breeding, bites of mosquitoes, disease symptoms and waste management) and attitudes of the community (towards home gardening, composting, waste management and maintenance of a clean and dengue free environment) were associated with the dengue free status of the study populations.

The vector controlling authorities should focus on socio-economic, demographic and KAPs in stimulating the community to cooperate in the integrated vector management strategies to improve vector control and reduce transmission of dengue within Kandy District.

Lahiru Udayanga M.Phil student



#### **Research Students :**

Ph.D. : A Medawatte

M.Phil. : DMREA Dissanayake

M.Sc. : WMKEH Wijesinghe (NRC)

Udayanga, NWBAL (NRC)

#### **Key Publications:**

Galev, M. L., Van Der Ent, A., Iqbal, M. C. M., & Rajakaruna, N. (2017). Ultramafic geoecology of south and southeast Asia. *Botanical studies*, 58(1), 18.

Wathukarage, A., Herath, I., Iqbal, M. C. M., & Vithanage, M. (2017). Mechanistic understanding of crystal violet dye sorption by woody biochar: implications for wastewater treatment. *Environmental geochemistry and health*, 1-15.

Udayanga, N.W.B.A.L., ; N. Gunathilaka, M.C.M. Iqbal, ; K Pahalagedara, U S. Amarasinghe, W Abeyewickreme,(2018). Socio-Economic, Knowledge Attitude Practices (KAP), Household Related and Demographic Based Appearance of Non-Dengue Infected Individuals in High Dengue Risk Areas of Kandy District, Sri Lanka. *BMC Infectious Diseases* (accepted).



**From Left:** Ms. S Perera, Ms. H Wijesinghe, Mr. R Dissanayake, Mr. RB Hapukotuwa, Mr. A Medawatte

# Plant Taxonomy and Conservation

This project is involved in a) taxonomic and biogeographically studies of flora of Sri Lanka, b) preparation of the National red list for flora, c) sustainable use of plants, d) factors affecting the conservation of flora of Sri Lanka including Invasive Alien Species, and e) restoration ecology. It goes beyond saying that Sri Lanka's rich biodiversity is facing numerous threats. Considering those threats causing loss of habitats and our exceptional endemism in plants Sri Lanka, with Western Ghats in India, is included in the global list of biodiversity hotspots. According to 2012 National Red list about 44% of our flowering plants are threatened.

Conservation of our floral wealth has become an important national priority. Conserving the natural forest ecosystems is vital for the wellbeing of both flora and fauna. The government is planning to increase the natural forest cover from the current 29.7% up to 32%. Assisted natural regeneration (ANR) is one of the important methods selected for restoring forest cover in degraded areas. NIFS-Sam Popham Arboretum is considered as the best site in Sri Lanka for ANR. On account of its significance as a bench mark site for Assisted Natural Regeneration, many forest ecologists and botanists use NIFS-SPA as a research site. It is also a popular tourist destination owing to the presence of unique fauna with a rich bird life and some unique animals such as Slender Loris and Pangolin. NIFS-SPA also has a dry evergreen rich vegetation consisting of over 200 species of trees. One of the main tasks of this project is to develop this important arboretum. In 2017 a GIS map was developed for the one third of the arboretum and establishment of interpretative signage was started.

Work related to the compilation of National Red list for flora was continued with the assistance of expert teams conducting meetings at the national herbarium. Research activities on natural products from medicinal and invasive plants were carried out in collaboration with Universities of Peradeniya and Jayawardena pura.



D. Siril A. Wijesundara obtained a special degree in botany from University of Sri Lanka (Peradeniya Campus) in 1978. He joined the Royal Botanic Gardens, Peradeniya in 1980 as a Curator. In 1991 he obtained M.Phil in Botany from University of Peradeniya for his work on Hakgala Strict Natural Reserve. In 1998 he obtained a Ph.D (Biology) from City University of New York. During his career at the Botanic Gardens, he served as Curator, Hakgala Botanic Gardens, Curator Royal Botanic Gardens Peradeniya and Curator, National Herbarium. Dr. Wijesundara was the Director, National Botanic Gardens from 1998 to 2006. In 2006 he was appointed as the Director General of the Department of National Botanic Gardens and served in that position until his retirement in 2015. He joined NIFS as a Research Professor in 2016. He was appointed as Honorary Professor, University of Hong Kong in 2006. Prof Wijesundara received Presidential awards for Scientific Research in 2001, 2002, 2007, 2008, 2009, 2011 and 2012. He currently serving many National Committees including National Biodiversity Expert Committee, National Man and Biosphere Committee, National Expert Committee on Mangrove Conservation, National Invasive Species Specialist Group and National Expert Committee on Climate Change Adaptation. In 2006 Prof. Wijesundara was elected as Fellow of National Academy of Sciences (Sri Lanka).

## **Floristic Survey of IFS-Popham Arboretum,**

### **Dambulla**

A 4.4-hectare land within the NIFS-Popham Arboretum, Dambulla had been selected for this study in 2017. Three different sub- woodland types have been identified in this selected area: (i) Area with nurse trees (mango), 1.4 ha, (ii) Area without nurse tree, 1.5 ha and (iii) Woodland (managed), 1.5 ha. GPS coordinates were taken on identified locations and digitized on a map. Total area was divided in to 10 x 10 m grids (plot) starting from right hand corner of the main entrance (facing Kandalama road) and was marked using PVC pipe segments of 3ft height. The girth and species names of woody individuals above 10 cm within the grid, were recorded. The data were entered into a GIS (Arc View) database. Herbarium specimens were collected from different species to authenticate all the species encountered within the study area. These specimens were preserved and mounted on herbarium sheets. A total of 72 species belonging to 65 genera and 29 families were recorded within the area sampled.

Taxonomic richness (total number of taxa) was 166. The overall diversity, species richness of canopy and sub canopy appears to have increased from 1995 to 2017. According to the present study the most diverse families are Fabaceae, Sapindaceae, Rubiaceae and Rutaceae. However, in 1995 Euphorbiaceae and Rubiaceae were the most diverse families.



## **Measuring the Impact of Selected Indoor Plants for the Amelioration of High CO<sub>2</sub> Concentrations in Indoor Environment**

A study was carried out to evaluate the effectiveness of some selected plant species, namely *Zamioculcas zamiifolia*, *Sansevieria trifasciata*, *Aloe vera*, *Gymnostachyum zeylanicum*, *Impatiens repens*, *Chirita* and *Sansevieria zeylanica* in improving indoor air quality during day and night times. Plants of comparable age and size of the said species were selected and placed in air-tight containers (4500 cm<sup>3</sup>) one each in 3 replicates. CO<sub>2</sub> gas (0.1 ml) of 1000±250 ppm was injected into each container and gas samples were collected at the beginning of the experiment (7.00 hours) and at four hourly intervals 11.00, 15.00, 19.00, 23.00, 3.00 and 7.00 hours and were analyzed for CO<sub>2</sub> concentration by gas chromatography (Model Shimadzu, GC- 9 AM) using a capillary column. Inter-specific variation in CO<sub>2</sub> absorption during day was evident which was highest in *Aloe vera*. (0.29 ppm.g.-hr-) followed by *Gymnostachyum zeylanicum* (0.02 ppm.g.-hr-). At night, *Aloe vera* recorded the superior CO<sub>2</sub> removal efficiency (0.34 ppm.g.-hr-) followed by

*Zamioculcas zamiifolia* (0.13 ppm.g.-hr-), *Sansevieria trifasciata* (0.06 ppm.g.-hr-) and *Sansevieria zeylanica* (0.02 ppm.g.-hr-) Preliminary studies showed a considerable interspecific variation in reducing CO<sub>2</sub> concentrations in indoor spaces during day and night. Therefore, there are prospects for improving indoor air quality of particularly congested and ill-ventilated abodes using plants effective in absorbing elevated CO<sub>2</sub> concentrations during day and night times.



## **The assessment on the distribution of Invasive Alien plant, *Ageratina riparia* in Horton Plains National Park**

Horton Plains National Park (HPNP) is one of highly environmentally sensitive areas in Sri Lanka which harbors greater biodiversity in montane region. One of threats to this natural ecosystem is the alien invasive species which have potential of destroying of stability of its biota. Relative cover of *Ageratina riparia* in HPNP were estimated using 2m x 2m quadrats placed at 50m intervals along Ohiya Road, Pattipola Road, World's End Trail, Thotapolakanda Trail and Kirigalpoththa Trail. Stratified random sampling technique was used for the estimation of relative coverage of this species in different habitats. It was observed that many of the forest edges are invaded by *Ageratina riparia*. Although this species is not found among grasses, it is found under the shade of Rhododendron trees scattered within the grassland.

Total area covered by *Ageratina riparia* in different habitat types (Cloud Forest, Forest Die Back site, Ecotone Between Forest and Grassland, Dwarf Bamboo and Tussock Grass) in HPNP is estimated to be 87.3 ha.



## **Screening the anthelmintic properties of five invasive alien plants against root knot nematodes**

Fifteen leaf extracts from five invasive plants, *Ageratina riparia*, *Miconia calvescens*, *Cestrum aurantiacum*, *Aristea eckloni*, and *Mimosa pigra* leaves were extracted using Hexane, DCM and MeOH were tested against root knot nematodes. Root knot nematode *Meloidogena incognita* was cultured in tomato roots and after 45 days of inoculation roots were well washed. Five uniform egg masses were hand-picked and placed on micro sieves and enclosed in petri dishes partially filled with 2.5ml crude oil extractions (4000ppm) (These extractions were dissolved in DMSO). Water and DMSO were used as controls. Three replicates from each were maintained. The dished were arranged in complete randomized design under laboratory conditions. .

After 24 and 48 h of treatment, the number of immersed juveniles was counted under ( $\times 10$ ) light microscope. After 48 h the egg masses were treated with 1% sodium hypochlorite to dissolve the gelatinous matrix. Then the un-hatched eggs were counted. Results showed that MeOH extract of *Ageratina riparia*, hexane extract of *Mimosa pigra* and hexane extract of *Miconia calvescens* was significantly effective against root knot nematodes.



## **Lichens of Sri Lanka**

A research project focusing on lichens found in unexplored Sri Lanka habitats was conducted by a visiting scientist Dr. Gotamie Weerakoon attached to this project based at NIFS. Many new lichens for science are discovered from this study in Sri Lanka. Well over 100+ new records including new Asian records, Indian Sub continental records, and new Sri Lankan records are among the lichens collected from that study. Several new species in fifteen different crustose genera are completed with descriptions already. The rest of the new species which belong to the lichen family *Graphidaceae* are awaiting their new descriptions. Chemical studies are completed for all the new species of *Graphidaceae*. Several doubtful and possible new foliose lichen species are awaiting for molecular analysis that need identification confirmation.

Several doubtful and possible new foliose lichen species are awaiting for molecular analysis that need identification confirmation. Specimens of family *Lobariaceae* are used to generate ITS, MCM7 and nu-LSU genes. The collected lichens will enrich the herbaria at the National Herbarium of Sri Lanka, and contribute to developing conservation actions needed in one of the most threatened floristic regions in the world.



## **Research Student :**

Ph.D.: TMSG Tennakoon at Link Natural Products  
(Registered at USJP)

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VGAU Samarasinghe at Chem. Dept. UOP  
RMR Nilanthi at DWLC  
Tharanga Wijewickrama at Bot. Dept. UOP  
Kamalapani Degamma at USJP

## **Key publications :**

Wijesundara D.S.A. 2017. Can native plants become invasive? *Ceylon Journal of Science* 46 (1) 2017: 1-2

Ariyaratne, W.A.M.P., DeepthiYakandawala, Rosabelle Samuel & Siril Wijesundara. 2017. Evaluating the occurrence and conservation statuses of Sri Lankan Orchids (Orchidaceae): Observations on newly recorded species and undocumented regions. *Phytotaxa*308 (1): 037–053.

Jayasinghe, S., Bandara, B. M. R., Wickramasinghe, A., Karunaratne, D. N., Wijesundara, D. S. A., & Karunaratne, V. (2017). The importance of harnessing the rich diversity of Sri Lankan flora for their medicinal value. *Ceylon Journal of Science*, 46(4), 3–13. DOI: <http://doi.org/10.4038/cjs.v46i4.7473>

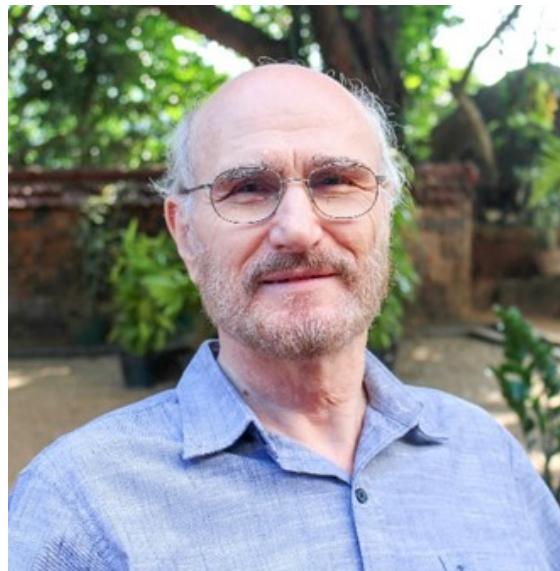


**From Left:** Ms. K Ranasinghe, Ms. D Madumali, Prof. DSA Wijesundara, Mr. C Lekamge

# Primate Biology

The research concerns observational studies of monkeys (primates) in their natural forest habitats. Our aims are: (1) to contribute new knowledge to the understanding of the evolution of social behavior in primates (and by extension in humans); (2) to provide a scientific basis for the effective management and conservation of primates and other organisms; and (3) to disseminate new knowledge through scientific publications as well through professionally produced documentary films with an eye towards - not only educating and entertaining, but also gaining public support for conservation efforts in the local and international communities. Our films contribute positively to the image of Sri Lanka as a tourist destination.

The scientific work has been buttressed by studies in population genetics, paternity exclusion, epidemiology and physiology as they relate to the behavior, ecology and vital statistics of wild monkeys. In practice, at our study site at Polonnaruwa, we have identified several thousand individual monkeys. For each macaque, we trace its behavioural, genealogical, ecological and demographic history and in this way link variables of behaviour and environment to those of survival. To this end, we require large samples over extended periods of time to assure statistical soundness. Some years ago we have begun similar investigations of the gray and purple-faced langur at our research site at Polonnaruwa. New studies focus on the genetic basis for species and subspecies characterization among the gray and purple-faced langur populations in Sri Lanka.



**Wolfgang Dittus.** McGill University, Canada: BSc (1965); MSc (1968). University of Maryland: PhD Zoology (1974). Smithsonian Postdoctoral (1975-76). Principal Investigator, Smithsonian Primate Biology Program in Sri Lanka (1977 to present, with NIFS since 1983). **Teaching:** US Fish and Wildlife Service and Government of India (1982); African Wildlife Foundation, UK (1995-1999); Millennium Foundation, UK (1996-2003). **Consulting/Associate Editor:** International Journal of Primatology (1989-1992); American Journal of Primatology (1991-2003); Journal of Primatology (2011 to present). **Conservation:** IUCN Primate Specialists Group (1995 to present); Director, Clean Reserve Project, Polonnaruwa, Ministry of Cultural and Religious Affairs, Sri Lanka (1998-2003). **Chairman,** Association for the Conservation of Primate Diversity (2003 to present). **Public education, international films:** 24 documentaries (1979-present). Off-Broadway theatrical play, New York, USA (2007-2011). **Financial Grants** (n=39, 1965-2007): Woodrow Wilson; Phillip Carpenter; National Geographic Society (2 grants); USA National Science Foundation (6 grants); various Smithsonian Institution (11 awards); Deutsche Forschungsgemeinschaft (2 grants); Earthwatch Institute (7 grants); Ministry of Cultural and Religious Affairs, Sri Lanka (1 grant); Harry Frank Guggenheim Foundation (2 grants). **Honorary Awards:** 2003-2008, Sri Lanka President's Award for Research (5 awards); NRC Merit Award for Scientific Publication (2015). **Publications:** 2260 citations,

Google Scholar h-index: 33.

Position: Visiting Research Professor

Telephone: 0094(0)777 282 700

E-Mail: wdittus@gmail.com

## **1. Demography and range use of toque macaque**

*Macaca sinica sinica.* Routine monthly census of 20 groups of toque macaques to monitor rates of birth, death, immigration and emigration. Census of “lost groups” of toque macaques that have left limits the 3 km<sup>2</sup> designated study area and transferred into surrounding human inhabited areas. Initiate drafting new maps to incorporate expanded areas of occupancy by 34 study groups. Monitor group fission.

Researchers: Mr. Sunil Gunathilake and Chameera Pathirathna, professionally certified naturalist staff of the Association for the Conservation of Primate Diversity (ACPD), Polonnaruwa.

## **2. Demography and range use of hanuman langur**

*Semnopithecus priam thersites.* Routine monthly census of 11 groups hanuman langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, change in age-sex composition of groups with time, mortality and transfer between social groups. Range use changes according to month and year.

Researchers: Mr. Sunil Gunathilake, senior naturalist of the ACPD, Polonnaruwa.

## **3. Demography and range use of purple-faced langur, PFL, *Semnopithecus vetulus philbrickii*.**

Routine monthly census of 14 groups PFL langurs to monitor rates of birth, reproductive seasonality, sex ratios at birth, change in age-sex composition of groups with time, mortality and transfer between social groups. Range use changes according to month and year.

Researcher: Mr. Sunil Rathnayake, naturalist staff of the ACPD, Polonnaruwa.

## **4. Nocturnal observation of slender loris *Loris***

*lydekkerianus nordicus* in and around the field research station (n=12) at Polonnaruwa. Aim to identify social organization, range use, diet and vital statistics such as birth and death.

Main Researchers: Chameera Pathirathna and Sunil Rathnayake, naturalist staff of the ACPD.

## **5. The genetics of langur populations; Semnopithecus vetulus, S. priam and their hybrids in Sri Lanka.**

This is a newly established collaboration between W Dittus, Suresh Benjamin of the NIFS and Pravenn Karanth of the Indian Institute of Science, Bangalore, India. The aim is to define the genetic differences among these populations as it pertains to the evolution of primate species.

**6. Primate Pathology.** The viral, bacterial and epidemiological cause of recent outbreak of venereal disease among Polonnaruwa toque macaques. Collaboration with Prof. Jayanthe Rajapakse, Dr. Kavindra Wijesundera and Dr. Neil Horadagoda (National University, Australia) and the Veterinary Faculty, Univ Peradeniya.

**7. Conservation outreach.** Seven educational events were carried out for local and foreign organizations and parties.

### **Key Publications:**

Dittus, W. The biogeography and ecology of Sri Lankan mammals point to conservation priorities. *Cey J Sci. Special Edition*, 46, 33–64, 2017 DOI: 10.4038/cjs.v46i5.7453

Roberts P, Blumenthal SA, Dittus W, Wedage O, Le-Thorp JA. Stable nitrogen, oxygen, and nitrogen, isotope analysis of plants from a South Asian forest: implications for primatology. *Am. J. Primat.* 79 (6), e22656. 2017 DOI: 10.1002/ajp.22656

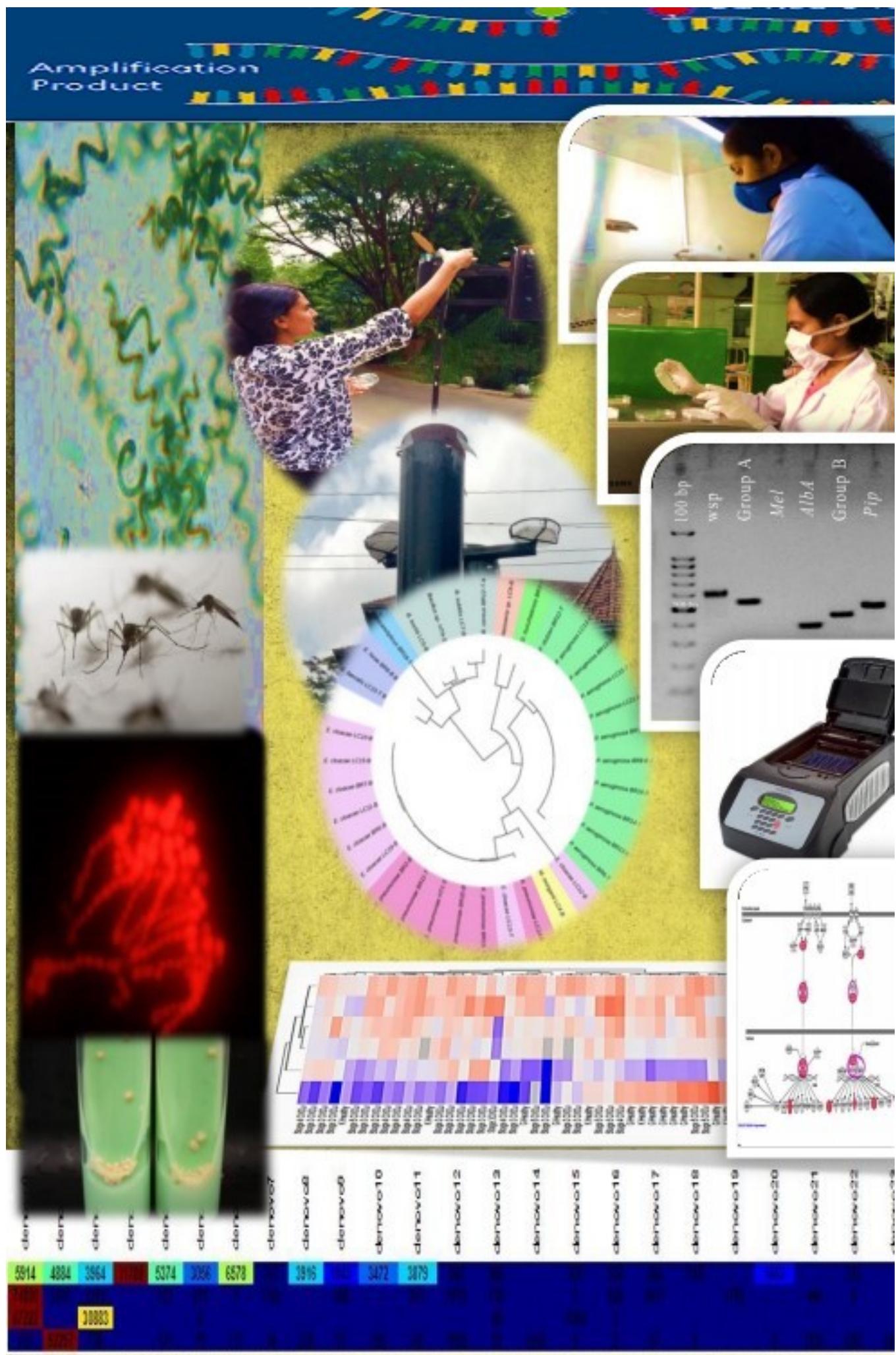
Power M., Dittus W. Vitamin D status in wild toque macaques (*Macaca sinica*) in Sri Lanka. *Am. J. Primat.* 79, . e22655. 2017 DOI: 10.1002/ajp.22655



**From Left:** Prof. W Dittus, Mr. S Gunathilake, Mr. S Rathnayake,

Mr. C Pathirathna





# **Molecular Biology & Biotechnology**

Molecular Biology is a look at life at the molecular level, focusing more on the genome and proteome, structure, function and regulation while in biotechnology, biological processes, organisms, or systems are used to manufacture products intended to improve the quality of human life. Rapid advances in molecular biology over the last 20 years has provided an array of techniques helping us to understand the different fields in biology.

Molecular Microbiology and Human Diseases project concentrate their research on understanding the microbial diversity in different environments including the human lung and the role of these microbes in disease progression. Their research also focuses on identifying biomarkers for the chronic kidney disease of uncertain aetiology (CKDu) which has been gripping the country for the last two decades.

The major research areas of the Medical Entomology project are DNA barcoding and population structure of Sri Lankan mosquito species, Anuran - biting mosquitoes and Ornithophilic mosquitoes in Sri Lanka, screening of the tropical bed bug for the presence of gene mutations associated with pyrethroid resistance and the Acaricide resistance of the brown dog tick *Rhipicephalus sanguineus*.

- **Molecular Microbiology & Human diseases**
- **Medical Entomology**

# Molecular Microbiology & Human Diseases

In our laboratory, research interests revolve around microbial ecology and human diseases. The key areas include understanding the distribution of microbial communities in the environment, particularly in the air and in the human lungs, and how molecular and microbiological tools could be utilized to investigate the role of microorganisms in disease pathogenesis.

Our current research on chronic kidney disease of uncertain aetiology (CKDu) focuses on identifying the blood transcriptome patterns of CKDu patients at different stages of the disease in comparison to healthy individuals, and also to identify significantly differentially expressed genes (DEGs) in relation to biological processes. We were able to identify a panel of six genes which could predict CKDu and CKD, with 75 to 98% accuracy.

The current research on pulmonary diseases focuses on the human lung microbiome. The study aims to identify how bacterial colonization differs according to the human respiratory diseases. Furthermore, it is aimed to figure out how human-bacterial cellular interactions affect the disease progression.

The indoor and outdoor airborne microorganism studies investigate how the microbial community is spread throughout the environment, their composition and enumeration, as well as identification of pathogenic microorganisms in the surroundings which we breathe.

A variety of modern scientific technologies are being used to achieve our objectives. The routinely used molecular techniques include PCR, qPCR, DNA Sequencing, Microarrays and advanced molecular technologies like next generation sequencing (NGS). Moreover, ELISA, flow cytometry and analytical techniques such as HPLC and LC-MS are used for unraveling the scientific problems studied by our research group.



**D. N. Magana- Arachchi;** B. Sc. (1994), Faculty of Science, University of Colombo, Sri Lanka; Ph.D.(2001), Faculty of Medicine, University of Colombo, Sri Lanka; Associate Research Professor /Project Leader, MM&HD, National Institute of Fundamental Studies (NIFS), Sri Lanka (March 2017 to date) Senior Research Fellow, Cell Biology/ MM&HD, National Institute of Fundamental Studies (NIFS), Sri Lanka (August 2013 - March 2017),Research Fellow /Project Leader, Cell Biology, Institute of Fundamental Studies (IFS), Sri Lanka,(December 2004 – July 2013);Post-Doctoral Research Associate, University of Nebraska Medical Center, USA (Nov.2002 – Sep.2004). Research Fellow, Plant Cell Biology, Institute of Fundamental Studies (IFS), Sri Lanka (December 2001 to October 2002). Assessor for Laboratory Accreditation ISO 17025 & for Good Laboratory Practice (GLP) - Sri Lanka Accreditation Board for Conformity Assessment (SLAB). **Awards;** Paul Ehrlich Foundation Fellowship; Presidential Research Awards ; WPSC Young Investigators Award; 6th Western Pacific Congress of Chemotherapy and Infectious Diseases, Malaysia; Prof. K. Rajasuriya Award for Tropical Medicine - Sri Lanka Medical Association.

Position: Associate Research Professor

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[dmaganaarachchi@gmail.com](mailto:dmaganaarachchi@gmail.com),

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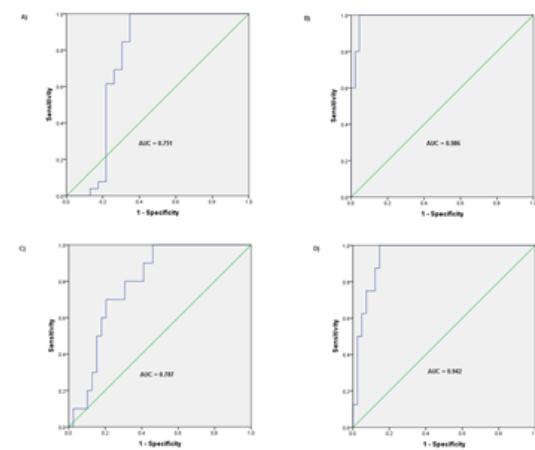
## Biomarker identification to predict causative factor/s and understand pathology of chronic kidney disease of uncertain etiology (CKDu) in Sri Lanka

Differentially regulated pathways in CKDu were identified using pathway analysis software in 2016, and the results were further analyzed in 2017. Genes selected from these pathways were validated using real time PCR and potential biomarkers were identified using regression analysis. Nineteen selected genes were analyzed for their expression patterns in 55 study subjects belonging to CKDu ( $n = 30$ ), CKD of cardiovascular origin ( $n = 5$ ), Girandurukotte healthy (GH;  $n = 10$ ) and Kandy healthy (KH;  $n = 10$ ). A regression model of six genes (HBZ, ADM, PI3, GJB4, IL1B and NAMPT) could predict CKDu, CKD, GH and KH with 75.1%, 98.6%, 78.7% and 94.2% accuracy. The pathway analysis software was used to identify and filter further potential biomarkers. Thirty five up regulated genes were identified. Thirty are known biomarkers in blood, five in urine, and five present in both blood and urine which can be used as potential biomarkers in future studies.

### Study of lung microbiota in lung cancer and bronchiectasis patients

The respiratory microbiome is an important and interesting subject regarding human health. The majority of the microorganisms that enter the human body gain entrance through the respiratory tract. The objectives of the study are to identify the microbial communities in the respiratory tract and the effect of these microorganisms regarding to the particular diseases. The study focuses on two respiratory diseases, lung cancer and bronchiectasis. Besides many other factors, microorganisms are suspected to play an important role in bronchiectasis. The presence of certain microorganisms and their activity is suspected to be a key factor for lung cancer development. The general objective of the study is to determine the changes that occur in the lung microbiota with the two different respiratory diseases.

In this research, two types of respiratory samples are being used. Bronchoalveolar lavage (BAL) and oropharyngeal swabs (OP) representing lower and upper respiratory tract, respectively. The samples are cultured to isolate bacteria including *Mycobacterium tuberculosis* and fungi. As a preliminary identification, Gram's staining and Ziehl- Neelsen acid-fast staining were performed. Pure culture isolates were (Figure 2) subjected to DNA sequencing



**Fig. 1:** Receiver operating characteristics (ROC) curves for predicting A) CKDu B) CKD with cardiovascular etiology C) Girandurukotte healthy and D) Kandy healthy using the six genes.



**Fig. 2:** Pure culture isolates

Thirteen bacterial species were identified using universal bacterial primers and the sequences were deposited in the NCBI Genebank nucleotide repository (Table 1). 16S metagenomics is being carried out to identify the bacterial communities in the respiratory samples and the bacterial load will be assessed in the future by real time PCR.

**Table 1:** Identified organisms with NCBI Genbank Accession Numbers

Organism	NCBI Genbank Accession Number
<i>Pseudomonas aeruginosa</i>	MF498494.1
<i>Klebsiella pneumoniae</i>	MF498493.1
<i>Enterobacter cloacae</i>	MF498501.1
<i>Enterococcus hirae</i>	MF498499.1
<i>Enterococcus faecalis</i>	MF498498.1
<i>Bacillus kochii</i>	MF498496.1
<i>Pseudomonas stutzeri</i>	MF498510.1
<i>Paenibacillus glucanolyticus</i>	MF498508.1
<i>Neisseria sp.</i>	MF498500.1
<i>Delftia tsuruhatensis</i>	MG733163.1
<i>Morganella morganii</i>	MG733162.1
<i>Bacillus sp.</i>	MF498497.1
<i>Bacillus subtilis</i>	MG733159.1

## Isolation and identification of airborne bacterial and fungal community in atmospheric particulate matter in Kandy, Sri Lanka

Airborne bacteria and fungi are actively engaged in atmospheric chemical, physical, and biological processes and are capable of spreading diseases. Samples were collected from nine sites within Kandy city. Identification of microbes was done using DNA sequencing for culturable microorganisms and real-time PCR for unculturable bacteria. Total microorganisms were measured using epi-fluorescence microscopy and real-time PCR. Twenty-eight bacterial and five fungal species were identified using culture based techniques.

The presence of *Staphylococcus aureus* and *Escherichia coli* were confirmed and genera *Salmonella* and *Mycobacteria* could not be detected through real-time PCR analysis. Mean culturable bacteria ranged from  $6.14 \times 10^5$  -  $5.35 \times 10^6$  CFU/m<sup>2</sup> in different sites. Mean total microorganisms were quantified using fluorescence microscopy which ranged from  $7.86 \times 10^6$  to  $3.20 \times 10^7$  cells/m<sup>2</sup>. Quantification of total microorganisms using real-time PCR analysis showed that the mean total cells in the sites ranged from  $7.19 \times 10^8$  to  $5.58 \times 10^9$  cells/m<sup>2</sup>.

### Research Students:

Ph.D. : S Sayanhooran (Till July, 2017)

M.Phil.: RWK Amarasekara (Till July, 2017), EMUA Ekanayake, \*YN Weerasinghe & \*N Pathmanathan (joined in October 2017)

### Key publications:

Sayanhooran S, Magana-Arachchi, D. N. Gunerathne, L. & Abeysekera T., Potential Diagnostic Biomarkers for Chronic Kidney Disease of Unknown Etiology (CKDu) in Sri Lanka: A Pilot Study, *BMC Nephrology*, 18 (1), 31-42, 2017

Weerasundara, L., Amarasekara, R.W.K., Magana-Arachchi, D.N., Ziyath, A.M., Karunaratne, D.G.G.P., Goonetilleke, A., Vithanage, M., 2017. Microorganisms and heavy metals associated with atmospheric deposition in a congested urban environment of a developing country: Sri Lanka. *Science of Total Environment*, 584, pp. 803 – 812

Sayanhooran S, Magana-Arachchi, D. N. Gunerathne, L, Abeysekera T., Sooriyapathirana S.S. Up regulation of oxidative stress related genes in a chronic kidney disease attributed to specific geographical locations of Sri Lanka, *Bio-Med Res. Int.*, 2016:7546265, 2016.



From left: Ms. P Nagasaijanani, Ms. EMUA Ekanayake, Ms. MAYN Weerasinghe, Ms. PS Madamarandawala

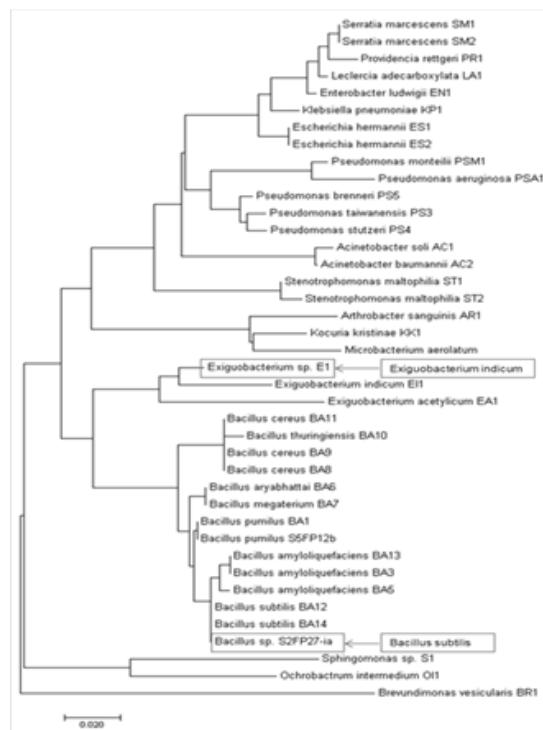


Fig. 3: Phylogeny of identified culturable bacterial species

# Medical Entomology

## DNA barcoding, Genetic diversity and population structure of Sri Lankan mosquito species

Using the genetic markers; *Cytochrome c Oxidase subunit I (COI)*gene and the Internal Transcribed Spacer 2 (ITS2) region, nearly one third of the Sri Lankan mosquito species have been characterized so far in this project and the phylogenetic trees have been constructed. Vector species of important mosquito borne diseases and several sibling species have been characterized. Further investigations, especially on the haplotype diversity in different mosquito populations and population genetic structure of these species are also being carried out.

We have analyzed the population genetic structure of three abundant malaria vectors; *An. subpictus s.l.*, *An. peditaneatus* and *An. vagus* from 5 administrative districts in two climatic zones; intermediate zone (Badulla, Kurunegala) and dry zone (Ampara, Batticoloa, Jaffna). *An. subpictus s.l.* specimens collected during the study belong to two sibling species; *An. subpictus* ‘A’ (from all study sites except Jaffna) and *An. subpictus* ‘B’ (only from Jaffna). According to the results, the genetic diversities were high for all the species and there was no positive selection driven in any of these species. There were no significant genetic structure variations among *An. peditaeniatus*, *An. vagus* and *An. subpictus* species A populations ( $P>0.05$ ), showing the possible gene flow between populations. Gene flow of *An. peditaeniatus*, *An. vagus* and *An. subpictus* species A populations was evident. Application of vector control measures against all mosquito species must be done with close monitoring since gene flow support the spread of insecticide resistance genes over a vast geographical area. The outcome will assist in proper planning of vector control programmes as uniform control measures may not be equally effective for genetically different populations.



**S.H.P. Parakrama Karunaratne** B. Sc. (1984), M.Sc. (by research) (1990), University of Peradeniya, Sri Lanka; Ph.D. (1994) London School of Hygiene and Tropical Medicine, University of London, UK; Senior Professor & Chair of Zoology (2001 to date), Dean-Faculty of Science (2007-2013) & Deputy Vice Chancellor (Jan 2018 to date)/ University of Peradeniya, Sri Lanka; Director & Senior Research Professor/ National Institute of Fundamental Studies, Sri Lanka (Oct 2015 to Dec 2017); Wellcome Trust Research Fellow (Oct 2002 – Sept 2004) & Visiting Research Professor (2004 – 2010)/ Liverpool School of Tropical Medicine, UK; Visiting Research Fellow/ School of Biosciences, Cardiff University, Wales, UK (1994 – 2001); Member of the DDT expert group, WHO, Geneva, Switzerland (2015 – 2019); 52 SCI Research Publications, Google Scholar h-index of 24 & 2102 citations (March 2018); Elected Fellow of the National Academy of Sciences Sri Lanka (2006 to date) & Elected Fellow of the Royal Entomological Society, London, UK (1997 to date). **Awards:** CVCD Excellence Award for the most outstanding senior researcher, University Grant Commission, Sri Lanka (2016), Vestergaard Frandsen Award for outstanding research contribution, NAVBD, Indian Council of Medical Research (2011); Bernard Soysa Memorial Award (Gold Medal) for Outstanding Scientific Research, SLAAS, Sri Lanka (2005); Hiran Thilakarathne Award for Outstanding Postgraduate Research, UGC, Sri Lanka (2001); Young Scientist Award, TWAS- Italy & NSF- Sri Lanka (1999); NSF Merit Award for the Best Scientific Research in Biology (1999); Presidential Research Awards & NRC Merit Awards for Scientific Publications; Wilson Peiris memorial Award Sri Lanka Medical Council (1989).

### **Anuran (frogs and toads) - biting mosquitoes and Ornithophilic mosquitoes in Sri Lanka**

Anurans and birds act as bridge vectors of diverse pathogens of emerging infectious diseases of humans and other wildlife. In Sri Lanka, any description on these mosquitoes and their role in transmitting diseases to anurans, wild birds and other organisms have never been reported. Our research focus on identification of mosquitoes that preferentially feed on anurans and birds. The diversity, distribution, abundance and biting behavior of those mosquitoes as well as the potential zoonosis diseases that can be transmitted from birds and anurans to humans and other wildlife of Sri Lanka will also be identified. A total of 2655 bird-biting mosquitoes of eight genera and 25 species have been identified so far. Out of these, 52% were *Culex* species which represents 35% of *Culex* species in the country. The most abundant species were *Culex sitiens*, *Cx. nigropunctatus*, *Cx. pseudovishnui* and *Cx. quinquefasciatus*. *Culex nigropunctatus* and *Cx. quinquefasciatus* were common to all habitats. The highest abundance was reported in lowland forests (49.6%) while it was lowest in highland forests (22.3%). Highest species similarity was reported from highland forest. Seasonal variations of the most abundant species were significantly different in selected habitats ( $p < 0.05$ ). Two distinct biting peaks were identified (*i.e.* from 6.00 to 9.00 p.m. and 10.00 p.m. to 2.00 a.m.). Mosquitoes are being screened for the presence of vertebrate pathogens to evaluate the potential vector status of these mosquitoes.

### **Screening of the tropical bed bug *Cimex hemipterus* for the presence of 'kdr' type gene mutations associated with pyrethroid resistance**

Tropical bed bug *Cimex hemipterus* is a serious indoor public health pest in tropical regions causing intense physical discomfort and mental distress to humans. Application of pyrethroid insecticides has become the major control strategy today. We have been studying the development of acaricide resistance and resistance mechanisms of *Cimex hemipterus* from in Sri Lanka. Activities of insecticide metabolizing enzymes *i.e.* esterases, glutathione S-transferases and monooxygenases, and insensitivity of organophosphate/ carbamate target site acetylcholinesterase (AChE) were evaluated by biochemical assays. Regions of the gene of pyrethroid/ DDT target site voltage gated sodium channel (VGSC) regulatory protein, were sequenced for possible *kdr* type mutations. Results were compared with previous values reported for the same populations in 2002. Resistance to propoxur has increased from 11% to 51% with about x20 increase in the individuals with elevated esterase mechanism. However, no noticeable change has occurred in malathion/ DDT resistance, in GST and monooxygenases activities and in AChE sensitivity for the past one and half decades.  $KT_{50}$  for deltamethrin and permethrin has increased in x131 and x15 times respectively over the period and five pyrethroid resistance-associated *kdr* mutations *i.e.* Y/L995H, V1010L, I1011F, V1016E, L1017F and a non-associated A1007S mutation were found in the  $\alpha$ -region of the VGSC gene for the first time in *C. hemipterus*.

### **Acaricide resistance of the brown dog tick *Rhipicephalus sanguineus***

*Rhipicephalus sanguineus* is the most prevalent dog tick in Sri Lanka and also the major vector for ehrlichiosis (caused by *Ehrlichia canis*) and canine babesiosis (caused mainly by *Babesia gibsoni*). *R. sanguineus* is able to withstand co-infections with many pathogens. Acaricides are extensively being used to control dog ticks and acaricide resistance has become a major problem in police kennels in Sri Lanka for the past few years. Present project assess the resistance status of *R. sanguineus* collected from the two major police kennels of the country. So far, a total of 10,922 *R. sanguineus* larvae from Kurunegala population and 12,254 from Kandy population were exposed to different concentrations of each acaricide [Technical grade acaricides (Permethrin, Flumethrin, Malathion, Coumaphos, DDT, Propoxur, Fipronil) and Formulated acaricides RIDD® (Amitraz), Frontline® (fipronil) and Bayticol® (flumethrin)]. For both populations,  $LD_{50}$  values of flumethrin and fipronil were lower than those of their commercially available formulated solutions, Bayticol and Frontline respectively. However, log-probit mortality curves plotted using the dosages of formulated products and the dosages of the active ingredient present in the formulated products showed that the added enhancers in the formulated products have effectively increased the efficacy of formulations. Bayticol® and RIDD® have been continuously used to control ticks in adult dogs and Frontline has been used on pups at both Police Kennels explaining the high resistance levels observed. According to the WHO (1998) discriminating dosages given for anopheline mosquitoes, both populations were susceptible only to permethrin and possibly resistant to all other acaricides tested. Preventive measures are being evaluated to combat the emerging resistance of these ticks.

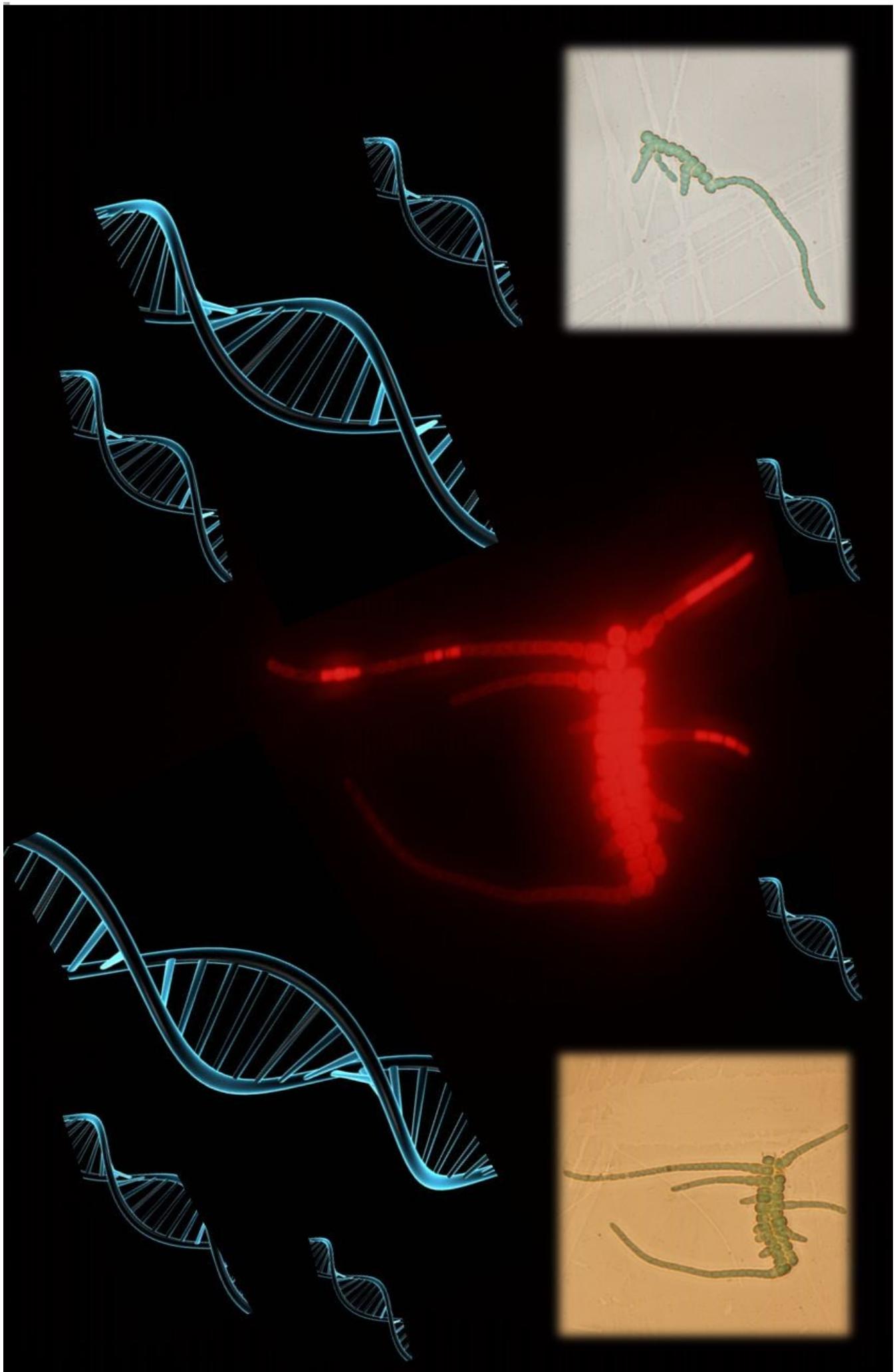
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#### **Research Group**

Prof. SHPP Karunaratne, Dr. WAPP de Silva, Ms. Thilini Weeraratne (PhD student), Mr. Nalaka Nugapola (PhD Student), Mr. Dilan Chaturanga (M.Phil Student), Ms. Janadaree Bandara (M.Phil Student)

#### **Key publication:**

Bandara, K.M.U.J. and Karunaratne, S.H.P.P. (2017) Mechanisms of acaricide resistance in the cattle tick *Rhipicephalus (Boophilus) microplus* in Sri Lanka. *Pesticide Biochemistry and Physiology* 139: 68-72.



# Rhizobium Project

## Rhizobiology of food and forage legumes

Research and development of rhizobial inoculants to enhance biological nitrogen fixation in food and forage legume plants in order to improve natural soil fertility and minimize the application of chemical nitrogen fertilizer that contributes to environmental pollution. Inoculants were screened, selected, field tested and released for application for soybean (*Glycine max*), mung bean (*Vigna radiata*), vegetable bean (*Phaseolus vulgaris*) and the forage legume white clover (*Trifolium repens*) and red clover (*Trifolium pratense*). Basic research is in progress to select inoculants for groundnut, black gram and cowpea.

## Water pollution and Cyanobacterial toxin production

Evaluation of toxigenic cyanobacteria (blue-green algae) in freshwater bodies of Sri Lanka and conducting research on amelioration of water pollution that leads to bloom formation by these organisms. Participated in the examination and analysis of water samples collected from different water bodies of Sri Lanka; qualitative and quantitative estimation of cyanobacteria.

## Utilization of cyanobacteria and their symbiotic systems

Use of beneficial cyanobacteria like *Spirulina* as food supplements and symbiotic systems such as *Azolla* as biofertilizer and animal fodder. Participated in the successful establishment of an outdoor ‘*Spirulina Tank Farm*’ at Wattegedera, Kurunegala District in collaboration with Major General (retired) Kamal Fernando, of the Mahatma Gandhi Center. Testing of *Azolla* as an *in situ* organic fertilizer, a soil ameliorator and feed ingredient for animals were investigated.



**S. A. Kulsooriya**, B. Sc. (Special) 1966, University of Ceylon, Ph. D. 1971, University of London, D. Sc. (Honoris causa) 2012, Sabaragamuwa University of Sri Lanka. Visiting Research Professor, NIFS (2009 to date), Emeritus Professor of Botany, (since 2006), Dean, Faculty of Science (2000 – 2003), Chair of Microbiology (1981) University of Peradeniya. Research Fellow (1978/79) International Rice Research Institute, Philippines; Visiting Consultant (1982/83/84) International Atomic Energy Agency, Austria; Visiting Scientist (1987/88) Weizmann Institute of Science, Israel; Visiting Professor, Washington State University, USA (1999/2000); Senior Fellow, GSI, San Jose State University, USA (2003/04). Fellow, Institute of Biology (since 1982), Fellow National Academy of Science (since 1986), Best Research award (Bioscience) NARESA (1986), Titular National Honor, *Vidya Nidhi* (1986). Presidential awards for publications 1999, 2000, 2007, 2008. Publications 2 books, 93 peer reviewed papers, 160 Research communications.

## Rhizobial isolates to produce inoculants

Isolation, screening, characterization, authentication and preliminary greenhouse experiments were conducted to select highly infective and effective rhizobial isolates to produce inoculants for ground nut (*Arachis hypogea* L.) and black gram (*Vigna mungo* L.).

## Rhizobial inoculants to minimize urea fertilizer application

The main efforts for this year were to further expand the use of rhizobial inoculants to cultivate soybean (*Glycine max* L.). The Government Department of Agriculture has embarked upon an island-wide extension program for soybean cultivation to make the country self-sufficient in this commodity. The Ministry of Agriculture requested our project to supply rhizobial inoculants for this program and this was a major task for us. In close collaboration with the crop leader for soybean Mr. Buddhika Abeysinghe, Assistant Director (Extension), Department of Agriculture, we provided them with our inoculants and also participated in some of their field activities. In areas like Hasalaka there was profuse nodulation due to inoculation.

Extension activities were also carried out with field tested rhizobial inoculants developed for vegetable bean (*Phaseolus vulgaris* L.) and mung bean (*Vigna radiata* (L.)R. Wilczek) prior to large scale distribution among farmers.

Large scale application of our inoculants to clover commenced at Ambewela farm replacing urea additions, from January 2017. The total rhizobial inoculants supplied for soybean in 2017 was for 6457 acres. Out of this inoculants for 4730 acres provided to the Department of Agriculture were distributed among farmers in the districts of Ampara, Moneragala, Matale, Anuradhapura, Puttalam, Vavuniya, Jaffna, Kandy, Trincomalee & Kurunegala under the national food production program of the government.

## Awareness and Training programs

Dissemination of knowledge and transfer of technology were focused mostly towards farming communities and field officers in the application of inoculants for targeted crops.

For soybean 33 workshops were held in the Districts of Moneragala (05), Amparai (10), Trincomalee (08), Puttalam (02), Vavuniya (04) and Jaffna (04). For vegetable beans 18 were held in Balangoda (03), Badulla (05), Nuwara Eliya (10), Matale (4) and Kandy (8). For groundnut 2 were held in Kurunegala and for mung bean 13 were held in Tissamaharama (05), Amparai (08),

Four strains out of 43 isolates were selected by greenhouse screening for groundnut. For black gram 10 strains were selected out of 31 isolates.

Plenty Foods(pvt)Ltd, (a subsidiary of Ceylon Biscuits Ltd,) was provided with inoculants for 1065 acres, which were distributed among their out grower farmers to produce soya grain for SAMAPOSA production.

The rest of the inoculants for 663 acres were taken by Oasis Marketing company and distributed among the out grower farmers of Maliban Biscuits company.

Inoculants for vegetable beans was for 60 acres and mung bean for 100 acres.



Inoculated clover at Ambewela Farm



Extension work with field officers and farmers



Mr. B. Abeysinghe , soybean crop leader



Profuse nodulation in clover



Excellent growth of inoculated soybean



Profuse nodulation of soybean

## Key Publications

S. A. Kulsooriya, Gamini Seneviratne and E. M. H. G. S. Ekanayake (2017) Chapter 09, Soil Microbial Diversity and its Utilization in Agriculture in Sri Lanka pp 203 – 224, In: J. K. Patra, C. N. Vishnuprasad and Gitishree Das (eds) *Microbial Biotechnology, Application in Agriculture and Environment*, Vol1, Springer Nature Publishers, Singapore

S. A. Kulsooriya, E. M. H. G. S. Ekanayake, R. K. G. K. Kumara and A. M. Sarath Bandara (2017) Rhizobial inoculation of *Trifolium repens* L. in Sri Lanka. *J. Natn Sci Foundation Sri Lanka*, 45 (4): 365 – 370. DOI: <http://dx.doi.org/10.4038/jnsfsr.v45i4.8190>

Kulsooriya, S. A., E. M. H. G. S. Ekanayake, R. K. G. Kosla Kumara & H. M. A. C. Gunarathna (2014) Use of rhizobial inoculants could minimize environmental health problems in Sri Lanka. Chapter 26, In: Krishna Pramanik & Jaya Kumar Patra (ed.) *Industrial and Environmental Biotechnology*, ISBN: 978-93-80012-67-4, Studium Press, New Delhi, India: 433 – 442.



**From Left:** Mr. RKGK Kumara, Ms. AMHDC Abeyratne, Prof. SA Kulsooriya, Mr. EMHGS Ekanayake,  
Mr. AHMA Tennekoon



Extensive cultivation of inoculated soybean



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# Publications in Journals

## ENERGY & ADVANCED MATERIALS

### Condensed Matter Physics & Solid State Chemistry

**Dissanayake, M.A.K.L.**, Kumari, J.M.K.W., Senadeera, G.K.R., Thotawatthage, C.A., Mellander, B-E., Albinsson, I. (2017). A novel multilayered photoelectrode with nitrogen doped TiO<sub>2</sub> for efficiency enhancement in dye sensitized solar cells, *Journal of Photochemistry and Photobiology A: Chemistry*, 349, 63-72

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Bandara, T.M.W.J., Fernando, H.D.N.S., Furlani, M., Albinsson, I., Ratnasekera, J.L., Ajith de Silva, L., **Dissanayake, M.A.K.L.**, Mellender, B-E.(2017). Combined effect of alkaline cations and organic additives for iodide ion conducting gel polymer electrolytes to enhance efficiency in dye sensitized solar cells, *Electrochimica Acta*, 252,208-214.

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Study of thermal behavior of vein graphite for advance technological applications T.H.N.G. Amaraweera, N.W.B. Balasooriya, **H.W.M.A.C. Wijayasinghe**, Journal of Geological Society of Sri Lanka, 18 (2017) 21-28 .

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## Molecular Microbiology & Human Diseases

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Gunarathne, V. Rajakaruna, N. **Vithanage, M.** Influence of soil water content on metal release in serpentine soil, The 9<sup>th</sup> International Conference On Serpentine Ecology 4 – 9 June 2017

Jayawardhana, B.A.Y.B. **Vithanage, M.**, Sorption behavior and adsorption of M-Xylene into municipal solid waste biochar, Postgraduate Institute of Science Research Congress - 2017, Postgraduate Institute of Science, University of Peradeniya, Sri Lanka, 8 – 9 September 2017

## **Ecology & Environmental Biology**

Ileperuma Arachchi, I.S., Athukorala., P., **Benjamin., S.P.** (2017).Unraveling the phylogeny of two closely related crab spider genera in Sri Lanka (Araneae: Thomisidae). ECA 2017.

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Kanesharatnam, N., Athukorala., P., **Benjamin., S.P.** (2017). Molecular and morphological data reveal a cryptic radiation of shiny South Asian jumping spider (Araneae: Salticidae). ECA 2017.

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## **Plant & Environmental Sciences**

Udayanga, N.W.B.A.L., Gunathilaka, P.A.D.H.N., **Iqbal, M.C.M.**, Kusumawathie, P.H.D, Najim, M.M.M., Amarasinghe, U.S. and Abeyewickreme W., 2017. Characterization of Dengue Incidence within the Kandy Municipal Council and Gangawata Korale Medical Officer of Health (MOH) areas, Kandy. In: 2<sup>nd</sup> National Dengue Mini Symposium, Faculty of Medicine, University of Kelaniya.

Wijesinghe, W.M.K.E.H., Dissanayake, D.M.R.E.A., Iqbal, S.S, Priyantha, N. and **Iqbal, M. C.M.** 2017., Removal of phosphate by Feldspar-Fly ash-Alginate composite .Symposium Abstracts, PGIS Research Congress, Postgraduate Institute of Science, University of Peradeniya , Sri Lanka, p 9.

Dissanayake, D.M.R.E.A., Wijesinghe, W.M.K.E.H., Iqbal, S.S, Priyantha, N. and **Iqbal, M.C.M.** 2017., Using a Composite of kaolin: alginate to Remove Fuchsine Dye from Aqueous Environment. Symposium Abstracts, Third Biennial International Symposium on Polymer Science and Technology, Golden Rose Hotel, Boralesgamuwa, Sri Lanka.

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Udayanga, N.W.B.A.L., Gunathilaka, P.A.D.H.N., **Iqbal, M.C.M.**, Kusumawathie, P.H.D, Najim, M.M.M., Amarasinghe, U.S. and Abeyewickreme W., 2017. Forecasting dengue incidence based on past dengue cases and vector density indices in Gangawata Korale and Kandy Municipal Council Medical Officer of Health (MOH) areas in Kandy District of Sri Lanka; An approach to mathematical modeling. In: Proceedings of the 73<sup>rd</sup> Annual Sessions, Sri Lanka Association for the Advancement of Science. pp. 137.

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Udayanga, N.W.B.A.L., Gunathilaka, P.A.D.H.N., **Iqbal, M.C.M.**, Kusumawathie, P.H.D, and Abeyewickreme W., 2017. Optimization of Critical Threshold Values for *Aedes* mosquitoes based on Breteau Index in Kandy District of Sri Lanka. In: International Postgraduate Research Conference-2017, Faculty of Graduate Studies, University of Kelaniya, Kelaniya, Sri Lanka.

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## Plant Taxonomy & Conservation

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Ariyarathne, W. A. M. P., Rosabelle Samuel, D.M.D. Yakandawala, and **D.S.A. Wijesundara**. 2017. Molecular Phylogenetics of Sri Lankan Anacardiaceae species using plastid and nuclear markers. Proceedings of the Symposium Understanding and Conserving Biodiversity: The use of Ecological, Phylogenetic and Evolutionary Relationships, 26th May 2017. Organized by the Biodiversity Secretariat, Ministry of Mahaweli Development and Environment in collaboration with the Institute of Biology Sri Lanka.

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## MOLECULAR BIOLOGY & BIOTECHNOLOGY

### Molecular Microbiology & Human Diseases

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Sivagnanasundaram, P., Amarasekara, R.W.K, Madegedara, R.M.D., Ekanayake, E.M.U.A. and **Magana-Arachchi, D.N.** (2017). Quantification of airborne bacterial and fungal communities in selected areas of kandy teaching hospital, Sri Lanka - a preliminary study. Proceedings PGIS Research Congress. 8<sup>th</sup> & 9<sup>th</sup> September, 2017.

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Rajakaruna, D.R.S.V., Balasooriya, B.L.W.K., Sivagnanasundaram, P., Amarasekara, R.W.K., Ekanayake, E.M.U.A. and **Magana-Arachchi, D.N.** (2017). Isolation, enumeration and molecular identification of indoor airborne microbe in a hospital setting in Sri Lanka. Proceedings of 16th agricultural research symposium, Wayamba University of Sri Lanka. 9<sup>th</sup>& 10<sup>th</sup> November, 2017.

Weerasundara, L., Karunaratne, D.G.G.P., **Magana-Arachchi, D.N.**, Vithanage, M. Health and ecological risk assessment of heavy metals in atmospheric deposition in Kandy City and suburbs, Sri Lanka, 10<sup>th</sup> International Research Conference - 2017, General Sir John Kothalawala Defense University, Sri Lanka, 3 – 4 August 2017.

Weerasundara, L. **Magana-Arachchi, D.N.** Karunarathne, D.G.G.P. Vithanage, M. Presence of heavy metals and polycyclic aromatic hydrocarbons in the atmosphere of Kandy City and associated health risks, 73<sup>rd</sup> Annual Sessions, Sri Lanka Association for the Advancement of Science, The Open University of Sri Lanka, 4 – 8 December 2017.

## Medical Entomology

Weeraratne, T.C., **Karunaratne, S.H.P.P.** and Surendran, N.S. (2017). Molecular characterization and population structure of Sri Lankan anopheline mosquitoes (Diptera: Culicidae). Proceedings of the Sri Lanka-Taiwan Joint Symposium on Advances in Entomological Research, Postgraduate Institute of Science, Peradeniya, 20<sup>th</sup> January: 6p

Nugapola, N.W.N.P., De Silva, W.A.P.P. & **Karunaratne, S.H.P.P.** (2017a). Identification Wolbachia strains in wild mosquito populations in Kandy. Proceedings of the Sri Lanka-Taiwan Joint Symposium on Advances in Entomological Research, Postgraduate Institute of Science, Peradeniya, 20<sup>th</sup> January: 12p.

Bandara, K.M.U.J., Dissanayake, D.M.A.P., De Silva, P. and **Karunaratne, S.H.P.P.** (2017). First report on emerging resistance to amitraz and flumethrin in *Rhipicephalus sanguineus* (brown dog tick) at police kennels, Kandy, Sri lanka: A case study. Proceedings of the Sri Lanka-Taiwan Joint Symposium on Advances in Entomological Research, Postgraduate Institute of Science, Peradeniya, 20<sup>th</sup> January:11p

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Weerarathne, T.C., Surendran, S.N. and **Karunaratne, S.H.P.P.** (2017). DNA bar-coding and genetic diversity of Sri Lankan mosquitoes (Diptera:Culicidae). Proceedings of the 2<sup>nd</sup> International conference on Tropical Medicine, University of Peradeniya, 8<sup>th</sup> and 9<sup>th</sup> December 2017: 49-50p.

Nugapola, N.W.N.P., De Silva, W.A.P.P. & **Karunaratne, S.H.P.P.** (2017b). Mechanisms of Pyrethroid Resistance in Dengue Mosquitoes *Aedes aegypti* and *Aedes albopictus*. Proceedings of the 2<sup>nd</sup> International conference on Tropical Medicine, University of Peradeniya, 8<sup>th</sup> and 9<sup>th</sup> December 2017: 47-48p.

Bandara, K.M.U.J., D.M.A.P. Dissanayake., Silva, P. and **Karunaratne, S.H.P.P.** (2017). Emerging Acaricide resistance of the brown dog tick *Rhipicephalus sanguineus* from two major police kennels, Sri Lanka. *Proceedings of the 2<sup>nd</sup> International conference on Tropical Medicine, University of Peradeniya, 8<sup>th</sup> and 9<sup>th</sup> December 2017*: 11p

Chathuranga,W.G.D., **Karunaratne, S.H.P.P.**, Fernando, B.R. and De Silva, W.A.P.P. (2017). Haemoparasites of wild birds and the role of ornithophilic mosquitoes in parasite transmission. *Proceedings of the 2<sup>nd</sup> International conference on Tropical Medicine, University of Peradeniya, 8<sup>th</sup> and 9<sup>th</sup> December 2017*: 43-44p.

Weeraratne, T.C., **Karunaratne, S.H.P.P.** and Surendran, N.S. (2017). Molecular characterization of mosquitoes belonging to subfamily Culicinae in Sri Lanka. *Proceedings and abstracts of National Conference on Insect Vector Biology, University of Jaffna 10th February 2017*: 13p

Nugapola, N.W.N.P., De Silva, W.A.P.P. & **Karunaratne, S.H.P.P.** (2017c). Presence of KDR type mutations in Pyrethroid and DDT resistant dengue mosquitoes *Aedes aegypti* and *Aedes albopictus*. *Proceedings and abstracts of National Conference on Insect Vector Biology, University of Jaffna 10th February 2017*: 14p

Ruwanika, K.P.D., Karunweera, N.D. and **Karunaratne, S.H.P.P.** (2017) Insecticide susceptibility patterns of *Phlebotomus argentipes*, from selected areas in Sri Lanka. *Proceedings and abstracts of National Conference on Insect Vector Biology, University of Jaffna 10th February 2017*

Chathuranga,W.G.D., **Karunaratne, S.H.P.P.**, Fernando, B.R. and De Silva, W.A.P.P. (2017). *Species composition and feeding pattern of ornithophilic mosquitoes in urban and rural areas in Gampola, Central Sri Lanka. Research Congress-2017, Postgraduate Institute of Science (PGIS), University of Peradeniya, Peradeniya, Sri Lanka*: 82.

Dhananji, G.P.H.R., Bandara, K.M.U.J., Nugapola, N.W.N.P., De Silva, W.A.P.P. & **Karunaratne, S.H.P.P.** (2017). Insecticide resistance of Bed Bug *Cimex hemipterus* in infested hostels of University of Peradeniya, Sri Lanka. *Research Congress-2017, Postgraduate Institute of Science (PGIS), University of Peradeniya, Peradeniya, Sri Lanka*: p. 85

Chathuranga,W.G.D., **Karunaratne, S.H.P.P** and De Silva, W.A.P.P. (2017). *Tree-hole breeding mosquitoes in selected forest patches in Kandy, Sri Lanka*. Proceedings of the Peradeniya University International Research Sessions (iPURSE)- 2017, University of Peradeniya:416-417p.

**Karunaratne, S.H.P.P.** (2017) Historic perspectives and challenges ahead Keynote address, *Proceedings of the 1<sup>st</sup> International Conference on emerging trends in Zoology, University of Sargodha, Panjab, Pakistan. 8<sup>th</sup> & 9<sup>th</sup> December, 2017.*

**Karunaratne, S.H.P.P** (2017) Insecticide Resistance in Insects Plenary Lecture, *Proceedings of the 2<sup>nd</sup> International Conference on Innovative Biological and Public Health Research, GC University, Lahore, Pakistan*6<sup>th</sup> & 7<sup>th</sup> December, 2017.

Ruwanika, K.P.D., Karunweera, N.D. and **Karunaratne, S.H.P.P.** (2017) *Phlebotomus argentipes*, the vector of leishmaniasis in Sri Lanka; study on susceptibility patterns. *Gordon Research Conferences & Gordon Research Seminars, "Frontiers of Science"on March 12 – 17<sup>th</sup> 2017 at Hotel Galvez, Galveston, Texas, USA*.

Ruwanika, K.P.D., Karunweera, N.D. and **Karunaratne, S.H.P.P.** (2017) *Phlebotomus argentipes*, the vector of leishmaniasis in Sri Lanka ; study on insecticide susceptibility patterns. *Annual Research Symposium-Faculty of Medicine, University of Colombo, 28<sup>th</sup> November, 2017.*

# Other Publications

## News Paper Articles

**Ape miniranvalin lithium ion battery hadai,** Athula Wijayasinghe interviewed by Gayan Suriyaarachchi, "Vijaya" Sinhala newspaper, 25<sup>th</sup> July 2017, p 31

**Batariyata nethivama bari carbon,** , Gayani Amaraweera, Niroshan Senevirathna and Athula Wijayasinghe, "Vidusara" Sinhala newspaper, 27<sup>th</sup> December 2017, p 7, 24.

**Desheeya miniranvalin lithium ion battery,** Athula Wijayasinghe interviewed by Gayan Suriyaarachchi, "Lankadeepa" Sinhala newspaper, 10<sup>th</sup> June 2017, p 15.

**Divitheeika Batariya,** Athula Wijayasinghe, Gayani Amaraweera and Niroshan Senevirathna, "Vidusara" Sinhala newspaper, 20<sup>th</sup> December 2017, p 7, 24.

**Hanthana vidyangayo desheeya miniranvalin lithium ion battery nipadavathi,** Athula Wijayasinghe interviewed by Gayan Suriyaarachchi, "Ada" Sinhala newspaper, 14<sup>th</sup> June 2017, p 6.

**Naveena thakshanika yedavumvalata sarilana lesa ape miniranvala agaya ihala nanveeme paryeshana samuhayaka pragathiya,** Niroshan Senevirathna, Athula Wijayasinghe, "Vidusara" Sinhala newspaper, 20<sup>th</sup> September 2017, p 14 -15

**Prathamika Batariya,** Athula Wijayasinghe, Gayani Amaraweera and Niroshan Senevirathna, "Vidusara" Sinhala newspaper, 13<sup>th</sup> December 2017, p 7, 24.

R. Liyanage, P. Piyathilaka, **Kukulu Peekuduwala Arsenic Bara Loha**, Lankadeepa, 25.12.2017.

*Mahanuwara Duwille Sangaunu Marayoo.* (The risk behind the atmospheric deposition in Kandy), 12 February 2017, Lankadeepa.

# Awards & Recognitions

## Condensed Matter Physics & Solid State Chemistry

Prof.M.A.K.L. Dissanayake received President's Awards for 2015 Scientific Publications: Awarded in November 2017 for TWO SCI publications.

Prof. M.A.K.L. Dissanayake received NRC Merit Award for Scientific publications in 2014 (one publication) Awarded on 20<sup>th</sup> January 2017.

Prof. M.A.K.L. Dissanayake received the NIFS Outstanding Scientist 2016- 2<sup>nd</sup> place at 2017 Annual Research Review 10<sup>th</sup> March 2017.

Prof. M.A.K.L. Dissanayake was the Editor-in-chief, Ceylon Journal of Science Peradeniya University quarterly journal From January 2016-December 2017.

Prof. M.A.K.L. Dissanayake was a reviewer for Journal of the National Science Foundation of Sri Lanka 2016/2017.

Prof. M.A.K.L. Dissanayake was Invited to a presentation at 44<sup>th</sup> NIFS School Science Programme: Delivered a Lecture-Demonstration on "*The Wonders of Sunshine*" to 150 School Students 15<sup>th</sup> December 2017.

Prof. M.A.K.L. Dissanayake presented on "*The use of scientific Research Methodology in Physics Research*" for School Teachers (NIFS Workshop) 14<sup>th</sup> June 2017

Prof. M.A.K.L. Dissanayake was a resource person at PGIS Workshop on Scientific Writing: Presentation on Experimental Methods for postgraduate research students 4<sup>th</sup> June 2017

Prof. M.A.K.L. Dissanayake was a resource person at PGIS Workshop on Scientific Writing: Presentation on Experimental Methods for postgraduate research students 2<sup>nd</sup> July 2017

Prof. M.A.K.L. Dissanayake finalized preliminary arrangements for the Organization of the Solar Asia -2018 International Research Conference (From April 2017 onward) held from 4<sup>th</sup> to 6<sup>th</sup> January 2018 at NIFS. Prof. Dissanayake was the chairman of the Organizing Committee From April 2017.

Prof. M.A.K.L. Dissanayake was an oral Examiner for PhD theses, University of Kula Lumpur, Malaysia 2017.

Prof. M.A.K.L. Dissanayake was an oral Examiner for PhD theses, University of Brunei, Brunei 2017.

Prof. M.A.K.L. Dissanayake was a reviewer for Journal of Power Sources, Elsevier 2017.

Prof. M.A.K.L. Dissanayake was a reviewer for Research Journal of Chemistry and Environment 2017.

Prof. M.A.K.L. Dissanayake was a reviewer for Optik International Journal for Light and Electron Optics 2017.

### **Other Recognitions**

Prof. M.A.K.L. Dissanayake was a member of the NSF Committee on Science and Technology Policy Research 2017.

Prof. M.A.K.L. Dissanayake was a coordinator and member, Project Management Committee of the Solar “EduTraining” Multi-university, National R&D project for manufacturing of thin film solar cells: Supported by the Ministry of S,T & R 2017.

Prof. M.A.K.L. Dissanayake was a reviewer for Basic Science Research Grant Proposals of the NSF 2017.

Prof. M.A.K.L. Dissanayake was an evaluator/Reviewer for evaluation of joint research projects by SL-NSF and Pakistan NSF August 2017.

Prof. M.A.K.L. Dissanayake was an evaluator for NRC Research Grants 2016-2017.

Prof. M.A.K.L. Dissanayake was an examiner for the PhD oral defense examination of Ms. M.M. Jamila, PhD in Science Education (PGIS) 28<sup>th</sup> June 2017.

Prof. M.A.K.L. Dissanayake was an oral examiner for the M.Sc. Oral Presentation by Mr. PKK Kumarasinghe, M.Sc. in Physics of Materials (PGIS) 14<sup>th</sup> July 2017.

Prof. M.A.K.L. Dissanayake was a reviewer for papers to be presented/published at the PGIS Research Congress, 2017.

Prof. M.A.K.L. Dissanayake was a member of the NASTEC Study Group on Basic Science Research Policy From 21<sup>st</sup> April 2017.

Prof. M.A.K.L. Dissanayake Visited China as a member of the Ministerial Delegation to initiate collaborative research on solar cells and facilitate R&D for manufacturing thin film solar cells in Sri Lanka and training a workforce competent in solar cell technology 21<sup>st</sup> to 29<sup>th</sup> July 2017.

### **Nanotechnology & Advanced Materials**

Mr. H. P. T. S. Hewathilake was the semi-finalist in SLAYS 3-Minutes Thesis Competition: “Development of Sri Lankan natural vein Graphite for Rechargeable Li-ion Batteries”, H. P. T. S. Hewathilake, N.W.B. Balasooriya, H.W.M.A.C. Wijayasinghe, H.M.T.G.A. Pitawala, SLAYS 3-Minutes Thesis Competition, Colombo, Sri Lanka, 1st March 2017.

Ms. S. Pynthamil was the best Oral Presenter in Mineral Science and Technology of the International Research symposium of Uva-Wellassa University, IRSUWU 2017: “Oxidation behavior of different morphological varieties of vein graphite”, S. Pynthamil, T.C. Senevirathna, T.H.N.G. Amaraaweera, H.W.M.A.C Wijayasinghe, Sri Lanka, 19th -20th January 2017.

3rd Place of the best oral presenter: Mr. H. P. T. S. Hewathilake, Value addition to Sri Lankan vein graphite as an anode material in rechargeable Li-ion batteries, H.P.T.S. Hewathilake, N.W.B. Balasooriya, H.W.M.A.C.Wijayasinghe, H. M. T. G. A. Pitawala, Research Symposium on Mineral Resources of Sri Lanka: Prospects and Challenges. Colombo, Sri Lanka 17th October 2017.

## **Energy & Advanced Material Chemistry**

Prof. J. Bandara received the Presidential Awards, , CAS president's international fellowship initiative (pifi) award (June ,2017- April 2018), Chinese Academy of science, China.

## **Material Processing & Device Fabrication**

Prof. G.R.A. Kumara received Presidents Awards for Scientific Publications in two SCI Journals- 2014.

Prof. G.R.A. Kumara received SUSRED Awards-2016 from National Science Foundations.

## **Natural Products**

Ms. C.L. Kehelpannala – Research Assistant attached to the Natural Product Project has won the Kandiah Memorial Award for Applied Sciences at the 46<sup>th</sup> Annual Sessions of the Institute of Chemistry Ceylon, 2017.

Mr. M.M. Qader – Research Assistant attached to the Natural Product Project has won the Kandiah Memorial Gold Award for Basic Sciences at the 46<sup>th</sup> Annual Sessions of the Institute of Chemistry Ceylon, 2017.

Mr. M.M. Qader – Research Assistant attached to the Natural Products project was awarded the Competitive Erasmus Mundus – Glink Fellowship to undertake collaborative research at the University of the West of Scotland, UK from European Commission (2017).

Prof. L. Jayasinghe, Presidential Awards for Scientific publications in 2015 – Awarded in 2017.

Prof. N.S. Kumar, Presidential Awards for Scientific publications in 2015 – Awarded in 2017.

## **Microbial Biotechnology**

Prof. G. Seneviratne received two NRC merit award in 2017.

Prof. G. Seneviratne was the associate Editor, Agriculture, Ecosystems & Environment (Elsevier; SCI journal with Impact factor of 4.099, first in the category “Agriculture multidisciplinary”).

## **Nutritional Biochemistry**

Dr. R. Liyanage received NRC Merit Award for Scientific Publication-2015.

Dr. R. Liyanage was invited to deliver a speech on “Heavy metal accumulation in food” at 44<sup>th</sup> school science program organized by NIFS.

Dr. R. Liyanage was a judge at Technical session of 29<sup>th</sup> Annual Congress of the postgraduate institute of agriculture,2017.

## **Earth Resources and Renewable Energy**

Prof. D. Subasinghe received President's Award for Scientific Publications – 23 November 2017.

Prof. D. Subasinghe was a member of the Energy Expert Group.

Prof. D. Subasinghe was the President-Elect of the Geological Society of Sri Lanka.

Prof. D. Subasinghe was a reviewer & Editorial Board member – Jour. Geol. Soc.

Member of the International Advisory Board – ACS College of Engineering, India.

## **Environmental Chemo-dynamics**

Dr. M. Vithanage was the Best Graduate Scientist, American Geophysical Union.

Dr. M. Vithanage received Presidential Awards for scientific publications (2006-2009 and 2011-to date).

Dr. M. Vithanage was the Chairperson: Young Scientist Forum, 2017, National Science and Technology Commission.

Dr. M. Vithanage received awards for science popularization from National Science Foundation and Sri Lanka Association for Advancement of Science, and for post graduate supervision by the National Science Foundation, Sri Lanka.

Dr. M. Vithanage was a Young Affiliate of the Third World Academy of Sciences considering her contribution to science as a young scientist.

Dr. M. Vithanage was a TWAS-NSF Awardee for Chemical Sciences in 2016.

Dr. M. Vithanage was the Associate editor: Groundwater for Sustainable Development Journal.

Dr. M. Vithanage was the Vice President, Section C, Sri Lanka Association for the Advancement of Science.

Dr. M. Vithanage was a Member of the Institute of Chemistry, Sri Lanka.

Dr. L.P. Jayarathna received Presidential Awards for Scientific Publications for 2015.

Dr. L.P. Jayarathna received SUSRED awards for 2013 from the National Science Foundation, Sri Lanka for the supervision of MPhil degrees .

## **Ecology & environmental Biology**

Prof. S.P. Benjamin received NRC Merit Award for Scientific publications – 2014, 2015.

Ms. U.G.S.L. Ranasinghe was a Semi-finalist in the SLAYS 3-Minutes Thesis Competition-2017, jointly organized by Sri Lankan Academy of Young Scientists (SLAYS) and National Science Scence Foundation of Sri Lanka (NSF) in collaboration with Coordinating Secretariat for Science, Technology and Innovation (COSTI), Sri Lanka.

## **Plant & environmental Sciences**

Prof. M.C.M. Iqbal received Presidential Award for publications 2015.

Prof. M.C.M. Iqbal, delivered a lecture on the “genome” at the 44th NIFS School Science Programme

### **Plant Taxonomy & Conservation**

Prof D.S.A. Wijesundara has been awarded "*Athi Vishishta Poorna Sewa Prasadini*"(අති විශිෂ්ට පුරුණ සේවා ප්‍රසාදීනි) at the Sewa Prasadini Abhises – 2017 (Service Excellence Awards) organized by the Ministry of Wildlife and Sustainable Development held at the Bandaranaike Memorial International Conference Hall (BMICH) on 3 March 2017 (on World Wildlife Day) under the patronage of HE the President of Sri Lanka Maithripala Sirisena to honour those who excel in the field of conservation of wildlife.

Prof D.S.A. Wijesundara was felicitated at the 37<sup>th</sup> Annual Sessions of the Institute of Biology “in recognition of my contribution to plant taxonomy, and engagement in research and ex-situ conservation of floristic diversity”.

Prof D.S.A. Wijesundara delivered an Invited Lecture on “Habitat destruction by IAS flora in Sri Lanka” at 27th Session of the Asia-Pacific Forestry Commission (APFC) Workshop on Habitat and species specific protocols for management of forest invasive species in the Asia-Pacific region held at BMICH, Colombo on 25-10-2017 .

Prof D.S.A. Wijesundara delivered an Invited Lecture on ‘Plant Migrations’ at BMICH organized by the Wildlife and Nature Protection Society (WNPS) of Sri Lanka on 20-07-2017.

Prof D.S.A. Wijesundara delivered an Invited Lecture on Diversity of Sri Lankan Lichens at Fourth National Workshop on Sri Lankan Lichens held at the NIFS from 24<sup>th</sup> May to 26<sup>th</sup> .

Prof D.S.A. Wijesundara delivered an Invited lecture on Urban tree planting” at Sri Lanka Next- A Blue Green Era Workshop held at BMICH, Colombo on 16-10-2018.

Prof D.S.A. Wijesundara delivered an Invited presentation on “Forest dieback in Montane forests of Sri Lanka” at workshop on dieback organized by the Wildlife Department held at Jade Green Hotel, Hambantota on 7-07-2017.

Prof D.S.A. Wijesundara delivered a Lecture on Invasive Alien Plants of Sri Lanka and their impact on Biodiversity and ecosystems” at a Workshop held at BMICH on Invasive Alien Species organized by IFL on 07-03-17.

Prof D.S.A. Wijesundara delivered a Lecture on “Diversity of Lichens in Sri Lanka” at a workshop organized by PGIS on 31-03-2017.

Prof D.S.A. Wijesundara delivered a Lecture on Invasive Alien Plants of Sri Lanka” at a Environment Ministry Workshop held at Mahaweli Training Centre, Hantane on 27-03-17.

Prof D.S.A. Wijesundara was a Ph.D. Thesis Examiner of Ms. Rumana Azad University of Ruhuna,

Prof D.S.A. Wijesundara was a Ph.D. Thesis Oral Examiner of Ms. Shalini Rajakaruna, University of Peradeniya.

Prof D.S.A. Wijesundara was a Co-Chair, National Invasive Species Specialist Group, Ministry of Mahaweli Development and Environment.

Prof D.S.A. Wijesundara was a member of the Third National Biodiversity Experts Committee, Ministry of Mahaweli Development and Environment.

Prof D.S.A. Wijesundara was a member of the National Species Conservation Advisory Group, Ministry of Mahaweli Development and Environment

Prof D.S.A. Wijesundara was a member of the National Expert Committee on Climate Change Adaptation, Ministry of Mahaweli Development and Environment

Prof D.S.A. Wijesundara was a member of the National Expert Committee on Mangrove Conservation and sustainable use, Ministry of Mahaweli Development and Environment

Prof D.S.A. Wijesundara was a member of the Basic Science Research Policy - Study Group of NAS-TEC

Prof D.S.A. Wijesundara was a member of the Board of Studies (Agriculture Biology), Postgraduate Institute of Agriculture, University of Peradeniya

Prof D.S.A. Wijesundara was a member of the Expert Committee, World Bank funded Ecosystem Conservation and Management Project (ESCAPM)

Prof D.S.A. Wijesundara was a member of the Faculty Board, Faculty of Science, University of Peradeniya, Sri Lanka

Prof D.S.A. Wijesundara was a member of the National Committee on Biodiversity and Environment, National Science Foundation (NSF )

Prof D.S.A. Wijesundara was a member of the National Committee on Man and Biosphere (MAB), National Science Foundation (NSF)

Prof D.S.A. Wijesundara was a member of the REDD+ Academic and Research Forum of Department of Forest Conservation

Prof D.S.A. Wijesundara was a member of the REDD+ Advisory and Coordinating Board (RACB) Department of Forest Conservation

Prof D.S.A. Wijesundara was a member of the Technical Expert Committee of the Department of Wildlife Conservation on Habitat Management plan for Udawalawa N.P. & Yala Complex (funded by the ESCAMP

Prof D.S.A. Wijesundara was a member of the Editorial Board of Wildlanka (Journal published by Sri Lanka Department of Wild Life Conservation)

Prof D.S.A. Wijesundara was a member of the Editorial Board of Sri Lanka Journal of Food and Agriculture (Journal published by Sri Lanka Council for Agricultural Research Policy)

Prof D.S.A. Wijesundara was a member of the Editorial Board of Tropical Agricultural Research (Journal published by Post Graduate Institute of Agriculture, Sri Lanka)

Prof D.S.A. Wijesundara was a member of the Editorial Advisory Board Rheedea (Journal published by Indian Association for Angiosperm Taxonomy)

## **Primate Biology**

### **International Committees:**

Prof. W. Dittus was an Associate Editor, Journal of Primatology

Prof. W. Dittus was a reviewer, Journal of Integrative Zoology

Prof. W. Dittus was a National Advisory, Informally for Department of Wildlife Conservation

International documentary films concerning Sri Lankan wildlife and culture promote tourism. In 2017 Prof. W. Dittus supported 5 productions from the UK (BBC), USA, and Europe.

## **Molecular Microbiology & Human Diseases**

Prof. D.N. Magana Arachchi delivered a lecture on “Practical aspects of using scientific method in a research project on air borne microbes”. Two-day training workshop for the Science teachers of the Hanguranketha Educational Zone. 14<sup>th</sup> June 2017 at the NIFS on Research methodology.

Prof. D. N. Magana Arachchi delivered a lecture on “Research methodology”. Two day training workshop on Training Teachers for Science and Technology Research in School Level at North Western Province. 10-11 October 2017, at Education Development Center, Ibbagamuwa. Conducted by Sri Lanka Association of the Advancement of Science (SLAAS)/ Ministry of Education/ Ministry of Science, Technology and Research

Prof. D. N. Magana Arachchi was a member of the Advisory Committee & Steering Committee of the setting up of Sri Lanka Institute of Biotechnology & Biotechnology Innovation Park

Prof. D. N. Magana Arachchi was a member of the Board of Study in Biochemistry & Molecular Biology , Post Graduate Institute of Science (PGIS), University of Peradeniya (till October 2017)

Prof. D. N. Magana Arachchi was a member of the panel for Evaluation of Presentations at Sixth YSF Symposium by National Science and Technology Commission on 20<sup>th</sup> January 2017

Prof. D. N. Magana Arachchi was an observer for Sri Lanka Accreditation Board (SLAB) for Laboratory Accreditation at Industrial Technology Institute (ITI) -21<sup>st</sup> & 22<sup>nd</sup> June 2017

## **Medical Entomology**

PROF. KARUNARATNE, S.H.P.P. delivered the keynote address on “Historic perspectives and challenges ahead” at 1<sup>st</sup> International Conference on emerging trends in Zoology, University of Sargodha, Panjab, Pakistan. 8<sup>th</sup> & 9<sup>th</sup> December, 2017.

PROF. KARUNARATNE, S.H.P.P. delivered a plenary lecture on “Insecticide Resistance in Insects”, at 2<sup>nd</sup> International Conference on Innovative Biological and Public Health Research, GC University, Lahore, Pakistan 6<sup>th</sup> & 7<sup>th</sup> December, 2017.

PROF. KARUNARATNE, S.H.P.P. delivered the keynote address on “Control of the vectors of mosquito borne diseases in Sri Lanka” at Exchange of Knowledge between Sri Lanka and Taiwan- Symposium and Workshop on Advances in Entomological Research, Postgraduate Institute of Science, 18<sup>th</sup> -20<sup>th</sup> January, 2017.

Prof S.H.P.P Karunaratne was a member of the DDT Expert Group, UNEP/ WHO, Geneva, Switzerland.

Prof S.H.P.P Karunaratne was a member of the Working Committee on Basic Sciences, National Science Foundation (NSF), Sri Lanka.

Prof S.H.P.P Karunaratne was a member of the Study Group on the Basic Science Research Policy, National Science & Technology Commission (NASTEC), Sri Lanka.

Prof S.H.P.P Karunaratne was a member of the Integrated Vector Management Technical Committee, Ministry of Health, Sri Lanka

Prof S.H.P.P Karunaratne was a member of the Integrated Mosquito Control Programme, Central Environmental Authority, Sri Lanka

Prof S.H.P.P Karunaratne was a member of the Associate Editor, Ceylon Journal of Science, University of Peradeniya, Sri Lanka.

Prof S.H.P.P Karunaratne was a member of the Editorial Board, International Journal of Entomological Research, Esci Journal Publishing.

# **Grants Received**

## **Research Grants**

### **Condensed Matter Physics & Solid State Chemistry**

Prof. M.A.K.L. Dissanayake received a Research Grant from the Ministry of Science, Technology and Research in 2017 for a muti-university/institute collaborative national “EduTraining” project towards R&D and training of personnel competent in thin film solar cell prototype manufacturing maintaining. NIFS is the principal coordinator. Rs. 240 mn for 2017-2020 for 4 universities (Peradeniya, Kelaniya, Jaffna and Ruhuna) and NIFS for 4 years.

Prof. M.A.K.L. Dissanayake received a grant of Rs. 3.1 mn from the NSF under Sri Lanka-Pakistan Collaborative Research Grant scheme of 2017 for a period of 3 years.

### **Energy & Advanced Material Chemistry**

Prof. J. Bandara received a NSF Technology Grant, 2017

### **Natural Products**

Prof. L. Jayasinghe (PI), Prof N.S. Kumar & Prof. N.K.B. Adikaram (CI) received research grant of Rs. 4,629,302.00 from NRC Sri Lanka (NRC 17-054). Project Title: Bioactive metabolites of endophytic fungi from the medicinal plants *Cocciniagrandis*, *Costus speciosus* and *Gymnema sylevestre* used in indigenous medicine for treatment of diabetes mellitus and possible commercial applications.

Prof. L. Jayasinghe (PI), Prof. N.S. Kumar (CI), Prof. N.K.B. Adikaram (Collaborator), Dr. N.R. Amarasinghe (Collaborator) received research grant of Rs. 2,646,300.00 from NSF Sri Lanka (NSF RG/2017/BS/06). Project Title: Chemistry and bioactivity of endophytic fungi from four popular condiment plants *Curcuma longa*, *Myristica fragrans*, *Syzygiuma aromaticum* and *Zingiber officinale* used in indigenous system of medicine in Sri Lanka: Possible applications in health and agriculture.

Prof. N.K.B. Adikaram (PI), Prof. L. Jayasinghe (CI), D. Yakandawala (CI) received research grant of Rs. 3,642,222.00 from NRC Sri Lanka Public Private Partnership programme (NRC-PPP 17/01). Project Title: Study of some postharvest diseases and disorders adversely affecting the export potential of mango var. TomEJC and their management.

Prof. J.P. Eeswara (PI), Prof. L. Jayasinghe (CI), S. Selvaskanthan (CI) received research grant of Rs. 4,129,916.00 from NRC Sri Lanka (NRC 17-17). Project Title: Rapid multiplication and production of Agarwood fragrant constituents by plant cell and tissue culture of *Gyrinopsis walla*

## **Bioenergy & Soil Ecosystems**

Dr. R. Ratnayake received the NRC No. 17-011 Rs. 4,695,723 (39,000 \$)- National research Council “Development of baseline soil information system for soil C and other nutrients for paddy growing soils in Sri Lanka”.

Dr. R. Ratnayake received National Science Foundation (NSF) Travel Grant for attending the 6<sup>th</sup> International Symposium on Soil Organic Matter held in Harpenden, United Kingdom, September 3-7, 2017.

## **Earth Resources and Renewable Energy**

Prof. N.D. Subasinghe received NSF Grant: RG/2016/EQ/11

## **Ecology & Environmental Biology**

Prof. S.P. Benjamin received NSF-OSTP Travel grant # OSTP/2017/14; RS. 108,720.00

Prof. S.P. Benjamin received the Alexander von Humboldt Foundation sponsorship, renewed research stay May-July 2017; ca. EUR 10000.00.

## **Molecular Microbiology & Human Diseases**

Prof. D.N. Magana-Arachchi received the Sri Lanka Pakistan Collaborative Research Grant—NSF-PSF/ICRP/2017/HS/01

## **Other Grants**

### **Condensed Matter Physics & Solid State Chemistry**

Prof. M.A.K.L. Dissanayake received support for Ph.D. Training of Mr. T. Jaseetaharan, Lecturer in Physics at South Eastern University of Sri Lanka. Monthly salary and funds for Chemicals and consumables: 2017

### **Ecology & Environmental Biology**

Ms. U.G.S.L. Ranasinghe received Ted Locket Grant (£500) from the British Arachnological Society to attend the 30<sup>th</sup> European Congress of Arachnology, University of Nottingham, United Kingdom.

## **On going Grants**

### **Condensed Matter Physics & Solid State Chemistry**

Prof. M.A.K.L. Dissanayake—Swedish Research Council (SRC) Grant 2015-2017 for collaborative research between NIFS, Chalmers University (Sweden), Department of Physics (Peradeniya, and Rajarata University (Mihinthale) on Dye sensitized solar cells. SEK 300,000 (total for 3 years for 3 Sri Lankan partners)

### **Nanotechnology & Advanced Materials**

Dr. H.W.M.A.C. Wijayasinghe (PI) - NRC grant 15-007, Development of Sri Lankan graphite for rechargeable batteries (2015-2018)

Dr. H.W.M.A.C. Wijayasinghe (Co I) - NRC grant 15-119, Development of Thermoelectricity Devices (2015-2018)

Dr. H.W.M.A.C. Wijayasinghe (Col. Sci.) - Grant Number NRC-TO-16-015, Development of model treatment facility for remediation of TDS and fluoride in groundwater- a sustainable solution for dry zone drinking water problem, (2016-2020)

### **Energy & Advanced Material Chemistry**

Prof. J. Bandara — NSF-2016

### **Material Processing & Device Fabrication**

Prof. G.R.A. Kumara — NSF Competitive Research Grant, Photon Upconversion as a Tool to Harvest Infrared Radiation for Direct Illumination in the Dark and to Fabricate Dye-sensitized Solar Cells to Generate Electricity under Illumination as well as in the Dark.

## **Natural Products**

Prof. L. Jayasinghe (PI), Prof. N.S. Kumar (CI) - research grant of Rs. 2,493,266.32. from NSF Sri Lanka (RG/2014/BS/02). Project Title: Chemistry and bioactivity of endophytic fungi from six plants used in indigenous medicine in Sri Lanka: Possible applications in health and agriculture.

Dr. N.R. Amarasinghe (PI), L. Jayasinghe (Collaborator) - research grant of Rs. 2,385,000.00 from NSF Sri Lanka (NSF/RG/2016/HS/04). Project Title: Investigation of acetylcholinesterase inhibitory activity of Sri Lankan grown spices as potential therapeutic agents for Alzheimer's disease.

Dr. N.R. Amarasinghe (PI), L. Jayasinghe (Collaborator) - research grant of Rs. 960,000.00 from the University of Peradeniya (URG/2016/17/AHS). Project Title: Investigation of chemistry and bioactivity of *Olax zeylanica*.

Dr. M.T. Napagoda (PI), Prof. L. Jayasinghe (Collaborator) - grant of Rs. 3,890,656 from NSF Sri Lanka (RG/2017/BS/05). Project Title: Development of effective sunscreen formulations from Sri Lankan medicinal plants.

Dr. M.T. Napagoda (PI), Prof. L. Jayasinghe (Collaborator) - grant of Rs. 2,096,468.00 from NSF Sri Lanka (RG/2015/BS/01). Project Title: A comprehensive study on the anti-inflammatory and antimicrobial secondary metabolites in selected medicinal plants.

## **Bioenergy & Soil Ecosystems**

Dr. R. Ratnayake - National Science Foundation (2016) Post graduate research scholarship programme. Grant No: NSF/SCH/2016/03, Amount: Rs. 2854142.00 "Isolation of Denitrifying Bacteria and their Potential use in Nitrate Removal from Well Water of Jaffna District".

Dr. R. Ratnayake— Government of Sri Lanka Presidential Scholarships for Foreign Students 2013/14, 20,000 USD "Biofuel and other algal products from cyanobacteria and micro algae in freshwater bodies of Sri Lanka"

Dr. R. Ratnayake- National Science Foundation- Research Equipment grant (2015) (Equipment: HPLC machine) Grant No: RG/2015/EQ/04 Amount: Rs. 45,00,000.00

## **Earth Resources and Renewable Energy**

Prof. N.D. Subasinghe (Principal Investigator), Dr. A. Wijayasinghe (Co-Investigator) — NRC Grant: NRC/15-119 Investigator driven grant of Rs.3,283,750.00. Project: "Development of Thermoelectric Devices for Energy Harvesting and Co-generation"

## **Environmental Chemo-dynamics**

Dr. M. Vithanage— NRC Grant No. 15-024, Potential use of municipal solid waste derives biochar as a cover and permeable reactive barrier material for the remediation of volatile organic compounds in landfills.

Dr. M. Vithanage— NSF grant No. RG/2014/EB/03, Quantitative assessment of potential human and ecosystem health risks imposed by atmospheric particulates in Kandy, Sri Lanka – Completed in 2017.

## **Ecology & Environmental Biology**

Prof. S.P. Benjamin— (2015-2018). NRC (Sri Lanka) Investigator driven grants # 17-017; RS. 4,969,600.00

## **Plant & Environmental Sciences**

Prof. M.C.M. Iqbal— National Research Council Grant no. TO 2014-04 (Co-grantee) *Target oriented multidisciplinary Research Grant*: Comprehensive research proposal on an operational model to control dengue in Sri Lanka using multiple vector control intervention, new product development and community engagement.

Prof. M.C.M. Iqbal— National Research Council Grant no. 2015-022 (Co-grantee) “Removal of nitrates and phosphates from drinking water using chemically and physically modified silicate materials”

Prof. M.C.M. Iqbal— National Research Council Grant no. 2015-144 (Co-grantee) “Historical trends in averages and extremes of rainfall, temperature and runoff data of Sri Lanka”

## **Plant Taxonomy & Conservation**

Prof. S. Wijesundara— Floristic Survey of IFS-Popham Arboretum, Dambulla. Funded by Ministry of Mahaweli Development and Environment. “The assessment on the distribution and investigating possible control methods of Invasive Alien plant, *Ageratina riparia* in Horton Plains National Park”. Funded by MAS Holdings Pvt. Ltd.

## **Molecular Microbiology & Human Diseases**

Prof. D.N. Magana-Arachchi (CI) - NSF – RG/2014/EB/03-Completed in June 2017

Prof. D.N. Magana-Arachchi (CI) - research grant ASP/01/RE/MED/2015/43

## **Medical Entomology**

Prof. S.H.P.P. Karunaratne— “Species diversity and the potential vector status of frog-biting mosquitoes in selected localities in the wet and dry zones of Sri Lanka” (co-Investigator). National Science Foundation, Sri Lanka. Rs. 1,420,620.00. (2016-2018.)

Prof. S.H.P.P. Karunaratne— “Dengue vector control in Sri Lanka: Occurrence of ‘kdr’ type mutations and *wolbachia* in *Aedes* mosquito populations, and the effect of insecticide fogging on insect pollinators ” (Principal Investigator). National Research Council, Sri Lanka. Rs. 3,356,608.00. (2014 -2017).

Prof. S.H.P.P. Karunaratne— “Characterization of anopheline mosquitoes of North and North-western Sri Lanka through DNA barcoding ” (Principal Investigator). International Research Centre, University of Peradeniya, Sri Lanka. Rs. 1,480,000.00. (2013-2017).

# Postgraduate Degrees Completed in 2017



**C. Liyanaarachchie, Ph.D.**, Antidiabetic properties of *Canarium zeylanicum* (*in-vitro* and *in-vivo*), *Osbeckia octandra* (*in-vitro*) and *Piper beetle* (*in-vitro*) and bioassay-guided fractionation of *C. zeylanicum* extracts. University of Peradeniya, Sri Lanka.

Supervisors: Prof. B.M.R. Bandara, Prof. Mangala Gunatillake & **Prof. L. Jayasinghe**



**Thilini Chathurika Weeraratne, Ph.D.**, Thesis title- 'DNA bar-coding, genetic diversity, genetic structure and age structure of selected mosquito species of Sri Lanka.' University of Peradeniya, Sri Lanka.

Supervisors: Prof. **S.H.P.P. Karunaratne** & Prof. S.N. Surendran



**Md. Fuad Hossain, Ph.D.**, Biodiesel & potential for other value added products from fresh water cyanobacteria in Sri Lanka & their morphological & Molecular Characterization. University of Ruhuna, Sri Lanka

Supervisors: Prof . K. L. Wasantha Kumara, **Dr. R. R. Rathnayake**, Dr. D.N. Magana-Arachchi



**G.R.N. Rathnayake, M.Phil.**, Chemistry and bioactivity of extracts and metabolites from endophytic fungi in the fruits of *Manilkara zapota* and leaves of *Passiflora edulis* University of Peradeniya, Sri Lanka.

Supervisors: **Prof. L. Jayasinghe & Prof. N.S. Kumar**



**T. Sritharan, M.Phil.**, Chemistry and bioactivity of extracts and metabolites from endophytic fungi in the fruits of *Carica papaya*, *Averrhoa carambola* and *Syzygium samarangense*. University of Peradeniya, Sri Lanka.

Supervisors: **Prof. L. Jayasinghe & Prof. N.S. Kumar**



**M.V.K. Munasinghe, M.Phil.**, Chemistry and bioactivity of secondary metabolites from endophytic fungi isolated from *Piper nigrum*, *Solanum insanum* and *Momordica charantia*. University of Peradeniya, Sri Lanka.

Supervisors: **Prof. L. Jayasinghe & Prof. N.S. Kumar**



**R.M.N.M. Rathnayake, M.Phil.**, *Synthesis of expanded graphite from Sri Lankan vein graphite for novel technological applications*. University of Peradeniya, Sri Lanka.

Supervisors: H.W.M.A.C. Wijayasinghe and H.M.T.G.A. Pitawala



**J.M.K.W. Kumari ,M.Phil.**, *Efficiency enhancement in dye sensitized solar cells by modification of the TiO<sub>2</sub> photoanode by incorporating metal nanopraticles, cations of varying size and nitrogen doping*. University of Peradeniya, Sri Lanka

Supervisors: **Prof. M.A.K.L. Dissanayake**, Dr. G.K.R. Senadeera



**A.M.J.S. Weerasinghe, M.Phil.**, *Development of novel polymer-free and polymer-incorporated quasi solid (gel) polymer electrolytes for dye sensitized solar cells*. University of Peradeniya, Sri Lanka.

Supervisors: **Prof. M.A.K.L. Dissanayake** (NIFS), Dr. V.A. Seneviratne (University of Peradeniya)



**R.K.C. Rajapaksha, M.Phil.**, *Assessment and Mapping of Soil C Stocks in Knuckles Forest Region of Sri Lanka*. University of Peradeniya, Sri Lanka.

Supervisors: **Dr. R.R. Ratnayake**, Prof. H.M.S.P. Madawala, Prof. S.K. Gunathilake



**N.B. Suriyaarachchi ,MPhil**, *Mapping Geothermal Resources in Sri Lanka: Combined Use of Magnetotellurics and Trancient Electromagnetic Method*.University of Peradeniya, Sri Lanka.

Supervisors: **Prof. N.D. Subasinghe**, Prof. H.A. Dharmagunawardhana



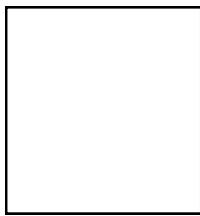
**Samadi Jayalath, M.Sc**, *Molecular identification of selected fresh water cyanobacteria and their effect on MRSA strain with different extraction solvents*. University of Peradeniya, Sri Lanka.

Supervisor: **Dr. R.R. Ratnayake**



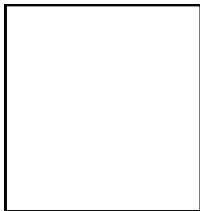
**A.M.K.C. Attanayake, M.Sc.,** Evaluation of hypolipidemic effect of different extracts of seeds. University of Peradeniya, Sri Lanka.

Supervisors: Dr. W.I.T. Fernando, **Prof. L. Jayasinghe** & Dr. P.H.P. Fernando



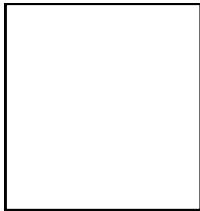
**B. S. Hettiarachchi, M.Sc.** "Preparation of Dye-sensitized solar cells using Graphene on soda lime glass as a counter electrode" .

Supervisors: **Prof: G.R.A. Kumara**



**K. Robinson, M.Sc.** "Graphene based counter electrode for development of dye-sensitized solar cells"

Supervisors: **Prof: G.R.A. Kumara**



**R.A. Jayarathna, M.Sc.,** Efficiency enhancement in dye-sensitized solar cells based on poly(ethylene oxide) solid electrolyte by plasticizer, mixed cations and nano filler effects . University of Peradeniya, Sri Lanka.

Supervisors: Prof. **M.A.K.L. Dissanayake**

# Research Assistants in 2017



Mr. A.M.J.S. Weerasinghe



Mr. G.R.N. Rathnayaka



Mr. A.M.K.L. Abeykoon



Mr. J.A.D.M.N. Jayakody



Mr. C.A. Thotawatthage



Mr. K.M.S.D.B. Kulatunga



Mr. D.M.V.Y.S. Bandara



Mr. K.N.L. De Silva



Mr. D.R.L. Dodangodage



Mr. K.P.V.B. Kobbekaduwa



Mr. G.D.K. Heshan



Mr. M.M. Qader



Mr. P.L.C.U.S.B. Lekamge



Ms. D. Thanabalasingham



Mr. R.I.C.N. Karunaratne



Ms. D.M.D.M. Dissanayake



Mr. S. Sayanthooran



Ms. E.M.U.A. Ekanayake



Mr. W.W.M.A.B. Medawatta



Ms. G.T.R. Abeynayake



Mr. B.A.Y.B. Jayawardhana



Ms. H.K.S.N.S. Gunarathne



Ms. C.L. Kehelpannala



Ms. J.M.K.W. Kumari



Ms. K.M.U.J. Bandara



Ms. Rizliya Visvanathan



Ms. Lakshika Weerasundara



Ms. S.K. Jayasekara



Ms. N. Kanesharatnam



Ms. U.G.S.L. Ranasinghe



Ms. P.C. Wijepala



Mr. N.B. Suriyaarachchi



Ms. R.P.S.K. Rajapaksha



Mr. F. Hossain



Ms. R.W.K. Amarasekara



Mr. R.M.V.N. Gunarathne



Mr. T. Jaseetharan



Ms. Abhiramy Thurairajah

Mr. D.M.R.E.A. Dissanayake



Ms. I.S. Illeperuma Arachchi

Mr. H.M.D.A.H. Bandara

Mr. K.V.G.S. Perera

Mr. P.A.R.P. Kumara

Mr. S.M.P.R. Kumarathilake

Ms. F.A. Deen

Ms. K.D.M.S.P.K. Kumarasinghe

Ms. M.A.Y.N. Weerasinghe

Ms. N. Pathmanathan

Ms. R.M.N.M. Rathnayake

Ms. S.W. Meepegamage

Ms. W.T. Awanthi



Ms. J.N. Kanagaratnam



Ms. K.D.M.S.P.K. Kumarasinghe



Ms. M.V.K. Munasinghe



Ms. S. Sathya

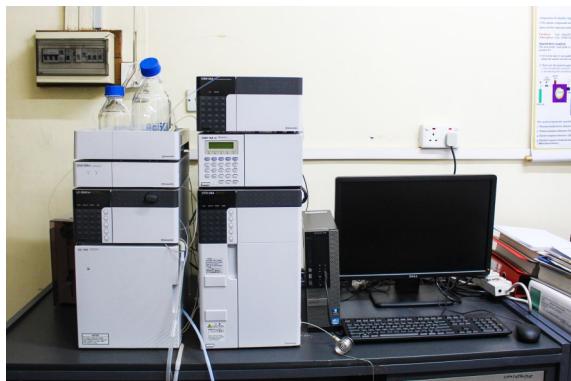


Ms. T.C. Senevirathna



Ms. W.M.K.E.H. Wijesinghe

# Equipment Facilities



Ion chromatograph



Gas Chromatograph-Mass Spectroscopy



CHN Analyzer



High Performance Liquid Chromatograph (HPLC)



Gas chromatograph



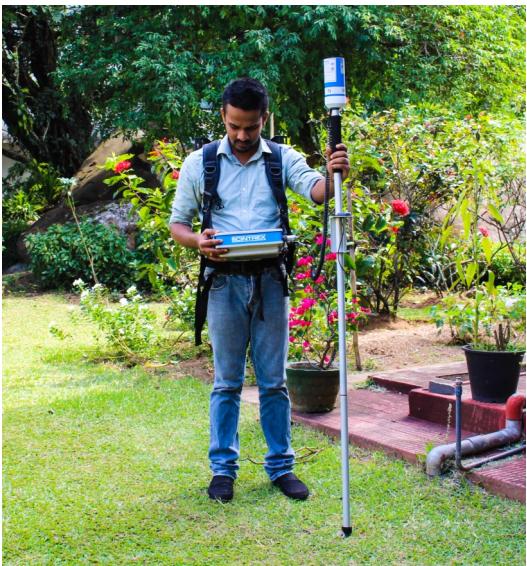
Inductively coupled plasma optical emission spectrometry (ICP-OES)



Auto-filtrator



Long Arm Binocular Microscope



Walking Magnetometer



Thermometric Titrator



Liquid Chromatography Mass Spectrometry



Battery Assembling Unit



Dietary Fiber Analyzer



X—Ray Diffractometer



# Organization

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# **Members of the Board of Governors - 2017**



Prof. Anura Wickramasinghe  
Chairman, Board of Governors  
Department of Chemistry  
University of Peradeniya



Prof. Mohan de Silva  
Chairman, University Grants Commission



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Director  
Senior Research Professor  
National Institute of Fundamental Studies



Prof. N.G.J. Dias  
Department of Computer Systems Engineering  
University of Kelaniya



**Prof. M.A.K.L. Dissanayake**  
Research Professor  
National Institute of Fundamental Studies



**Dr. W.K.B.N. Prame**  
Former Director General  
Geological Survey and Mines Bureau



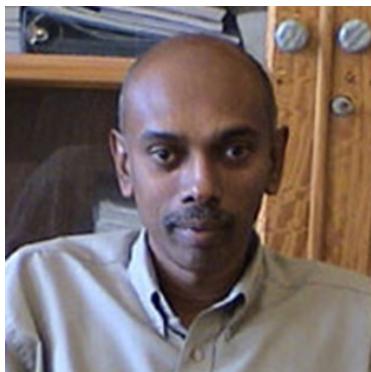
**Prof. C.P. Deepal W. Mathew**  
Department of Biochemistry and Molecular Biology  
University of Colombo



**Prof. Jayantha Wijeyaratne**  
Department of Zoology and Environmental Management  
University of Kelaniya  
Chairman, National Science and Technology Commission



Prof. U.L.B. Jayasinghe  
Research Professor  
National Institute of Fundamental Studies



Prof. H.M.D. Namal Priyantha  
Department of Chemistry  
University of Peradeniya



Mr. J.M.U.P. Jayamaha  
Treasury Representative  
Additional Director General  
Department of Public Enterprises



Dr. P.S.B. Wanduragala  
Secretary to the Board of Governors  
National Institute of Fundamental Studies

# Research Council

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Director

National Institute of Fundamental Studies

**Prof. D.M.D. Yakandawala**

Faculty of Science

University of Peradeniya

**Prof. Ruwan Duminda Jayasinghe**

Faculty of Dental Studies

University of Peradeniya

**Prof. H.M.D. Namal Priyantha**

Professor Chemistry, Dept. of Chemistry

University of Peradeniya

**Prof. R.L. Chandrajith**

Department of Geology

University of Peradeniya

**Prof. G.K.R. Senadeera**

Department of Physics

The Open University of Sri Lanka

**Prof. D.K. Weerakoon**

Department of Zoology

University of Colombo

**Prof. M.A.K.L. Dissanayake**

National Institute of Fundamental Studies

**Prof. A. Nanayakkara**

National Institute of Fundamental Studies

**Prof. J. Bandara**

National Institute of Fundamental Studies

**Prof. U.L.B. Jayasinghe**

National Institute of Fundamental Studies

**Prof. G. Seneviratne**

National Institute of Fundamental Studies

**Prof. D. S. A. Wijesundara**

National Institute of Fundamental Studies

**Prof. S.P. Benjamin**

National Institute of Fundamental Studies

**Prof. M.C.M. Iqbal**

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**Prof. N.D. Subasinghe**

National Institute of Fundamental Studies

**Prof. G.R.A. Kumara**

National Institute of Fundamental Studies

**Prof. D.N. Magana-Arachchi**

National Institute of Fundamental Studies

**Dr. R.R. Ratnayake**

National Institute of Fundamental Studies

**Dr. M.S. Vithanage**

National Institute of Fundamental Studies

**Dr. H.W.M.A.C. Wijayasinghe**

National Institute of Fundamental Studies

**Dr. R. Liyanage**

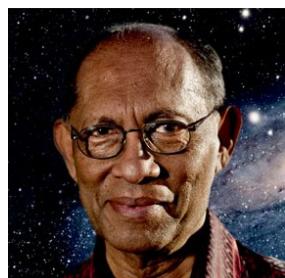
National Institute of Fundamental Studies

**Dr. P.S.B. Wanduragala**

Secretary to the Board of Governors

National Institute of Fundamental Studies

# Former Directors



Prof. Chandra Wickramasinghe  
1981 - 1984



Prof. Cyril Ponnamperuma  
1985 - 1991



Prof. K. Tennakone  
1996 - 2008



Dr. N.R. de Silva  
2008 - 2009 (Acting Director)



Prof. C.B. Dissanayake  
1991-1996, 2009 - 2015



Prof. S.H.P.P. Karunaratne  
2015 - 2017

# Director's Office



Prof. U.L.B. Jayasinghe  
Acting Director  
National Institute of Fundamental Studies

## Director

Prof. U.L.B. Jayasinghe is the Acting Director of the National Institute of Fundamental Studies and is the Chief Executive Officer (CEO) of the Institute. The Acting Director presides over the research and administrative matters, observes performance and progress of research work and controls the resources and expenditure of the Institute. He ensures that the mission is fulfilled and the Institute is moving towards its vision.

## Director's Office

Manages the full range of responsibilities and tasks that are needed to be undertaken for effective functioning of the Institute.

Provides the overall management for the achievement of primary aims of the Institute.

Supports the institute's research programs, projects, initiatives and innovations to achieve the aims and objectives of the institute.

Coordinates with the Ministry and other organizations in providing information on research and administrative affairs.

Organizes meetings and other activities essential for the advancement of research and administration.

Provides services including recruitment and selection of new employees, performance management and evaluation, employee promotions and maintenance of records of all staff members of the institute.



From Left: Ms. DMADE Liyanage, Ms. MD Jeewa Kasthuri, Ms. OWK Seneviratne, Mr. D Malwewa

# Administration Division



## Secretary

Dr. P.S.B. Wanduragala

Secretary to the Board

Secretary/ National Institute of Fundamental Studies

This Division consists of the following sections:

- Administration
- Reception
- Transport
- Workshop
- Maintenance

### Duties and responsibilities entitled for the Administration Division

- Maintaining office procedures in Administration division
- Work related to recruitments
- Work related to contractual services
- Arranging Tender Board and Suppliers Committee meetings and keeping minutes of them
- Calling Tenders and quotations for goods and services – local purchases
- Preparing Administrative reports annually
- Supervision of NIFS visitor's rooms
- Maintaining leave records of NIFS Staff
- Call for registration of suppliers annually
- Work related to construction and renovations
- Checking overtime, fuel orders and contractual payments
- Man the reception desk and preparation of reports when necessary
- Directing visitors to appropriate contacts
- Maintenance of the Building (Electrical, Water, Sanitary etc.)
- Insurance coverage of NIFS staff
- Maintain NIFS vehicles



**From Left:** Mr. DMDB Dissanayake, Mr. KM Ariyawansa, Mr. KBTB Gunasekara, Mr. ABGW Jayaweera, Mr. DG Dharmasena, Mr. AGJS Aluthgedara, Mr. DJMWP Jayasekara, Mr. DGK Dorakumbura, Ms. C Ranasinghe, Ms. TP Hettiarachchi, Mr. KASD Kuruppuarachchi, Ms. RPM Weerasooriya, Ms. CLS Illangakoon, Mr. DG Gunathilake, Mr. MA Lal, Mr. AVAP Kumara, Mr. GST Gunathilake, Mr. RSK Gunawardhana, Mr. HADN Jayasinghe

# Science Education and Dissemination Unit

## OBJECTIVES

Foster the exchange of technical and scientific information for the scientific community & promote the public understanding of science.

### TEAM:



**From Left:** Mr. TV Wijethunga, Mr. GCKS Bandara, Ms. HMGNN Herath, Ms. KIK Samarakoon, Dr. CTK Tilakaratne, Mr. VM Ekanayake, Mr. SDPGP Piyathilaka, Mr. DPDM Senadeera

## FORUMS FOR THE SCIENTIFIC COMMUNITY

### Special Lectures :

“Fundamentals of sustainable consumption & production” (SCP) by Mr. Fuad Hossain (18/01/2017)

“Plants of Extreme’s soils; model systems for ecological evolutionary & applied research” by Prof. Nishanta Rajakaruna (28/03/2017)

“Is your Incubator safe to us ? by Avon Pharmo Chem (Pvt) (14/06/2017)

“බඩු මදුරුවා හඳුනාගනිමු” - මහාචාර්ය එස්. ඒ.වී. පි.පි කරුණාරත්න (10/07/2017)

“Hes-I” multiple functions based on different mode of activation” By Dr. Jackson James (19/07/2017)

“Material characterization with Keithley 4200” by Dr. Abhaya Joshi (28/08/2017)

“Functional energy materials and interfaces” by Prof. Upul Wijayantha (30/08/2017)

“ජාතික ආහාර නිශ්චාදන සංග්‍රාමය ගන්නේරුව උදාහරණ හෝග පර්යේෂණ ආයතනයේ සහකාර අධ්‍යක්ෂ (පර්යේෂණ), සන්ධාන කහදවල මහත්මියගේ සහ කෘෂිකරම දෙපාර්තමේන්තුවේ සහකාර කෘෂිකරම අධ්‍යක්ෂ දායානි කරුණානන්ද මහත්මිය”

“Good Laboratory Practices” (Ms. WDSP Perera, Mr. NP Athukorale, Mr. WJ Banda, Mr. AK Pathirana) (29/11/2017)

## **Journal Clubs**

“Engineered cardiac tissue grown recombinant spidroin fiber meshes” by Ms. Nilani Kanesharatnam (03/05/2017)

“Thermoelectricity :low cost solution to recover waste heat” by Mr. Kanishka Kobbekaduwa (09/05/2017)

“Down converting lanthanide doped TiO<sub>2</sub> photo – Electrodes for efficiency enhancement of dye sensitized solar cell” by Mr. Janith Weerasinghe (17/05/2017)

“Genetic Signatures of exceptional longevity in humans: lessons learned’ by Mr. S. Sayanthooran (31/05/2017)

“Budding willow branches shaped Na<sub>3</sub>V<sub>2</sub>(Po<sub>4</sub>)<sub>3</sub>/c nanofibers synthesized via an electrospinning techniques & used as cathode material for sodium ion batteries” Mr. Niroshan Karunaratna (14/06/2017)

“Differentiation of signals generated by eye blinks and mouth clenching in a portable brain computer interface system” by Mr. Vibodha Bandara ( 12/07/2017)

“Urban Aerosols harbor diverse and dynamic bacterial populations” by Ms. R.W.K. Amarasekara (26/07/2017)

“Adsorption of basic dye (methylene blue) on to activated carbon prepared from rattan sawdust” by Mr. G.D.K. Heshan (09/08/2017)

“A forest bathing trip increases human natural killer activity and expression of anti- cancer protein in female subjects” by Mr. P.L.C.H.S.B. Lekamge (23/08/2017)

“Influence of the dopant concentration on the photocatalytic activity al- doped TiO<sub>2</sub> by Mr. K.N.L. De Silva.

“Boosting CZTS solar cells efficiency by a thin Ag intermediate layer between absorber and back contact” by Mr. A.M.K.L. Abeykoon (04/10/2017)

“Targeted & sustained brain delivery of curcumin micro emulsion with aid of DHA” by Ms. S. Sathya (29/11/2017)

## **WORKSHOPS**

The 4th National Lichen Workshop 2017, was held from 24<sup>th</sup> to 26<sup>th</sup> of May 2017 with the collaboration of Dilma Conservation in creating a deeper understanding about lichens among young scientists encouraging them towards new areas of study and exploration. The three day workshop was conducted by an eminent team of scientists with 40 participants.

A two-day training workshop for the Science teachers of the Hanguranketha Educational Zone on 14<sup>th</sup> and 15<sup>th</sup> June 2017 at the NIFS premises on Research Methodology. This was organized on the request of the Zonal Director of Education - Hanguranketha. 35 teachers participated in this training workshop. Training workshop consisted of a series of Lectures, Lab visits and a Practical session

Half-day session titled “The importance of practicing science” for teaching instructors (30 participants). This programme was mainly focused on capacity building of Teaching Instructors and organized by Science branch of Ministry of Education held at National Institute of Plantation Management, Colombo on 2<sup>nd</sup> October, 2017.

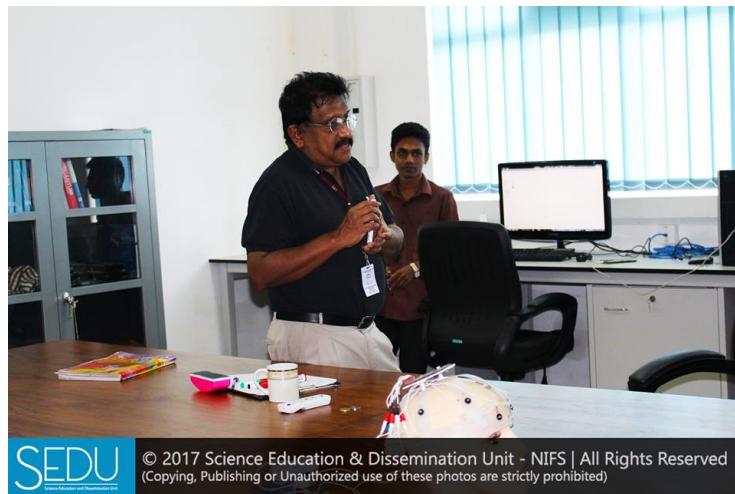
### World Science Day programme

In par with the ‘World Science Day Programme’ the Ministry of Science Technology and Research organized Science Week from 10<sup>th</sup> November – 17<sup>th</sup> November 2017. The Kandy district programme of the world science day was held at NIFS on 13<sup>th</sup> November 2017. In this programme, 280 school children and teachers participated from Kandy district.



### Workshop on Patenting Research Findings

A workshop on “Patenting Research Findings” was held at the NIFS on 20<sup>th</sup> December 2017. Director General of Sri Lanka inventor’s commission assisted in identifying patentable research findings, preparing applications and obtaining patents. In this event 20 senior scientists and 65 postgraduate students were participated in this event.



### **LABORATORY VISITS FOR POSTGRADUATE STUDENTS, AND UNDERGRADUATE STUDENTS**

25 undergraduates from Department of Soil Science, Faculty of Agriculture University of Ruhuna, visited to NIFS on March 14th 2017.

50 final year undergraduate students of Department of Physics, University of Sri Jayawardhanapura visited to NIFS on August 17th 2017.



### **EXHIBITION**

The National Institute of Fundamental Studies participated in the National Exhibition “*Thirasara Ugayaka Haritha Udaanaya*” which was organized by the Presidential Secretariat. This exhibition was held from 31<sup>st</sup> of March 2017 to 4<sup>th</sup> of April 2017 at BMICH, Colombo.

National Institute of Fundamental Studies participated in the National Exhibition on “Vidya” which was co-organized by the University of Kelaniya and Ministry of Science Technology and Research. This exhibition was held from 2<sup>nd</sup> to 7<sup>th</sup> October, 2017 at, University of Kelaniya.

Assistance given to 05 Schools to conduct school exhibitions.



## PROMOTION OF PUBLIC UNDERSTANDING OF SCIENCE

### Open Science Circle in Electronic Media (OSCEM)/ Vidu Nena Hawula project

Vidu Nena Hawula - South Asia's 1st Science Message Service and Open Science Circle, also known as OSCEM (Open Science Circle in Electronic Media) was launched in January 2012 with the aim of improving the science literacy and scientific temperament of Sri Lankans. OSCEM offers a combination of services to its members to enrich their inquiring minds and to inculcate enthusiasm for science among the school community and the general public. It provides a daily Science message service and maintains an open Science quiz based on weekly asked questions, via text messages (SMS), e-mail and social media networks such as Facebook, Twitter, Google plus and also a Science Blog in Sinhala. Furthermore it provides an open forum for the subscribers to discuss their problems related to science behind day-to-day activities with the scientific community. This free service is provided on all weekdays except government holidays in both Sinhala and English medium. 223,010 views and post impressions views achieved through the social media during this period. <http://vidunenahawula.com>

### School Science Programme (SSP)

The 44<sup>th</sup> SSP was held from 12<sup>th</sup> to 15<sup>th</sup> December 2017. School Science Programme (SSP) is one of the most important annually conducted programme for the dissemination of science among the younger generation. The primary goal of the SSP is to expose young students to a few selected frontier areas of science and to provide an opportunity for them to interact directly with scientists actively engaged in research. One hundred and sixty two students from all over the country participated in the programme.



### LAB VISITS FOR SCHOOL COMMUNITY

On February 14th 2017, 43 students from Dharmaraja College, Kandy visited NIFS. Hundred and five Science stream students of Rippon Girls' College visited NIFS. (26<sup>th</sup> May 2017)

### POPULARIZATION OF SCIENCE TROUGH ELECTRONIC & PRINT MEDIA

SEDU is engaged in popularization of science and disseminating research findings of NIFS through different ways of communication. It holds and daily update social media networks of NIFS and SEDU such as Facebook, Twitter and LinkedIn which easily enable science communication and dialogue and official websites. Moreover, we write news and feature articles to printed and electronic newspapers. In 2017, around 21 newspaper articles were published to disseminate science to general public. Besides that, three television programs were conducted.

## **Other Publication**

Piyathilaka P, 43<sup>rd</sup> School Science Program of National Institute of Fundamental Studies. 25<sup>th</sup> January 2017. **Vidya-Dinamina.**

Senevirathna G, Piyathilaka P, Desheeya Pohora Kunu Mulle- Rata Pohora Wejabille. 22<sup>nd</sup> February 2017. **Vidya-Dinamina.**

Nanayakkara A, Piyathilaka P, Brain Computer Interfaces are Coming. March 2017. **The Sri Lankan Scientist.**

Piyathilaka P, Why Fundamental Research?. March 2017. **The Sri Lankan Scientist.**

Piyathilaka P, Jathika Mulika Adyana Ayathanaye Warhika Paryeshana Samuluwa 2017. 29<sup>th</sup> March 2017. **Vidya-Dinamina.**

Nanayakkara A, Piyathilaka P, Sithiwili Walin Upakarana Palanaya Dan Yathaarthayak. 2<sup>nd</sup> April 2017. **Irida Silumina.**

Bandara J.M.S, Piyathilaka P, New hope to control Chronic Kidney Disease. 25<sup>th</sup> April 2017. **Daily News**

Piyathilaka P, NIFS assesses its own work. 25<sup>th</sup> April 2017. **The Island.**

Piyathilaka P, Tharuna Buddiya Udesa wu Sansadaya (Young Scientists Forum). 3<sup>rd</sup> May 2017. **Vidusara**

Bandara J.M.S, Piyathilaka P, Rajarata Wakugadu Rogayata Mula Bhuugatha Jalaye ethi rasayanika. 14<sup>th</sup> May 2017. **Irida Lankadeepa**

Piyathilaka P, Tharuna Buddiya Udesa wu Sansadaya (Young Scientists Forum). 10<sup>th</sup> May 2017. **Vidya-Dinamina**

Piyathilaka P, Sri Lankawe Lichen pilibada Jathika wedamuluwa. 28<sup>th</sup> June 2017. **Vidya-Dinamina.**

Parakrama S.H.P.P, Piyathilaka P, Maduruwanta Wisha Sahitha Becteria Nipadaweeema. 24<sup>th</sup> July 2017. **Dinamina**

Parakrama S.H.P.P, Piyathilaka P, Defend against dengue- How Does dengue spread?. 26<sup>th</sup> July 2017. **Vidya-Dinamina.**

Piyathilaka P, National Institute of Fundamental Studies, The leading Institute for Basic Scientific Research in Sri Lanka. 26<sup>th</sup> July 2017. **Vidya-Dinamina.**

Madumali K.A.A.D, Piyathilaka P, Newm Wathaya samaga Suwabara Nindak. 20<sup>th</sup> September 2017. **Vidusara.**

Kulasooriya S.A, Piyathilaka P, Ranila Boga Sadaha Uriya Wenuwata Raizobium Amukulaka (Rizobium project produce inoculates or Food and Fodder legumes in Sri Lanka). 24<sup>th</sup> September 2017. **Irida Lankadeepa.**

Kulasooriya S.A, Piyathilaka P, Ranila Boga Sadaha Uriya Wenuwata Raizobium Jaiwa Pohora (Rizobium biofertilize instead of Urea). 24<sup>th</sup> September 2017. **Irida Lankadeepa.**

Parakrama S.H.P.P, Piyathilaka P, Malpeni Bona Maduruwa Dengue walata hoda Wisadumak. 30<sup>th</sup> October 2017. **Rawaya.**

Liyanage R, Piyathilaka P, Kukulu Peekudu wala Arsenic Bera loha (Arsenic heavy metal found in Chicken liver). 25<sup>th</sup> December 2017. **Lankadeepa**

Senadheera D.P.D.M, Karunaratne A.W, Piyathilaka P, Widywae Nawa Man Osse Oba Dinawana Wrutheeyya Sudusukam. 10<sup>th</sup> November 2017. **Vidya-Dinamina.**

## **Publication**

**C. T. K. Tilakaratne**, T. M. S. S. K. Y. Ekanayake, Achievement level of Science Process Skills of Junior Secondary Students: Based on a Sample of Grade Six and Seven Students from Sri Lanka. *International Journal of Environmental and Science Education*, 12(9) 2089-2108 (2017).

## **Abstract**

Mohamed F.S.N., **Tilakaratne C.T.K.**, and Chandrasena W.D. "Difficulties in teaching and learning physics in grade six science: a case study in matale educational zone", Proceedings of the Postgraduate Institute of Science Research Congress, 163pg, 2017

# Collaborative and Consultation Division

The Collaborative and Consultation Division (CCD) of the National Institute of Fundamental Studies (NIFS) was established in 2009 following the suggestions of His Excellency the President of Sri Lanka as the Chairman of the Board of the Management. It was established to function as a mechanism for collaborative research with outside organizations and to transfer scientific knowledge and technologies developed at the NIFS to the society at large scale. The CCD is chaired by the Director of the NIFS and coordinated by Prof. S. A. Kulasekera (visiting Research Professor) with Prof. Gamini Seneviratne and Dr. Renuka Ratnayake as co-coordinators.

The objectives of the CCD are: to promote, regularize and monitor collaboration of NIFS projects with outside organizations including the private sector and encourage NIFS scientists to engage in productive consultations. Any interested parties for collaboration and Consultation, such as Universities, research Institutes, NGOs & CBOs registered in Sri Lanka, corporate & private sector organizations, should contact the Director of NIFS for further details.

Two activities initiated by the CCD in 2010 are progressing very well and have become the model projects that have delivered extremely useful products on a large scale to strengthen low cost, environmentally benign, sustainable agriculture in Sri Lanka. These are the biofilm-biofertilizer project implemented in collaboration with Lanka Biofertilizers Limited under Nature's Beauty Creations PLC and the Rhizobium project popularized in collaboration with Plenty Foods (Pvt), Oasis Marketing (Pvt) Limited and the Department of Agriculture.. Two other recent projects that are gaining a high reputation is the development of Sri Lankan graphite for re-chargeable batteries by the Nanotechnology and Advanced Materials project headed by Dr. Athula Wijayasinghe. These are conducted in collaboration with the Uwa Wellassa University and the Sri Lanka Institute of Nanotechnology.



Biofilm treated (left) control (right) rice



Testing rhizobium inoculants for *mung* bean



Rhizobium inoculated soybean



Laying out rhizobium trials at Ambewela



Tea fertilized with biofilm biofertilizer



Battery assembling

# **NIFS- Sam Popham Arboretum, a unique woodland in Dambulla**

This unique site of dry zone forest was once owned by an Englishman, Mr. Francis Home Popham (Sam) Popham, who gifted it to National Institute of Fundamental Studies (then IFS) in 1989 to carry out research and educational activities. Original site of this arboretum bought by Popham in 1963 was a seven and half acre-scrub jungle. Mr. Popham allowed the indigenous tree saplings in the site to emerge and establish by removing the 'weedy' shrubs around them. Consequently, the scrub jungle was turned into a dry zone woodland with a closed canopy. Local villagers used to call the arboretum 'Suddagewatta' (White man's property)

During the early years Popham used to live in a mud hut within this site and later he constructed a beautiful stone (granite) cottage designed by the well-known architect, Deshamanya Geoffrey Bawa. Being a keen naturalist and a serious environmentalist Mr. Popham meticulously kept records on climate data of the arboretum including number of rainy days, monthly and annual rainfall, atmospheric temperature, wind patterns -velocity and direction of wind, fluctuations of ground water table etc.

After taking over the land in 1989, IFS bought another 27 acres of adjoining scrub land to expand the arboretum. Popham's method of "Assisted Natural Regeneration (ANR)" was practiced to convert that land also into a dense woodland.

Currently, NIFS-SPA is visited by many local and overseas researchers for educational purposes and ecological research. On account of its significance as a bench mark site for Assisted Natural Regeneration, many forest ecologists and botanists use NIFS-SPA as a research site. It is also a popular tourist destination owing to the presence of unique fauna with a rich bird life and some unique animals such as Slender Loris and Pangolin. NIFS-SPA also has a dry evergreen rich vegetation consisting of over 200 species of trees.

Since 2005 the management of NIFS-SPA is carried out by Ruk Rakaganno (the Tree Society) for NIFS.



# **Internal Audit Division**



Mr. Indika Wijesinghe

The Internal Audit Division functions under the direct supervision and guidance of the Director.

The Division is responsible for independent and objective reviews and assessment of the Institute's activities, operations, financial system and internal controls adhering to Laws, Circulars, Financial Regulations and provisions of the Establishment Code and to make observations and recommendations to the Senior Management.

When dealing with internal audit functions of the Institution, special attention is given for the following as per the Financial Regulation 133,

- Ascertaining whether the system of internal controls of the Institution is designed properly and operating effectively in order to prevent, detect and correct misstatements due to error, omission and fraud.
- Ascertaining the reliability of the accounting and other records and ensuring that the accounting methods applied by the Institution provide the information necessary for the preparation of true and fair financial statements.
- Appraising the quality of performance of staff in carrying out the responsibility assigned to them.
- Ensure that the assets belong to the Institution are safeguarded from losses of all kind.
- Ensure the adherence of the provisions of the Establishments Code, Financial Regulations of Government and other supplementary instructions issued from time to time by the Ministry in charge of the subject of Public Administration and by the Treasury.
- Carrying out special investigations when necessary.
- Following the guidelines and directions given from time to time by the Department of Management Audit, Conducting the Audit and Management Committee meetings quarterly and taking follow up action to monitor the progress in the implementation of decisions taken at those meetings.

Four Audit and Management Committee meetings were held during the year 2017 on 1<sup>st</sup> April, 3<sup>rd</sup> June, 2<sup>nd</sup> September and 2<sup>nd</sup> December respectively.

# Accounts Division

This division consists of the Accountant (supervisor-in-charge), an Accounts Officer, four Senior Staff Assistant (Clerks, Book-Keeper, Stores Keeper), three Management Assistants and an Office Machine Operator. The division provides support for finance and accounting services at the institute in the following areas:

- **Funding Sources:** Recording of cash received from the General Treasury and other external local and foreign sources.
- **Payroll:** Preparation of salaries based on personal information, taxes and other deductions and allowances.
- **Personal Provident Fund:** Maintenance of the contribution of Employees Provident Fund by keeping cards and records separately for individual employees, investing & monitoring fixed deposits and withholding tax.
- **Staff Loan:** Management of the EPF and concessionary loan schemes, and maintenance of relevant records.
- **Cash payments:** Payment of a wide variety of purchases, taxes; upkeep all supporting documents and files to assure the amount to be paid is correct and in compliance with relevant government rules and regulations.
- **Budgeting:** Estimating the sources and expenditure for the period; this also serves a number of important purposes such as monitoring and controlling the finances of the institute.
- **Procurement & Inventory:** Keeping track of all purchases such as stationery, hardware & general items, and local inventory items.
- **Final Accounts Statement:** Preparation of comprehensive final accounts and statements in compliance with Sri Lanka public accounting Standard and accepted accounting principles.
- **Maintenance of Financial Records:** Ensure proper maintenance and updating of accounting records and preparation of financial reports upon request.



**From Left:** Ms. MK Nissanka, Mr. BJ Weerasooriya, Mr. MAP Perera, Ms. MP Palliya Guruge, Ms. RMVP Rathnayake, Ms. PSS Samarakkody, Ms. TP Gamlath, Ms. LNMDSK Nishshanka, Mr. MP Ariyaratne, Mr. MKD Keshan

# Procurement & Laboratory Stores

## Our Objectives

The Procurement and Laboratory Stores is committed to providing the necessary resources to achieve the goals of the National Institute of Fundamental Studies.

## Our Team:

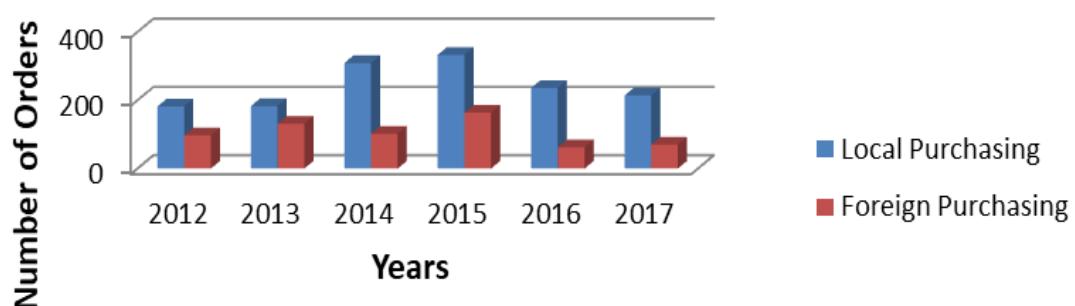


**From Left :** Ms. PRI Maduwanthi (Trainee), Ms. DMKL Kumari (Chief Technical Officer), Ms. GWRP Chandrakanthi (Senior Staff Assistant/ Stenographer), Eng. Ms. WDSP Perera (Laboratory Manager), Ms. HMTL Sumanarathne (Management Assistant), Ms. EDSM Alwis (Trainee)

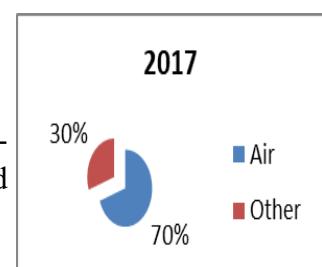
## Our Services

Foreign and local purchasing for all items including laboratory equipment, chemical, glassware and consumables.

### Local and Foreign Purchasing for the Past Few Years



- Handling chemical and glassware Stores and implementing and monitoring the Bin Card System.
- Handling customs procedures for all import and export items
- Maintains a record of assets owned by institute. The system includes a complete description of the asset; its acquisition date and cost, location, condition and other information.



# **Library**

The NIFS library was established in 1985 with a small collection of books and journals donated by Prof. Cyril Ponnampерuma, well-wishers and the Asia Foundation. Since then it now has a modest collection of over 6800 books and about 120 Journal titles covering the life, physical and mathematical sciences as well as the philosophy and history of science. It also has a collection of fundamental text books, monographs and edited volumes.

## **Objectives**

- Collecting, compiling, retrieving and disseminating information related to our research for the benefit of NIFS research staff and other interested parties, and also NIFS research publications for the benefit of outsiders.
- Developing a well-balanced and relevant information collection.
- Providing access to information in all formats nationally and internationally.
- Creating new technologies and continuously developing facilities for the advancement of learning and research.
- Developing opportunities for improving the library environment and optimizing existing physical facilities for both users and staff.
- Co-operating to promote the aims and objectives of the Institute.



## **Acquisition of Books, Periodicals and Reports**

During last year, 71 new books were added to the collection, consisting of 59 purchased books, and 12 books received on complimentary basis. A large number of periodicals, newsletters, and annual reports from local and foreign institutions were also received on a complimentary or on an exchange basis. The library subscribes to 14 journals related to our research.

## **The current library services**

- Reference and lending services.
- Document delivery.
- Resource sharing.
- Inter-library loan facility.
- Information alert services.
- New item arrivals alert service.
- Sourcing web based electronic journals and articles.
- Scientific literature updating service (SLUS).
- Providing updated, necessary information to the NIFS administration such as government circulars, E-code etc.
- Providing access to the internet using updated computers and facilitating library users with photocopying and scanning facilities.

## **Digitization of Institute Publications**

The National Science Foundation digitized our Institute's publications. The aim of the project was to establish an institutional e-repository and provide quick enhanced on-line access to Institute publications. Here, 1584 entries were electronically scanned and uploaded to the server (ifs.nsf.ac.lk/).

## **Memberships of External Committees**

The Senior Assistant Librarian of the NIFS was appointed as a member of the D.S. Senanayake Memorial Public Library Advisory committee.

## **Other Activities**

Delivered a series of lectures on “Improving reading habits in children and introduction of the Library System” for Schools at the Thalathuoya central, Kandy, October 04,2017.



**From Left:** Ms. Chandrika Thilakarathna, Ms. RM Witharana

# Computer Division

The Computer Division has as its mission to serve as the in house IT solution provider for the institute and fully geared to provide an important and supportive role for the progress and fulfilling the needs of the institute. Their main task has been providing the necessary software and hardware facilities for the research projects and ensuring smooth functioning and total system administration of the entire network system of the institute. They also regularly upgrade the network related software and acquire latest and necessary hardware facilities that give an enhanced and efficient service to all internet and IT system uses in the institute.

The whole staff has benefited by having this IT service facility right in the institute without going in search for help elsewhere that saves lot of time and money and hence provides an efficient service to the whole staff. A customised IT service depending on the needs of the individual is also one of the key services provided that would solve all their personal computer software and hardware problems and also by installing the necessary software upgrades.

One of the network related services that the end user is unaware of and goes unnoticed is, the maintaining and monitoring of the optimum usage of the network lease line facility that would enhance the quality and faster network access. The computer division also provides and maintains the virus guard facility to the entire network system and upgrades the necessary software required that is necessary for the smooth and safe functioning of the total computer network system.



Mr. MRB Weerakoon



Ms. SSK Sakalasooriya

# Instruments and Maintenance Division

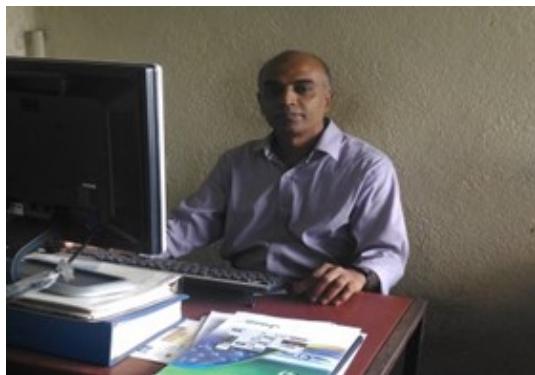
The Instrument Maintenance Division ( IMD ) was established at the time of the inception of the then Institute of Fundamental Studies, way back in 1986. The main aim of this division is to support all the research activities and projects functioning in the institute by ensuring proper functioning of all the research related equipment from the very basic research tools to very high end analytical instruments used in various research activities.

The maintenance division not only ensures the proper functioning of a wide array of analytical instruments but also ensures the smooth functioning of the entire telephone system in the institute, maintains the automated attendance system, the central UPS system, the backing up power generator and distribution system at the institute.

Moreover, the instrument maintenance division participates and serves in various committees appointed by the Director and also prepares and sets necessary specifications in purchasing of instruments required by the research staff.

The most highlighted or distinctive feature of this division is, that they extend and share their experience and help other institutes in their instrumentation problems and conduct instrument training programs and reinstallation of various analytical instruments. They also have designed, organized and conducted, with the support of their colleagues, a number of instrumentation training programs for the benefit of other institutes in the country.

The instrument maintenance division is planning to spread its wings in the coming years by having more staff and to build up and have a well-equipped instrument maintenance facility, and also to acquire more knowledge that would eventually enhance the quality of service to the institute as well as for the country as a whole.



Mr. MNB Kulathunga



Mr. HMAB Herath

# Technical Staff

**The mission of the Technical staff of the National Institute of Fundamental Studies is to support and cooperate in the research activities where analytical and technical expertise is required.**

The present technical staff of the Institute is highly experienced and capable staff mainly supports the ongoing research activities in their respective research projects by proper collection of field samples, preparation of samples and analysis of various kinds of samples using proper Analytical instruments.

The technical expertise and services are not only granted for the research activities but also the smooth functioning of the projects by maintaining supplies of required chemicals and glassware relevant to the research activities .



Mr. DS Jayaweera



Mr. S Opatha



Mr. AK Pathirana



Mr. NP Athukorala



Mr. VM Ekanayake



Mr. G Bandara



Mr. Jayasekara Bandara



Ms. D Aluthpatabedi



Ms. RKC Karunaratne



Ms. RSM Perera



Ms. I Rathnayake

## The Function of the Technical Staff

- Supports and cooperates in their respective research projects in achieving the goals set by the project leader.
- Programming, operation and maintenance of computers and network system of the institute.
- Maintenance and operation of the PABX and telephone network, automated attendance system for the whole staff.
- The maintenance and supervision of the electrical installation, switchgears, generator and the Central UPS system.
- Maintaining the chemical, glassware store and inventory in the institute
- Web designing, providing technical support to school science programs, conferences, seminars and workshops.
- Servicing and maintaining of the entire analytical instrument range in the institute
- Act as heads of respective divisions, hold duties and responsibilities, ensures smooth functioning of each division.

One of the key features of services provided to the institute is, unlike in other institutes, we do not have service agreements with local representatives for providing network services, instrument services or any other required services unless otherwise it is under warranty or there is a need for specific spare parts. This saves funds for the institute.

Another contribution of the technical staff is the contributions offered and valued times devoted and knowledge/experience shared by serving in various committees.

**University Technical Officers Enhancement Programme**  
**Ministry of National Policies and Economic Affairs, Sri Lanka**  
**National Human Resources Development Council (NHRDC), Sri Lanka**  
**at**  
**University Community Transformation Centre (UCTC)**  
**Universiti Putra Malaysia**  
**Serdang, Selangor, Malaysia**  
**22<sup>nd</sup> - 28<sup>th</sup> October 2017**



**From Left:** Mr. GPAK Pthirana, Mr. NP Athukorala, WG Jayasekara (Chief Technical Officers) and Miss WDSP Perera (Laboratory Manager),

The training obtained from this overseas competency development program facilitated to uplift our knowledge on many aspects of laboratory technical approaches. Further, it also accommodated to share the knowledge and experiences of local and foreign laboratory personnel. According to the local research requirements and the available resources for work, Standardized Operating procedures, Laboratory Safety Manuals, Chemical Inventory, Safety Data Sheets & Warnings should be prepared by the laboratory personnel who are most knowledgeable and involved with research in the institute. Documentation procedures and appropriate warning signs must be placed as required.

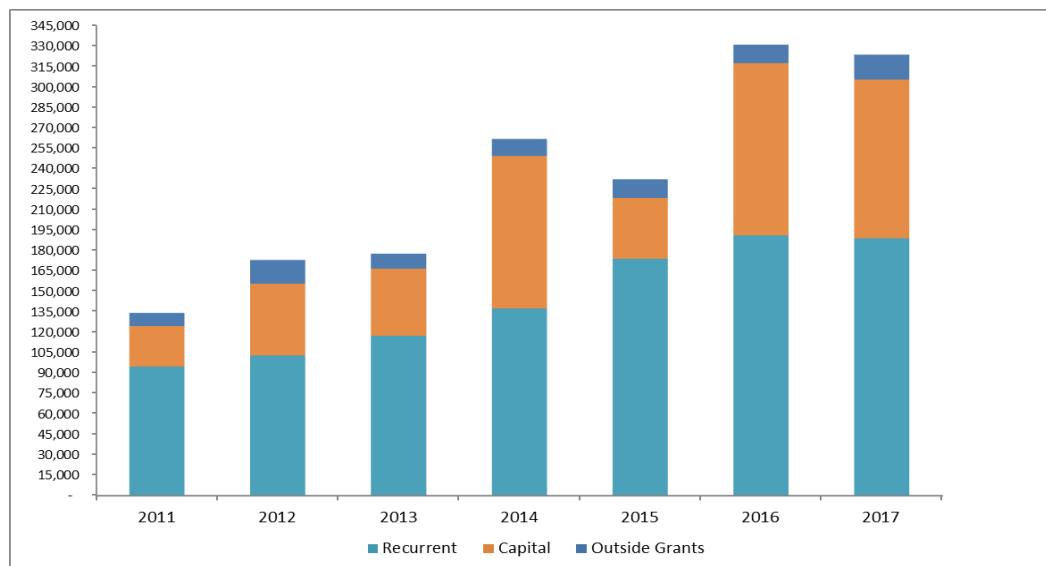
Considering the infrastructure of an institute, the laboratories should have basic facilities for sample preparation and analysis. The separated rooms should be catered for computational work, wet research, microscopes and health hazardous chemicals with a fume hood. The lab should be fixed with an air curtain for dust free positive pressure environment in the institute.

The program helped to widen our knowledge on Health and Safety practices. Taking into account the disposal management of chemicals, much more attention should be paid in accordance with the local situation. Since proper chemical management is vital to protect the health and safety of an institute and surrounding, communities and the environment, proper waste management and disposal procedures should be introduced under the local government regulations.

# BUDGET

## Total Annual Expenditure (Rs. '000)

Item	2011	2012	2013	2014	2015	2016	2017
<b>Recurrent</b>							
Personal Emoluments	64,723	71,734	84,561	88,317	113,461	122,653	122,432
Travel Expenses	531	581	532	1,295	1,163	1,257	1,325
Supplies	7,484	8,952	10,018	16,491	16,205	15,431	14,012
Maintenance Expenses	5,454	3,796	2,891	8,496	7,105	8,525	10,243
Contractual Services	12,488	13,540	14,258	16,396	17,204	19,366	22,067
Others	4,042	4,306	5,185	6,497	18,845	23,818	18,847
<b>Recurrent Expenditure</b>	<b>94,722</b>	<b>102,909</b>	<b>117,445</b>	<b>137,492</b>	<b>173,984</b>	<b>191,050</b>	<b>188,926</b>
<b>Capital</b>							
<b>Capital Expenditure</b>	29,731	52,644	49,210	111,897	44,593	126,473	116,548
	<b>29,731</b>	<b>52,644</b>	<b>49,210</b>	<b>111,897</b>	<b>44,593</b>	<b>126,473</b>	<b>116,548</b>
<b>Outside Grants</b>	9,752	17,425	11,068	12,512	13,626	13,626	10,445
	<b>9,752</b>	<b>17,425</b>	<b>11,068</b>	<b>12,512</b>	<b>13,626</b>	<b>13,626</b>	<b>18,333</b>
<b>Total</b>	<b>134,205</b>	<b>172,978</b>	<b>177,723</b>	<b>261,901</b>	<b>232,202</b>	<b>331,149</b>	<b>323,807</b>



Total Annual Expenditure for the past seven years

## අනුස්මරණය



ජාතික මූලික අධ්‍යක්ෂ ආයතනයේ විදුලී කාර්මික මහතා ලෙස සේවය කළ ජී.චී.ඩර්මසේන මහතා 2017/08/01වන දින අභ්‍යවප්‍රාප්ත විය. මිය යන විට 58 වියේ පසුව ජී.මහතා විසර 20 කට අධික කාලයක් ආයතනයේ සේවය කළ ආයතනයේ පැරණිතම සේවකයෙක් විය. වර්ෂ 2002 දී ආයතනයේ ස්ථීර සේවයට එක්ව දර්මසේන මහතාගේ දක්ෂතාවයන් සහ ආයතනයේ දියුණුව උදෙසා සිදුකළ කැපවීම උදෙසා ජී.මහතා පසුව විදුලී කාර්මික විශේෂ ග්‍රේණියට උසස්වීම ලබන ලදී.

# **NIFS Staff 2017**

**Director :** Prof. S.H.P.P. Karunaratne  
**Secretary :** Dr. P.S.B. Wanduragala

## **Research Staff**

### **Senior Research Professors**

Prof. A. Nanayakkara  
Prof. J.M.S. Bandara  
Prof. U.L.B. Jayasinghe  
Prof. P.R.G. Seneviratne

### **Research Professors**

Prof. M.A.K.L. Dissanayake  
Prof. D.S.A. Wijesundara  
Prof. G.R.A. Kumara

### **Associate Research Professor**

Prof. S.P. Benjamin  
Prof. M.C.M. Iqbal  
Prof. N.D. Subasinghe  
Prof. D.N. Magana-Arachchi

### **Senior Research Fellows**

Dr. R.R. Ratnayake  
Dr. M.S. Vithanage

### **Research Fellows**

Dr. R. Liyanage  
Dr. H.W.M.A.C. Wijayasinghe  
Dr. I.P.L. Jayaratne

### **Visiting Research Professors**

Prof. S.A. Kulsooriya  
Prof. N.S. Kumar  
Prof. Y. Fujimoto (Japan)  
Prof. N. Kuhnert (Germany)  
Prof. N.K.B. Adikaram

### **Visiting Associate Research Professor**

Prof. G.K.R. Senadeera

### **Visiting Senior Scientist**

Dr. W.P.J. Dittus

### **Research Assistants Gr. I**

Mr. C.A. Thotawatthage  
Mr. W.W.M.A.B. Medawatte  
Mr. M.M. Qader

## **Research Assistants Gr. II**

Mr. S.M.P.R. Kumarathilake  
Mr. K.M.S.D.B. Kulatunga  
Ms. C.L. Kehelpannala  
Ms. R.P.S.K. Rajapaksha  
Ms. U.G.S.L. Ranasinghe  
Ms. J.M.K.W. Kumari  
Mr. G.R.N. Rathnayaka  
Ms. D. Thanabalasingham  
Ms. W.T. Awanthi  
Mr. K.P.V.B. Kobbekaduwa  
Mr. A.M.J.S. Weerasinghe  
Mr. R.I.C.N. Karunaratne  
Mr. D.M.V.Y.S. Bandara  
Ms. P.C. Wijepala  
Ms. R. Visvanathan  
Mr. K.N.L. De Silva  
Ms. D.M.D.M. Dissanayake  
Ms. N. Kanesharatnam  
Mr. S. Sayanthooran  
Ms. H.K.S.N.S. Gunarathne  
Mr. G.D.K. Heshan  
Ms. K.M.U.J. Bandara  
Mr. D.R.L. Dodangodage  
Ms. J.A.D.M.N. Jayakody  
Ms. S.K. Jayasekara  
Ms. R.W.K. Amarasekara  
Ms. E.M.U.A. Ekanayake  
Ms. W.M.L.S. Weerasundara  
Mr. P.L.C.U.S.B. Lekamge  
Mr. A.M.K.L. Abeykoon  
Mr. B.A.Y.B. Jayawardena  
Ms. G.T.R. Abeynayake  
Mr. H.M.D.A.H. Bandara  
Mr. K.V.G.S. Perera  
Mr. D.M.R.E.A. Dissanayake  
Ms. F.A. Deen  
Ms. K.D.M.S.P.K. Kumarasinghe  
Mr. P.A.R.P. Kumara  
Ms. S.W. Meepegamage  
Ms. M.A.Y.N. Weerasinghe  
Ms. N. Pathmanathan  
Mr. N.B. Suriyaarachchi

## **Technical Staff**

### **Chief Technical Officers**

Mr. M.N.B. Kulathunga  
Mr. W.M.R.B. Weerakoon  
Ms. D.M.K. Lakshmi Kumari  
Mr. N.P. Athukorale  
Mr. W. Jayasekara Banda  
Mr. S. Opatha  
Mr. H.M.A.B. Herath  
Ms. S.S.K. Sakalasooriya  
Mr. D.S. Jayaweera  
Ms. R.K.C. Karunaratne  
Ms. R.S.M. Perera  
Ms. D. Aluthpatabendi  
Mr. A.K. Pathirana

## **Technical Officer Gr. III**

Ms. R.H.W.M.I.C. Ratnayake

**Director's Office**

Ms. M.D. Jeewa Kasthuri  
Ms. O.W.K. Seneviratne  
Ms. D.M.A.D.E. Liyanage  
Mr. M.P.D.K. Malwewa

Personal Secretary to the Director  
Stenographer Gr. I  
Management Assistant Gr. III  
Office Aid

**Internal Audit Division**

Ms. W.S.N.F. Jayasooriya  
Ms. C.O. Gunasena  
Mr. W.M.I.U.B. Wijesinghe

Internal Auditor - resigned on 03.08.2017  
Management Asst. Gr. III  
Internal Auditor - w.e.f. 20.11.2017

**Library**

Ms. T.C.P.K. Tilakaratne  
Ms. R.M. Witharana

Senior Assistant Librarian  
Library Assistant Gr. III

**Science Education & Dissemination Unit**

Dr. C.T.K. Tilakaratne  
Ms. K.I.K. Samarakoon  
Mr. V.M. Ekanayake  
Mr. G.C.K.S. Bandara  
Mr. S.D.P.G.P. Piyathilaka  
Ms. H.M.G.N.N. Herath  
Mr. D.P.D.M. Senadheera

Coordinator  
Stenographer Gr. II  
Technical Officer Gr. III  
Technical Officer Gr. III  
Communication & Media Officer  
Management Asst. Gr. III  
Audio Visual Assistant

**Accounts Division**

Ms. P.S.S. Samarakkody  
Ms. L.N.M.D.S.K. Nishshanka  
Ms. M.K. Nissanka  
Ms. M.P. Palliya Guruge  
Ms. R.M.V.P. Rathnayake  
Mr. G. Ariyaratne  
Ms. T.P. Gamalath  
Mr. M.K.D. Keshan  
Mr. B.J. Weerasooriya  
Mr. M.A.P. Perera

Accountant  
Accounts Officer  
Senior Staff Assistant-Book Keeper  
Senior Staff Assistant - Clerical  
Senior Staff Assistant - Clerical  
Senior Staff Assistant - Store Keeping  
Management Assistant Gr. III  
Management Assistant Gr. III  
Management Assistant Gr. III  
Office Machine Operator

**Procurement & Lab Stores Division**

Ms. W.D.S.P. Perera  
Ms. D.M.K.L. Kumari  
Ms. G.W.R.P. Chandrakanthi  
Ms. H.M.T.L. Sumanaratne

Laboratory Manager  
Chief Technical Officer  
Senior Staff Assistant- Stenographer  
Management Assistant Gr. III

**Administration Division**

Mr. K.A.S.D. Kuruppuarachchi  
Ms. R.P.M. Weerasooriya  
Ms. T.P. Wijewickrama  
Ms. C.L.S. Illangakoon  
Ms. C. Ranasinghe  
Mr. D.G. Gunathilake  
Mr. A.G.S.T. Gunathilake  
Mr. A.B.G.W. Jayaweera  
Mr. M.A.G. Somananda  
Mr. K.M. Ariyawansa  
Mr. R.S.K. Gunawardena  
Mr. K.G.T.B. Gunasekara  
Mr. H.A.D.N. Jayasinghe  
Mr. D.M.D.B. Dissanayake  
Mr. D.J.M.W.P. Jayasekara  
Mr. A.V.A.P. Kumara  
Mr. U.B.R.S. Udapitiya  
Mr. M.A. Lal  
Mr. R.B. Hapukotowa  
Ms. D.R.T.L. Harischandra  
Mr. G.D. Dharmasena  
Mr. D.G.K. Dorakumbura

Administrative Officer  
Senior Staff Assistant- Clerical  
Senior Staff Assistant- Stenographer  
Senior Staff Assistant- Stenographer  
Staff Assistant- Stenographer  
Record Keeper Gr. I  
Management Assistant Gr. III  
Driver- Special Grade  
Driver- Special Grade  
Driver- Special Grade  
Driver- Special Grade  
Driver Gr. I  
Driver Gr. III  
Driver Gr. III  
Mechanist- Special Grade - resigned on 12.06.2017  
Machinist - Special Grade  
Machinist Gr. III - w.e.f. 11.12.2017  
Laboratory Attendant- Special Grade  
Laboratory Attendant- Special Grade  
Lapidarist Gr. III  
Electrician Gr. I (†2017.08.01)  
Mason Gr. I

**Colombo Office**

Mr. A.D. Gunawardena

Karyala Karya Sahayaka- Driver



# **ANNUAL REVIEW 2017**

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