INSTITUTE OF FUNDAMENTAL STUDIES

ANNUAL REVIEW

2009

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IFS...

The Institute of Fundamental Studies (IFS) the premier Research Institute in the country devoted to basic research, was established in 1981 by an Act of the Parliament of Sri Lanka. It was initially established in Colombo and was shifted to Kandy in 1985. The objectives of the Institute is to conduct research of a fundamental nature with particular emphasis on mathematics, physics, chemistry, life sciences, social sciences and philosophy each taken in the broadest sense.

The IFS is administered by a Board of Governors comprising thirteen members with His Excellency the President as the Chairman. The Prime Minister and the Leader of the Opposition are among the members of the Board. The Research Council whose membership includes external academics and researchers of the IFS serves as an advisory body on all scientific matters.

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RESEARCH AREA: BASIC FOOD CHEMISTRY

(COMPARISON OF ANTIOXIDANT CAPACITIES OF CERTAIN FRUIT PEELS)

RESEARCH TEAM:

Dr. S.K.W. Ellepola - Research Fellow (Team Leader)

RESEARCH DESCRIPTION

The objective of the proposed research was to explore the potential of fruit waste materials as sources of powerful natural antioxidants. The peels of *Punica granatum* (Pomegranate), *Nephelium lappaceum* (ramubutan) and *Garcinia mangostana* (mangosteen) fruits were used. The ethanolic fruit peel extracts were subjected to the scavenging tests of DPPH radicals and ABTS radicals. Antioxidant potentials of different peel extracts will be compared after evaluating free radical scavenging tests. It was predicted that the peel of Rambutan may be considered potentially useful as a source of natural antioxidant for food or drug products because of its high antioxidant activity. Studies are underway. Current Research:

1. Isolation of rice proteins (Globulin, Glutelin, Albumin, gliadin) by Osborne's fractionation
2. Structural characterization of isolated rice proteins (glutelins) by FTIR spectroscopy

Collaboration work with Food Chemistry labs, University of Hong Kong.

RESEARCH AREA: CELL BIOLOGY

RESEARCH TEAM

Dr. D.N. Magana-Arachchi	- Research Fellow (Team Leader)
H.M. Liyanage	- Research Assistant
M.G.K.M. Meegahakumbura	- Research Assistant
R.P. Wanigatunge	- Research Assistant

RESEARCH DESCRIPTION:

Detailed characterization of naturally occurring microorganisms is an unresolved problem microbiologist facing throughout the world. The vast diversity of the microbial world discovered during the last decade was mainly due to the cultivation independent techniques. The full cycle RNA approach to microbial ecology has revealed that not yet cultured *Bacteria* and *Archaea* are abundant in almost all environmental and clinical samples (Amann et al., 1995; Juretschko et al., 1998). The progress made in the development of molecular techniques, amplification of the 16S ribosomal RNA molecules followed by cloning and sequencing have greatly expanded the known phylogenetic variety of microbial species on earth.

The aim of Plant Cell Biology project is to exploit molecular tools for characterizing and identifying microorganisms in their natural settings and to highlight interest of these techniques to identify the non-cultivable microbial organisms. **The secondary products obtainable from these microorganisms such as proteins, enzymes and compatible solutes are of great interest to Biotechnology.**

Tuberculosis (TB) has been a dreaded disease in Sri Lanka for centuries. **Multidrug-resistant (MDR) *M. tuberculosis* is an emerging problem of great importance to public health, with higher mortality rates than drug-sensitive TB.** The main objective of the study is to develop a simple, rapid and inexpensive assay based on PCR methodology for direct detection of MDR strains from patient's clinical samples

Scope of the project;

a. Isolation and identification of cyanobacteria to ascertain their biodiversity
b. Development of molecular assays for detection of water –borne toxicants
c. Study on *Mycobacterium tuberculosis* strains
d. Study of aspects of bio control and formulation of methodologies for the isolation of *cry* genes in *Bacillus thuringiensis*
e. Innovation of methods to isolate genomic DNA

Study on Cyanobacteria

The studies started in previous year were continued. Experiments were carried out with field /cultured samples (soil and water) collected from Gregorys' Lake, Nuwara Eliya, Ulhitiya, Henanigala, Rathkinda tanks and soil samples from Henanigala to isolate cyanobacterial species and to determine the phylogenetic relationship using the 16S rDNA sequences. Inorganic Carbon (IC), Total Carbon (TC), Total Organic Carbon (TOC) and Total Nitrogen (TN) were measured for Lake Gregory samples (87 samples). In water and soil samples collected from different areas of Sri Lanka revealed the presence of ~ twenty genera of cyanobacteria based on culture characteristics and microscopic observations on morphology. They were tentatively identified as *Aphanocapsa* sp., *Oscillatoria* sp., *Spirulina* sp, *Aphanotheca* sp., *Plectonema* sp, *Chlorogloeopsis* sp, *Calothrix* sp, *Synechococcus* sp., *Leptolyngbya* sp., *Synechocystis* sp. *Limnothrix* sp, *Pseudanabaena, Microcystis aeruginosa, Lyngbya* sp., *Microcystis* sp, *Chroococcidiopsis* sp, *Xenococcus* sp., *Gleocapsa* sp. *Merismopedia* sp. and *Cylindrospermopsis* sp. Several unidentified unicellular and filamentous Cyanobacteria were also present. To determine the phylogenetic relationship, 16S rDNA sequencing was completed from the tentatively identified 130 cultured cyanobacterial species. Around 130 nucleotide sequences obtained from Gene Sequencing were deposited in GenBank under accession numbers GQ979700 - GQ979702, GU368104- GU368116, GU300772- GU300773, GU594024-GU594040 and the remaining will be deposited in due course.

PCR conditions were optimized for identification of cyanobacteria using phycocyanin locus (PC-IGS).

Microcystis aeruginosa, Merismopedia sp. Ku 1, *Cyanothece* sp. TW 1 and *Chroococcidiopsis* sp. YRS 4a were identified with PC-IGS after sequencing. Extraction of toxin was carried out for environmental samples collected from Kalawewa & Nacchaduwa and bioassays using brine shrimp and FTIR analysis were performed for the extracted toxins. According to FTIR and brine shrimp bio assays there is a considerable risk with cyanotoxins, in both tanks. However, from site to site considerable differences were observed in level toxicity.

Data were collected from 55 kidney patients of unknown aetiology at Giradurukotte Kidney dialysis Clinic. PCR amplification was done for environmental water samples with M13 and M14 primer pair to identify the presence of Cylindrospermopsin toxin gave positive amplification indicating the presence of toxic *Cylindrospermopsis* species in dry zone waterbodies.

Development of molecular assays for detection of water –borne toxicants

In many eutrophic fresh water lakes, cyanobacteria frequently form toxic mass occurrences. A PCR procedure was developed to identify the microcystin producing genera with self - designed primers for Genus specific *mcyA*. Environmental water samples collected from Kurunegala, Padaviya, Konduwatuwana tanks gave positive amplification for PCR indicating the presence of species who have the ability to produce microcystins.

Study on *Mycobacterium tuberculosis* strains

Two research areas on tuberculosis were continued.

1. Restriction Fragment Length Polymorphism (RFLP) analysis and Spoligotyping on *Mycobacterium tuberculosis* strains isolated from patients attending the Central Chest Clinic Kandy – NSF Grant –RG/2006/HS/07

2. Rapid Detection of multidrug – resistant *Mycobacterium tuberculosis* strains using PCR assays. NRC Grant- /07/47

RFLP analysis and Spoligo typing were completed for the study population. Currently analysis of results on RFLP and spoligotyping is being carried out. DNA extractions and amplifications to determine the pattern of drug resistance for TB were continued. Gene sequencing was completed for 23 strains of *Mycobacterium tuberculosis* and nucleotide sequences obtained from Gene Sequencing for *inhA, katG* & *rpoB* genes were deposited in GenBank under accession numbers, GQ369430 to GQ369437; GQ 868653-GQ868655 and GQ871909 –GQ 871920. The mutations identified in the Rifampin resistant isolates were not previously reported both locally and internationally.

As the two Research assistants working on TB projects left IFS during this year, study on TB was haltered for some time.

Study of aspects of bio control and formulation of methodologies for the isolation of *cry* genes in *Bacillus thuringiensis*

Using a specific staining technique several isolates of *B.thuringiensis* were identified. PCR conditions were optimized for selected 5 genes (Cry 4A, Cry 4B, Cry 10A, and Cry 11A, Cyt A) with *Bacillus thuringiensis iaraelensis* standard strain.

Due to the unavailability of -80^{0}C freezer further studies on *B.thuringiensis* was haltered.

Innovation of methods to isolate genomic DNA – completed.
The isolation of DNA from the analyzing samples is a crucial step in the process of DNA-based molecular biological assays. A guanidium thiocyanate /silica based method was developed for isolating high quality DNA from variety of bacterial, archaeal and bamboo species.

Ms. Rasika P.Wanigatunge Completed Bench work & writing up the M.Phil Thesis on "Identification and Characterization of Cyanobacteria using 16S rRNA Genes and Detection of Toxin Producing Cyanobacterial Species using Molecular Markers"

Dr. V. Ambalavanar Completed Bench work & writing up the M.Phil Thesis on "Detection of Multidrug resistant Mycobacterium tuberculosis strains using PCR assays"

Research Grants

1. **Grant No**; RG/2006/HS/07 –National Science Foundation – Rs 1,616,387.00
Project titled "Restriction Fragment Length Polymorphism (RFLP) analysis and Spoligotyping on *Mycobacterium tuberculosis* strains isolated from patients attending the Central Chest Clinic Kandy".

2. **NRC/06/47**- National Research Council, Sri Lanka - Rs 4,233,000.00
Project titled "Rapid Detection of multidrug – resistant *Mycobacterium tuberculosis* strains using PCR assays"

COLLABORATIVE RESEARCH

Tuberculosis
(i) Prof.V.Thevanesam; Department of Microbiology, Faculty of Medicine, University of Peradeniya.
(ii) Dr.D.Medagedara; Consultant Chest Physician, Respiratory Unit, General Hospital, Kandy

Algal toxins & Kidney Disease
Dr. T.Abeysekara; Consultant Physician, Dialysis Unit, General Hospital, Kandy

Research on Cyanobacteria
Dr.N.V.Chandrasekaran; Department of Chemistry, Faculty of Science, University of Colombo.

RESEARCH AREA: CHEMICAL AND ENVIRONMENTAL SYSTEMS MODELING

RESEARCH TEAM:

Dr. M. Vithanage	- Research Fellow (Team Leader)
I.P.L. Jayarathna	- Research Assistant
I.G.C. K. Kumara	- Research Assistant
R.M.A.U. Rajapaksha	- Research Assistant

RESEARCH DESCRIPTION:

Our research group works on understanding and modeling the hydrogeology and chemical processes in groundwater systems in order to find solutions for human benefit. To accomplish this, we have established two sub components; chemical modeling and hydrogeological modeling. Weathering and other pedogenic processes release chemical elements, ions and compounds from parent rock to soil and/or leach to groundwater. Soils, water, and plant enrichment or deficit in trace metals often cause human health problems. However, these chemical interactions are inherently complex and no single method is capable of understanding the system. Studying these processes is very important to understand fate and transport of trace metal pollutants and also to remove excess pollutants from waters. Therefore the aim of chemical modeling sub group is to perform mechanistic, spectroscopic and molecular modeling of solid-water interfacial interactions to understand the interactions of chemical species with geological material.

Groundwater is an important source of water for many uses. Several problems in groundwater are created by both natural and human activities such as heavy metal and nutrient pollution by agriculture, industries and waste, saltwater intrusion due to heavy pumping, tsunami and storm surge events etc. Since groundwater lies beneath the surface it is impossible or difficult to observe the fate and transport of such pollutants. Therefore groundwater modeling plays an important role in predicting such situations.

Natural dissolution mechanisms of serpentinite; Possible toxic element leaching to the environment

Weathering of and pedogenic processes release chemical elements, ions and compounds from parent rock to soil and/or leach to groundwater. Such environments enriched in trace metals often cause human health problems. In order to understand

fate of transport of these trace metal pollutants it is important to comprehend their natural sources as well. Ultramafic rocks such as serpentinite in Sri Lanka is known for high concentrations of trace metals, Cr, Ni, Co and Fe in particular may cause groundwater pollution leading to ecological and health problems. Therefore, this research was aimed to understand the mechanisms of natural dissolution of heavy metal species such as Cr, Ni and Mn from serpentinite rock and soil, to assess change in the metal dissolution behavior based on environmental factors such as pH, oxides etc and surface complexation modeling. Results from the potentiometric titration to obtain the zero point charge (pHzpc)of the serpentinite soil (63-105 micrometer) showed that the pHzpc is at pH 8.7. This demonstrates that the serpentinite soil surface consists of variable surface charge sites which will be useful for dissolution mechanisms of heavy metals in the soil. Also the surface area calculated based on the Methylene Blue method denoted that the surface area for the particular soil fraction is about 60 square meters.

Competitive adsorption of arsenic on Natural Red Earth surface

The effect of reaction time and competing ions on arsenic retention on Natural Red Earth (NRE) under laboratory controlled and uncontrolled conditions was investigated. Batch experiments for kinetic and isotherms were performed for solid solutions with concentrations of PO_4^{3-}, NO_3^- and SO_4^{2-} (530.95, 80.63, 260.28 mM respectively) as competing ions. FTIR studies were carried out to identify the possible surface site interactions with competing ions. Kinetic data were best described by a pseudo-second order model. As(III) adsorbed well on to NRE than As(V) in all experiments; however, the time taken to the equilibrium was the same (90 min) for both As species. Competitive adsorption isotherm experiments showed a higher effect of PO_4^{3-} on the reduction of adsorption of both arsenic species than that with SO_4^{2-} and NO_3^-. FTIR spectra indicated an inner sphere bonding of Fe-O sites with SO_4^{2-} and $PO4^{3-}$ groups while an outer-sphere weak complexation was observed with NO_3^-. These findings indicates that the laboratory uncontrolled condition has a very small effect on arsenic adsorption on NRE with competing ions and as a consequence, we conclude that the NRE could be potentially effective in removing arsenic in potable water.

Mechanistic modeling of arsenate from drinking water by gibbsite nano particles

Gibbsite nano particles were used to understand its ability to adsorb arsenate in aqueous systems. Arsenate adsorption was pH dependant and sorption favored at acidic media. Affinity of gibbsite for arsenate at pH 5 was nearly 4 fold greater than that of pH 9. Arsenate on gibbsite nano crystal surface at pH 5 was observed as monolayer coverage. Model calculations imply significant lowering of active surface sites for arsenate adsorption as pH increases. A 98% of arsenate removal observed at pH range

of 4 to 8.5. Arsenate adsorption exhibited negligible changes with ionic strength variation indicating inner-sphere surface complexation mechanism.

Synthesis and characterization of iron oxide co-shell nano particles

Increasing efforts have been developed to the potential applications of magnetic nanoparticles in various fields, such as information storage, colour imaging, bio-processing, catalysts, magnetic resonance imaging and medicinal applications. Ferromagnetic iron oxide was synthesized by using modified co-precipitation method. Resulting particles were characterized using X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), Diffused Reflectance Fourier Transform-Infrared Spectroscopy (DRIFT-IR) and Thermal Gravimetric Analysis (TGA). TEM image of the synthesized γ-Fe_2O_3 nanoparticles reveals that the particles are in 5 – 20 nm range, and well fitted with spaniel cubic structure, but when particles are dry it prefer to agglomerate with neighboring particles to reduce their surface charges. Magnetic γ-Fe_2O_3 nanoparticles were synthesized by the co-precipitation method and this work confirmed that magnetic γ-Fe_2O_3 nanoparticles are in nano-scale and well matches with spaniel cubic structure.

Hydrogeochemical classification of groundwater in Hambantota District, Sri Lanka

Hydrogeochemical characteristics of groundwater in Hambantota district in Sri Lanka have been investigated and mapped to identify the groundwater types in the region. Groundwater samples were collected from forty three (43) tube wells at various locations in the study area. Systematic random sampling was applied for the selection of sampling locations. The physico-chemical parameters such as pH, EC, TDS, temperature, major cations and major anions were analyzed in order to understand the basic hydrogeochemistry of the water. The groundwater at many locations in the study area exceeds the WHO drinking water standards and therefore is not suitable for drinking purposes. The chemical composition of the groundwater is characterized by high EC, TDS, chloride, fluoride and this could be due to various reasons such as saltwater intrusion, weathering of rocks with high Ca, Mg etc. Widely distributed aquifer type in the study area is the Na/K – Cl type.

RESEARCH AREA: COMPUTATIONAL MATHEMTAICS AND PHYSICS

BRAIN COMPUTER INTERFACE

RESEARCH TEAM:

Prof. A. Nanayakkara	- Research Professor (Team Leader)
Z. Safaff	- Research Assistant

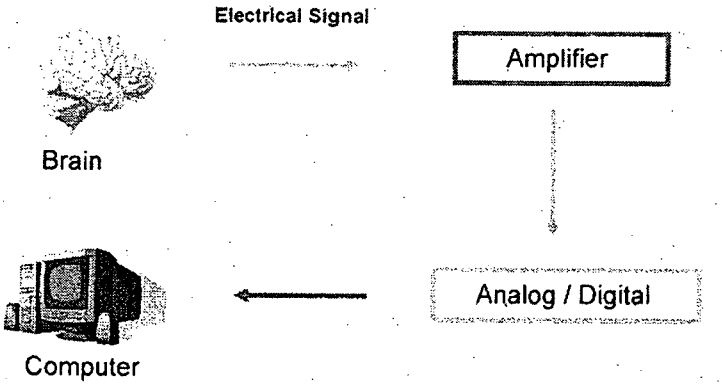
GROUP PHOTOGRAPH:

RESEARCH DESCRIPTION:

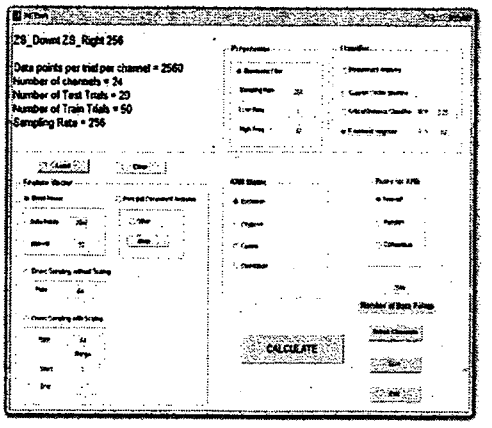
This project is aiming at building a Brain Computer Interface (BCI) system, which provides communication link between the human brain and a computer, especially for patients who suffer from severe motor impairments (late stage of Amyothrophic Lateral Sclerosis (ALS), severe cerebral palsy, head trauma and spinal injuries). This way, the patients who are with severe physical disabilities can control equipments such as Wheel chairs, TVs, etc. and communicate with computer voice in his or her native language (in Sinhala, Tamil or English)

For many years, several research laboratories around the world and various research groups in Europe and USA have been working on systems, which allow for a direct dialog between man and machine. One of the outcomes of these efforts is "Brain Computer Interface" (BCI). A brain-computer interface (BCI) or direct neural interface is literally a direct technological interface between a brain and a computer not requiring any motor output from the user. That is, neural impulses in the brain are intercepted and used to control an electronic device such as computer. The Electroencephalogram (EEG)-based Brain Computer Interface is one of the methods used in BCI, which measures the brain activity in order to control a device just by thoughts. EEG - based Brain-Computer Interface (BCI) system is a an alternative communication software channel, which allows people to use scalp-recorded EEG activity to control a device such as a computer cursor to give paralyzed patients greater ability to interact with their environment.

BCI systems consist of two components; hardware and software. With the hardware, EEG signal is amplified and then digitized. Then the digitized EEG signal is analyzed by a digital computer. According to the outcome of the analysis, the computer will take actions using pre-programmed instructions. In this project, we have been involved in developing a BCI by monitoring thoughts of individuals through Electroencephalographic (EEG) signals, and then translate them into a digital data stream, which can be understood by a computer.



During 2009, we developed the main BCI software called IMTE (*Identification of Mental Tasks through EEG*) which carried out signal processing and classification of EEG data. IMTE has a Graphical User Interface (GUI) with user friendly features and supports various signal processing techniques (See Figure)



This software is developed for testing various combinations of preprocessing, feature vector construction, and classification methods for optimizing the performance of identifying mental tasks. We have implemented the following signal processing and Classification methods in the IMTE software.

Signal Processing Methods: Band Pass filtering, Bandpower, Downsampling, and Principal Component Analysis (PCA)

Classification Methods: Linear Discriminant Analysis, Non-linear Discriminant analysis, Mahalanobis analysis, Support Vector Machine (Linear kernel, Quadratic kernel, Polynomial kernel, Rbf kernel , and Multilayer Perceptron), K - Nearest Neighbor (KNN) classification method and Critical distance classification method (This is a new classification method developed by us for investigating possible improvements in classification of new mental tasks that have been found.)

During the year 2009, we achieved two main goals. First we have found a group of new mental tasks which can be recognized by our IMTE software with very high accuracy compared to the existing mental tasks that are already being used by other BCI researchers in the world. The performances of these new mental tasks and one of the most popular mental tasks (involved in imaginary motor movements) were tested with three healthy individuals and all of them showed very good performances for newly found mental tasks.

Secondly we have completed the development of IMETE software and found a new classification method (we named it as **Critical distance classification method**). The tests which were carried out on this method showed promising results. Further, we carried out several studies so as to investigate several computational techniques for analyzing and classifying EEG signals according to the signatures of mental tasks hidden in them. This includes finding suitable preprocessing methods, effective and efficient feature vector construction techniques and most accurate classification methods for recognizing mental tasks.

The research assistant in the BCI RESEARCH AREA submitted the thesis to Postgraduate Institute of Science at University of Peradeniya for her MPhil degree. The title of the thesis is

Title: *Brain Computer Interface (BCI) based on Electroencephalographic (EEG) patterns due to new cognitive tasks.*
Name: Zahmeeth Sakaff

Manuscripts based on above research work will be submitted for publication in refereed journals shortly.

RESEARCH AREA: COMPUTATIONAL MATHEMTAICS AND PHYSICS

MICROCONTROLLER BASED SPEECH SYSTEM FOR PERSONS WITH SPEECH DISABILITIES

RESEARCH TEAM:

Prof. A. Nanayakkara - Research Professor (Team Leader)
S.H.D.P. Wijethunga - Research Assistant

RESEARCH DESCRIPTION:

Individuals with speech disabilities (non-vocal) need an effective way of communication with the general public. In this project we are developing a portable electronic speech system based on micro controllers which can produce Sinhala speech, according to the input received from the disable person.

Input devise may vary according to the disability of the individual. A keypad or an electronic glove can be provided for individuals who can use their arms or hands. For individuals who cannot use their hands and arms, electrical signals produced by working mussels (EMG) in any part of their bodies can be used as the input devise.

The project consists of three parts:

(1) Development of hybrid of Sinhala Phonemes and Diphones database and software to generate speech.
(2) Development of the speech system using low cost micro controllers (MCs) with high quality Sinhala speech.
(3) Optimization of speech system for high quality Sinhala speech.

Computer generated Sinhala Speech

In the first stage a hybrid of Sinhala Phonemes and Diphones database will be developed. Features of Sinhala speech will be investigated in detail to develop general speech rules to be used in the speech system. In the second stage feasibility of using low cost MCs for quality Sinhala speech system will be investigated. In this stage both most popular low cost MCs which are available in Sri Lanka and new MCs with low power consumption and high speed features will be studied. Data will be stored SD card and access though SPI and I^2C or other communication protocols. This hardware module is a common speech module which can receive instructions from hand glove, keyboard, and amplified signals from EMG or brain computer interface systems. The schematic diagram is shown below in Figure(1).

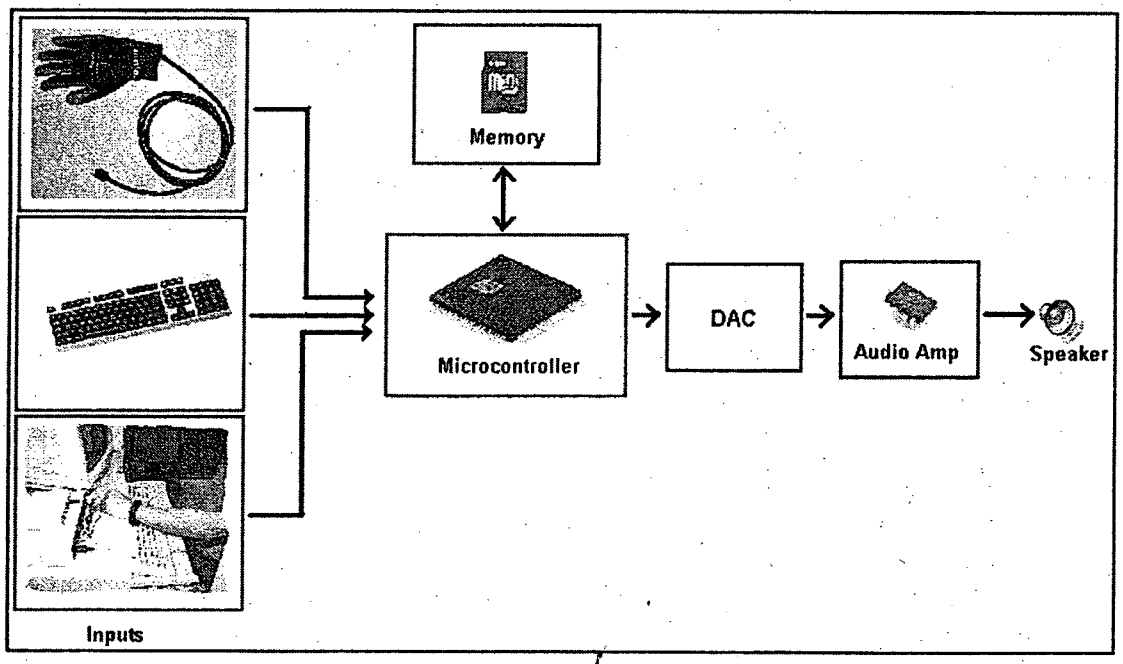


Figure (1)

Preliminary investigations on the subject indicated that in order to produce high quality Sinhala speech, storage space for the speech database must be over 10MB. Additionally, processing speed must be fast enough to access the speech database quickly and to impose language rules efficiently. The software was developed for recording and constructing speech databases. We have completed the construction of speech database with Phonemes. Diphones database will be developed to improve the quality where it is necessary. Software for generating Sinhala speech (Sinhala Text to Speech) was developed and currently it is used for testing the quality and the naturalness of the speech generation.

RESEARCH AREA: ECOLOGY AND ENVIRONMENTAL BIOLOGY

RESEARCH TEAM:

Dr. S. P. Benjamin	- Senior Research Fellow (Team Leader)
S. G. Batuwita Arachchige	- Research Assistant
M.B.U. Perera	- Research Assistant
P.M.H. Sandamali	- Research Assistant
Z. Jaleel	- Research Assistant-volunteer
R. Tennekoon	- Research Assistant- volunteer
N. Atukorala	- Senior Staff Technical Officer

RESEARCH DESCRIPTION:

Biodiversity of soil Arthropods and their role in productivity of agricultural land.

This study focuses on pseduoscorpions and spiders, animal groups of high conservation necessity. Pseduoscorpions and spiders are top predators that play a major role in controlling populations of other soil and surface dwelling organisms harmful to humans. Due to rampant soil degradation and related loss of habitat, the collection, study and assessment of the conservation status of soil arthropods in essential. Since the commencement of the project in June 2009, around 100 specimens of pseduoscorpions and 500 specimens of spiders have been collected and around 50% have been identified to generic level. All collected specimen have been cataloged. An illustrated checklist, a first publication on pseudoscorpions of Sri Lanka is being prepared. Four papers have been published for 2009 on spiders.

Floristic survey of economically important Orchids of the genera Bulbophyllum and Dendrobium.

Our floristic survey focuses on the orchid genera *Dendrobium* and *Bulbophyllum*. All 11 species of *Bulbophyllum* and two out of 8 species of *Dendrobium* are endemic. Thus, the study of their biology and conservation status is of high importance. We are using traditional alpha taxonomic as well as molecular methods for characterization of orchid biodiversity. Field work has commenced and several sites in and around Kandy have been sampled. Four species of orchids of interest have been collected and identified. Propagation methods for the collected orchids are being developed.

RESEARCH AREA: ELECTROCHEMICAL MATERIALS

RESEARCH TEAM:

Dr. H. W. M. A. C. Wijayasinghe	- Research Fellow (Team Leader)
P. B. Samarasinghe	- Research Assistant

RESEARCH DESCRIPTION:

The increasing demand for energy has made it extremely important to develop high efficient electrochemical energy conversion devices such as fuel cells and batteries. This project mainly emphasizes the synthesis and characterization of low-cost and performance enhanced materials for these electrochemical energy conversion applications. In going alone this direction, investigation of Sri Lankan minerals for these potential high tech applications and applying Nano-Technology to enhance performance of these materials are also being investigated. So far, this project engaged with the research and development work under five sub-projects involving three types of fuel cells; Molten Carbonate Fuel Cell (MCFC), Intermediate Temperature Solid Oxide Fuel Cell (ITSOFC) and Microbial Fuel Cell (MBFC), and two types of batteries; Silver-ion Batteries (AIB), Rechargeable Li-ion batteries (LIB).

RESEARCH AREA : GEOTHERMAL SOURCE MAPPING

RESEARCH TEAM:

Prof. C.B. Dissanayake - Research Professor (Team Leader)
Dr. N.D. Subasinghe - Senior Research Fellow

RESEARCH DESCRIPTION:

Geothermal power is one of the cleanest renewable energy sources. All the possible hydropower potential within Sri Lanka has been utilized and this is a small fraction of its growing energy demand. Sri Lanka now depends nearly 80% on the imported fossil fuel for power generation. Development of geothermal energy will benefit Sri Lanka in ways such as power, hot water for industrial use, drying a vast spectrum of agricultural products, air-conditioning, development of tourism around hot springs, etc.

No serious study on geothermal resources has been conducted in Sri Lanka. One of the major obstacles to such a survey is the lack of equipment and expertise. With collaborations of geophysicists from Canada, UK as well as from Sri Lanka, this new project was started in late 2009. A grant proposal was completed and submitted to the Natural Environment Research Council (NERC) UK through University of Edinburgh to borrow the necessary equipment and to cover the cost of shipping etc. This has been successful and a grant worth of approximately SL Rs. 3 million has been approved for this operation, by the NERC, UK. Geological Survey and Mines Bureau (GSMB) in Sri Lanka and scientists from NARA have already expressed their keenness in participating this program.

Though Sri Lanka has no active high enthalpy regimes (volcanic or tectonically active regimes) the availability of low enthalpy sources is evident in the form of thermal springs. Aided by new drilling technology there is new hope for hot dry rock (HDR) or enhanced geothermal systems (EGS) development in Sri Lanka. Information on geothermal temperatures has been a key parameter on the development of any type of geothermal energy.

Existing data on the geothermal resources in Sri Lanka were gathered. Reports from the National Science Foundation (NSF), geological maps and relevant data from the Geological Survey and Mines Bureau (GSMB) were collected.

Collection of existing data and literature on geothermal resources in Sri Lanka was made. Field work program and mapping sites were decided. Budget, field requirements and the participating personnel were decided. Recruitment of two research assistants is currently going on.

It was decided that magneto-telluric (MT) techniques are imperative in acquiring vital information on geothermal resources in Sri Lanka. Having no MT equipments in Sri Lanka, the cheapest and most effective way to achieve this goal was to have collaborations with other institutes in the developed world that has access to such facilities. Collaborations were started with Dr. Morrel Fonseka (Canada) and Prof. Bruce Hobbs (UK) to get the equipment as well as the expertise required for this project. Local institutes such as GSMB and NARA will also be supporting this work.

Number of research institutes/universities in Thailand were visited and the possibilities of collaborative work were discussed. Some water samples were collected from hot springs in Thailand and brought to Sri Lanka for analysis and comparison with those from the local hot springs.

COLLABORATIVE RESEARCH

Prof. Bruce Hobbs, University of Edinburgh, UK.
Dr. G.M. Fonseka, Canada
Mr. Nalin Silva, GSMB, Sri Lanka (Geophysicist)
Mr. Priyantha Jinadasa. NARA, Sri Lanka (Geophysicist/PhD student)

RESEARCH AREA: MICROBIAL BIOTECHNOLOGY

[BIOFILM-BASED BIOFERTILIZERS (BBs)]

RESEARCH TEAM:

Prof. G. Seneviratne	- Research Professor
Prof. S.A. Kulasooriya	- Visiting Professor
M.P.N.K. Henakaaarachchi	- Research Assistant
S.A.J. Sandamali	- Research Assistant
A. Subasinghe	- Research Assistant
R.C.K. Karunaratne	- Senior Staff Technical Officer
M. A. Lal	- Work Assistant

Microorganisms are generally perceived as harmful although less than 1% of their species are pathogenic. In our studies, we use beneficial microbes to develop microbial biofilms which are communities of microorganisms that live together in a common mucilaginous matrix and function as a single multi functional unit. Current project in progress on BBs is development and field testing of them for tea. This has progressed well and we are hopeful of introducing this technology to the tea industry in the near future once the Tea Research Institute (TRI) makes its recommendations after the collaborative research done with it are completed. The use of BBs has been found to be able to reduce chemical fertilizer use by about 50% in tea.

Research is also in progress to extend the use of BBs to other crops like rice, rubber, legumes, maize etc.

Reduced use of chemical fertilizers has several advantages such as reduction of fertilizer imports, minimizing environmental pollution, lowering greenhouse gas emissions and enhancing soil carbon sequestration.

For tea, nursery and field trials were conducted at Talawakelle, Hantana, Ratnapura, Passara. In the BBs research for rice, a field trial was done at the Rice Research and Development Institute (RRDI), Batalagoda. It was based on the 'Parachute' method for transplanting rice. Results showed that the BBs together with ca. 40% of recommended chemical fertilizers can produce a rice yield equivalent to that of the full recommended chemical fertilizers. To continue isolation of more effective microbes from rice roots, latest microbial culture media were adopted to isolate root associated N_2 fixing bacteria, other beneficial bacteria, fungi and cyanobacteria on the soil surface of paddy fields. For

rubber, microbial isolation from rubber plant roots was started. The isolated microbes are now being tested for beneficial properties like organic acid production, nitrogenase activity, biofilm formation etc. For bean, nodule rhizobia and other beneficial bacteria and fungi were isolated from the roots.

COLLABORATIVE RESEARCH

All above research were conducted in collaboration with the Tea Research Institute (TRI) and Rice Research and Development Institute (RRDI). Specific parts of the above research studies were conducted by final year Research students and M. Sc. Students for their partial fulfillment of degrees, from University of Peradeniya, Sabaragamuwa University and Uva Wellassa University.

RESEARCH AREA: MICROBIAL BIOTECHNOLOGY

(BIOFUEL PRODUCTION FROM ALGAE- Production of cellulosic biofuels from invasive weeds in Sri Lanka)

RESEARCH TEAM:

Dr. R. Ratnayake	- Research fellow (Team Leader)
Prof. S.A. Kulasooriya	- Visiting Professor
K.M.D. Gunathillake	- Research Assistant

RESEARCH DESCRIPTION:

The project was aimed at producing biofilms which can be used to obtain biofuels from given substrates directly, by integrating the three steps of delignification, saccharification and fermentation which is currently applied in modern industries. Invasive weeds are used as substrates because their utilization will convert them to a useful resource and minimize their threat to indigenous biodiversity of Sri Lanka.

Currently the following sub projects are been carried out

(1) Development of biofilms for the production of cellulosic Biofuels from invasive weeds in Sri Lanka
(2) Analysis of the changes of carbohydrates and isolation and identification of the microflora of certain water weeds through senescence.

The initial experiments were completed. Part of the isolation and identification of some lignocellulose degrading microorganisms in ecological niches where they are inhibiting. Different developmental stages of weeds (young, mature and senesced) were checked for their lignocellulose contents. Experiments were initiated to study the microbial degradation of these substances into simple compounds.

B.Sc. research area titled "Isolation and identification of the microflora of certain water weeds and the analysis of the changes of carbohydrates through senescence" was submitted to the Uva- Wellassa University of Sri Lanka by O.S. Perera.

(Project commenced on October 2009)

RESEARCH AREA: NATURAL PRODUCTS CHEMISTRY

Search for bioactive compounds from natural sources as potential resources for control of human and plant diseases

RESEARCH TEAM:

Prof. N.S. Kumar	- Research Professor
Prof. U.L.B Jayasinghe	- Research Professor (Team Leader)
A.G.A.W. Alakolanga	- Research Assistant
H.M.S.K.H. Bandara	- Research Assistant
W.C. de Silva	- Research Assistant
N.H.N. Priyanwada	- Research Assistant
A.M.D.A. Siriwardena	- Research Assistant
D.S. Jayaweera	- Senior Staff Technical Officer

RESEARCH DESCRIPTION:

Natural products are chemical compounds produced by plants, fungi, marine organisms etc. These compounds can be used to improve the quality of human life. The use of natural products in the management and treatment of diseases in humans and plants is culturally more acceptable and offers less risk than use of synthetic compounds.

Important agricultural crops are subjected to attack by a number of pathogens that retard growth and development leading to heavy loss in quality and quantity of the harvest. The agrochemical industry is continually searching for new phytotoxic compounds including weedicides and herbicides because synthetic compounds are often toxicologically and environmentally undesirable.

Mosquito borne diseases (malaria, dengue, encephalitis and filarial), which affect more than 700 million people annually, are of serious concern to public health problems in developing countries. Use of larvicides in mosquito breeding sites is one way to control the mosquito problem. Larvicides originating from natural sources have promising potential for the control of the mosquito vector. Frequent use of synthetic pesticides and larvicides gives rice to various problems. Physiological resistance, environmental problems due to degradation, high operational cost, toxic effects on non-target organisms (such as humans, fish, birds) are some detrimental effects that arise from the use of synthetic compounds.

The natural products chemistry research group at the IFS is conducting research in the following areas in order to identify environmentally friendly antioxidant, antifungal, antibacterial, bioactive compounds originating from natural sources that will help to improve the quality of human life.

Fungal toxins: Pure cultures of several fungi have been isolated from diseased agricultural crops such as banana, sesame, ground nuts, mung bean, onion and edible fruits such as banana, papaya, avocado, uguressa and lovi to study the chemistry and bioactivity of fungal toxins. Some of the pure cultures of fungi were tentatively identified as *Fusarium solani*, *Fusarium wilt*, *Trichoderma viride*, *Trichoderma harzianum*, *Cercospora canescens*, *Macrophomina phaseolina* and *Colletotrichum sp.*. Pure cultures of each fungus were inoculated in solid media of rice and liquid media of potato dextrose. After 5 - 6 weeks of growth, solid media were ground and extracted successively with the organic solvents n-hexane, ethyl acetate and methanol. The liquid media were filtered through a buchner funnel and extracted with n-hexane and ethyl acetate respectively. Bioassays to detect and determine antifungal activity, cytotoxicity, antioxidant activity and phytotoxicity of all these extracts are in progress.

A pure culture of the ambrosia fungus (*Monacrosporium ambrosium*), symbiote of shot-hole borer beetle (*Xyleborus fornicatus*) of tea (*Camellia sinensis*) was prepared on a laboratory culture medium. The fungus was also grown on a solid rice medium and on a potato dextrose liquid medium, and processed and described above.

Proanthocyanidins are biologically active flavan-3-ols found in plants. Proanthocyanidin fractions were separated from freeze dried samples of tea flush (*Camellia sinensis*) and freeze dried fruits of Lovi (*Flacourtia inermis*) by extracting with 70% aqueous acetone.

Antimicrobial activity of methanol extracts of some edible grains and mosquito larvicidal activity have been studied against seven *Candida* species.

*The project titled "Experimental evaluation of essential fatty acid rich plants to increase the conjugated fatty acid content in animal products " has come to the final stage.

RESEARCH AREA: PHOTOCHEMISTRY

RESEARCH TEAM:

Prof. J. Bandara	- Research Professor (Team Leader)
J. Akilavasan	- Research Assistant
H.M.S. Wasana	- Research Assistant
W.M.K.T. Wejerathna	- Research Assistant
U.W. Pradeep	- Research Assistant- Volunteer
T.M.I.S. Tennekoon	- Research Assistant- Volunteer
L. M. K. Meegahakotuwa	- Research Assistant- Volunteer
D. Aluthpatabedi	- Senior Staff Technical Officer
M. H. Kodikaraarachchi	- Pre-university Research Assistant- Volunteer

RESEARCH DESCRIPTION:

The Sun provides approximately 100,000 terawatts to the Earth which is about 10000 times more than the present rate of the world's present energy consumption. Photovoltaic cells are being increasingly used to tap into this huge resource and will play key role in future sustainable energy systems. However, the cost of photovoltaic electricity production is still too high to be competitive with nuclear or fossil energy. The recently discovered cells based on mesoscopic inorganic or organic semiconductors commonly referred to as 'bulk' junctions due to their three-dimensional structure are very attractive alternatives which offer the prospect of very low cost fabrication. The prototype of this family of devices is the dye-sensitized solar cell (DSC), which accomplishes the optical absorption and the charge separation processes by the association of a sensitizer as light-absorbing material with a wide band gap semiconductor of mesoporous or nanocrystalline morphology. In Photochemistry group, research is carried out ways to fabricate these low cost DSSC. In addition to fabrication of DSSC devices to convert solar energy into electrical energy, we also carry out research on ways to convert solar energy into chemical energy such as hydrogen energy. We also carry out research on water purification techniques.

1. Dye sensitized photoelectrochemical cells (DSSC) constructed using nano-porous films are gaining recognition as promising photovoltaic devices for conversion of solar energy. The efficient sensitizations of semiconductor nanocrystallites with inorganic and organic dyes have been demonstrated. The attempts have been made to increase the solar power efficiency minimizing the charge recombination processes. The Photochemistry project

successfully demonstrated use of n-p junction electrodes for the control of charge recombination in dye-sensitized solar cells.

2. Finding a suitable hole collector for DSSC with required properties is a great challenge, i.e. appropriate band gap, band positions and method for its deposition preserving the properties of the adsorbed dye layer. It is also needed to have proper contacts between dye and the p-type materials. The use of p-type oxide semiconductors as hole-collectors in dye-sensitized solar cells was successfully demonstrated and the problems encountered in p-type oxide as hole conductors were investigated by the photochemistry group.

3. Photochemisty project is actively involved in photochemical and photoelectrochemical purification of water. We have successfully built up a coupled reactor consisting of chemical and biological reactors for the treatment of service station waste water and the final assessment of the reactor is being carrying out.

4. Recently a project on Florien removal was initiated and work is under progress.

COLLABORATIVE RESEARCH :

Dr. J. Kiwi, Swiss Federal Institute of Technology, Switzerland, (water purification technology)

Dr. R. Weerasuriya, University of Peradeniya, (Florien removal methods)

RESEARCH AREA: PLANT BIOLOGY

RESEARCH TEAM:

Dr. M.C.M. Iqbal	- Senior Research Fellow (Team Leader)
P.K.D. Chathuranga	- Research Assistant
M. Madannayake	- Research Assistant
M.D.P. Kumarathunge	- Research Assistant
B.R. Randunuge	- Research Assistant - NSF
R.S.M. Perera	- Senior Staff Technical Officer
R.B. Hapukotuwa	- Laboratory Attendant

RESEARCH DESCRIPTION:

The research programme of the Plant Biology project concerns climate change and environmental pollution. The projects related to climate change are on the assessment of biomass in the dry zone forests of Sri Lanka and mapping the occurrence of dengue incidence in the Mawanella region.

Climate change is a consequence of global warming, which has been brought by increase carbon released to the atmosphere through human activities such as burning of fossil fuel and forests. Our purpose in determining the biomass of our forests is to determine how much carbon is stored in our forests and to understand the influence of increased carbon dioxide in the atmosphere on carbon fixation. Besides the dry zone forests, studies are also being conducted in the IFS Arboretum in Dambulla.

The increased temperature has altered the life-cycle of insect borne diseases such as dengue, which caused an unprecedented number of mortalities last year. Our studies are to combine the different factors contributing to dengue incidence using Geographic Information Systems (GIS) and create a map which shows areas that are vulnerable to dengue occurrence in the future. This would enable vulnerable areas to be identified to take preventive measures.

Environmental pollution by heavy metals is a serious health problem since it is invisible and the effects take a long time to manifest after accumulation in the body. Such toxic metals are lead, chromium, cadmium, mercury and Nickel. These enter our environment from industrial wastes and discarded electronic appliances and batteries. Their removal from the environment is difficult requiring expensive engineering and chemical technologies. There are certain plants which can take up these heavy metals from the soil and waterways and store them without any harm to themselves. We are

investigating such plants, particularly to remove metals from waterways which tend to be polluted by industrial wastes.

I. Biomass and carbon sequestration in natural forsts

a. Estimation of aboveground biomass in IFS-Popham Arboretum, Dambulla

Permanent sampling plots of dimensions 30x30 m (15 plots) and 20x20 m (5 plots) were demarcated. Each sampled tree was tagged using aluminum plates and trees > 5 cm diameter at breast height (DBH) were enumerated for DBH and height. The species name of each sampled tree was also recorded.

b. Aboveground biomass estimation in some wet zone forests (secondary data analysis)

Data from Peak wilderness were converted in to AGB using published allometric models.

c. Assessing species contribution to AGB in Sinharaja

Published data from 25 ha forest dynamic plot in Sinharaja was analyzed to investigate dominant tree species contributing to aboveground biomass in tropical wet evergreen forests.

Aboveground carbon density (biomass carbon/ha) of Dambulla Arboretum and Peak wilderness were estimated. A list of species with a significant contribution to the aboveground biomass in Sinharaja forest was completed. Total aboveground biomass of five dry zone forests was also estimated based on forest inventory data.

II. Heavy metal uptake by plants from the environment

Biosorption: Dead biomass of *Cabomba spp.* was studied as a bio-sorbent to remove Cr (VI) and Cr (III) from aqueous solutions. Batch sorption studies were conducted in 250 ml conical flasks at pH 5 and 25 °C. Dry biomass (0.2 g) was thoroughly mixed with 100 ml of chromium solution (5 ppm). The residual Cr concentration in the solution at different time intervals was analyzed by atomic absorption spectrophotometer (AAS).

Adsorption of Cr (VI) on to the biomass reached equilibrium within 125 min. whereas that of Cr (III) reached equilibrium within 09 min. At equilibrium, 20% of the Cr (VI) was removed and 40% of Cr (III). The bio-sorption kinetics of both Cr (VI) and Cr (III) followed a complex process involving both pseudo first-order and second-order kinetic models.

Phytoremediation: Uptake of Ni by *Fimbristylis falcata* was studied. Plants were grown hydroponically in Ni treated Hoagland's solutions. Plants were harvested after 2 weeks and the roots and shoots were digested separately using microwave digester. The plants were able to tolerate a Ni concentration in solution ranging from 50 µM to 350 µM. The Ni content in control plants was negligible when compared to Ni treated plants. Ni content in roots was greater than that in shoots.

III. Risk map for dengue in Mawanella

Dengue has now become the most dreaded mosquito borne viral disease affecting man in Sri-Lanka. Cases are reported in almost all the districts in the country causing death to more than three hundred and forty people last year.

The methodology consists of Data collection, Development of GIS database, Risk score identification, GIS analysis and modeling, Output. The study will show the potential risk areas, and environmental factors that are associated with the disease vector habitats and human transmission.

The project was carried out in the Mawanella MOH area as a pilot project. The dengue incidents recorded in Mawanella region were taken from October to December. The GPS locations of patients and the possible identified breeding locations were taken and mapped. The base digital maps were taken from the survey department, which are relevant to the study. The maps were constructed for temperature, rain fall and the pH of water containers and analyzed with the distribution of dengue patients and breeding locations. Dengue Risk Map (DRM) was prepared using ARC GIS soft-ware. The areas of High risk, Moderate risk and Low risk were identified which will be useful for future prevention strategies of dengue.

COLLABORATIVE RESEARCH

a. Biomass and carbon sequestration in the natural forests of the dry zone.

Collaborating institutions:

Mr. A. Sathurusinghe,
Deputy Conservator, Dept. of Forestry, Battaramulla.
Prof. W.A.J.M. de Costa, Dr. T. Sivanantheverl,
Faculty of Agriculture, University of Peradeniya

b. Developing a risk map for dengue incidence in Mawanella

Collaborating institutions:

Dr. Jagath Gunatilake,
The coordinator
MSc in GIS and Remote Sensing
Post Graduate Institute Of Science
University of Peradeniya
Peradeniya, Sri Lanka.

Dr. Abdul Haji
Medical Officer in Health
Mawanella Hospital
Mawanella

c. Heavy metal uptake and bio-adsorption by plants

Collaborating institutions:

Dr. S.S. Iqbal
Dept. of Chemistry, Open University of Sri Lanka, Nawala
Prof. Namal Priyantha,
Dept. of Chemistry, University of Peradeniya

RESEARCH AREA: PRIMATE BIOLOGY

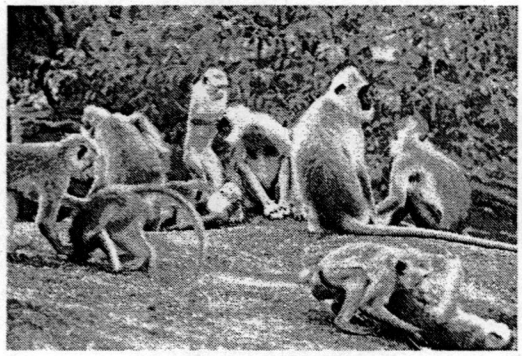
RESEARCH TEAM

Dr. Wolfgang Dittus - Visiting Scientist

RESEARCH DESCRIPTION:

The overall aim of the program is to establish new knowledge concerning the biological foundations for social behaviour in non-human primates (and by inference, man). This aim has interdisciplinary ramifications. Hence, past research and publications have addressed the interrelationships among factors concerning social organization, matrilineal kinship, ecology, environmental change and their effects on demography (Darwinian fitness). For example, our research was the first to establish an actuarial life-table for primates and showed that social behaviour influences individual differences in survival, breeding success, and morphological development. Our aims and data collection protocols require consistency over many years.

In practice, to investigate such phenomena we have identified more than four thousand macaque individuals (living plus dead), distributed among 34 different social groups at our dry evergreen forest study site, at Polonnaruwa. For each macaque, we have traced its behavioural, genealogical, ecological and demographic history. In addition we have recently completed the patrilineal identification of about 1,500 macaques. Such large samples are required to assure statistical soundness.



In this photo the toque macaques and hanuman langurs relax, play and groom in peaceful co-existence. But when feeding, these two species compete ferociously for limited forest resources. Our study site at Polonnaruwa provides opportunities for close observations and study of primate behavior (Photo by W. Dittus).

It was not clear by which physiological and similar mechanisms behaviour affected death rates. Therefore, the research was expanded (with the aid of collaborators from a variety of institutions) to investigate the potential role of disease (parasitism) and

physiology (milk composition, blood chemistry, hormone levels) in relation to behaviour and demography. Different aspects of physiology and disease have been more intensively investigated in the primates at Polonnaruwa particularly in association with of the Faculty of Veterinary Medicine, University of Peradeniya. In addition, we have become active in aspects of nature conservation and in outreach educational programs to local communities to assist in mitigating the human-monkey conflict.

(a) ***Routine demographic, ecological and behavioral monitoring.*** There have been major ecological changes in the macaque population at Polonnaruwa in the last few years owed to human activity. As a result, the macaques often leave the Nature Sanctuary Forest and raid surrounding village houses for garbage and garden produce. Therefore we have changed the focus of macaque groups that we monitor for demographic information. We have kept track of shifts in ecology and range use.

(b) ***Ecology of three sympatric primates.*** On a regular monthly schedule we sampled the diets, home ranges and interspecific interactions among the toque macaque, and the two langur species *Semnopithecus priam* and *Trachypithecus vetulus*. The aim of this study is to clarify the ecological relations that allow these three potentially competing species to co-exist in sympatry.

(c) ***Long-term change in macaque ecology***. We are monitoring the shifts in diet and activities among macaque groups that are exposed to human influences. These data should help in finding solution to the human-monkey conflict issues.

COLLABORATIVE RESEARCH

- Prof. RPV Jayanthe Rajapakse, Professor of Parasitology and Head of the Department of Pathobiology, University of Peradeniya, Peradeniya.
- Dr. Ashoka Dangolla, Faculty of Veterinary Medicine and Animal Health, University of Peradeniya.
- Professor Peter Nuernberg, Cologne Center for Genomics CCG, University of Cologne, Germany
- Kerstin Becker (Graduate student), Cologne Center for Genomics CCG, University of Cologne, Germany
- Rashika Kumarasingha (Graduate student), Department of Pathobiology, University of Peradeniya, Peradeniya
- Amanda Schenk, Fulbright Scholar, Sri Lanka-USA

A multi-year collaborative project dealt with genetic investigations (UP and CCG) involving 1,500 genetically typed toque macaques at Polonnaruwa. Its purpose was to determine the degrees of inbreeding in relation to known demographic and behavioral dynamics. Results of this study were presented at the Meeting of the American Primatological Society and are currently being prepared for publication.

The second collaborative project (UP and Fulbright) had begun only recently and dealt with investigations of the behavioral and ecological factors underlying monkey-human conflicts.

RESEARCH AREA: SOLID STATE CHEMISTRY AND CONDENSED MATTER PHYSICS

RESEARCH TEAM

Prof. G.K.R. Senadeera	- Associate Research Professor (Team Leader)
Y. Ariyasinghe	- Research Assistant
W.S.S. Gunethilake	- Research Assistant
C.A.Thotawattage	- Research Assistant
T.R.C.K. Wijayarthna	- Research Assistant

RESEARCH DESCRIPTION

The solar electricity is presently a rapidly growing but often relatively expensive renewable energy form. Recently however, new molecular photovoltaic materials have been developed, which could enable a production of low cost solar cells in the future.

In this context, we have focused our investigations on the preparation and characterization of thin films of semiconductor nano-structures, identification of new semiconducting materials which can be used in photovoltaic applications. As an practical application of our work, investigations are being carried out in usage of dye solar cells in bio- sensing (specially DNA) applications.

Apart from that, investigations are being broadened in following aspects.

1. Investigations on usage of low cost materials in electrochromic display applications.
2. Production of nano-graphite and graphite composites from Sri Lankan Natural Graphite to use in various applications. (Eg: Applications in Lubricants and Li-Batteries).

Research and development achievements that can be used in industry:

1. The identification of complexes of Cu(I) bromide with sulfides which could be used as a novel hole conducting material in low cost solid state solar cells ***(Sri Lankan Patent No. 11982)***.
2. Construction of a fully automated spray pyrolysis unit (equipment) to prepare homogenous nanocrystalline oxide semiconducting thin films

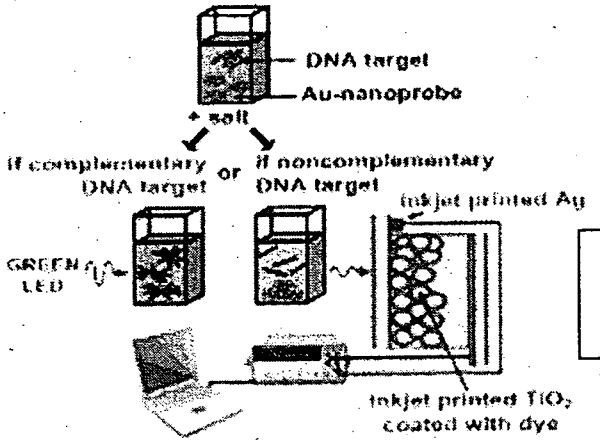
3. Successfully fabricated efficient solar photovoltaic device comprising with chemically attached poly 3-thiopnenyl acetic acid as the sensitizer for several nanocrystaline semiconductors, ***(An international patent No. NKS 2624-2003-36805).*** NIPPON KAYAKU CO.,LTD. Functional Chemical Res. Lab. 26-8,Shimo 3-Chome,Kita-Ku,Tokyo,Japan

4. For the first time in the field of polymer sensitized solid sate solar cells , novel, volatile solvent free, solar cells were fabricated with mesoporous TiO_2 electrodes and polythiophene. derivatives. ***(Chemical Communications Royal Society of Chemistry UK, 2005,17,2259).***

5. Discovery of a new method for deposition of CuSCN on dye coated TiO_2 films.

RESEARCH ACHIEVEMENTS IN 2009

(a) Investigations on Dye sensitized solar cells (DSCs) which can be used in sensor applications



Schematic representation of DNA detection of novel biosensor

(b) Efficient passivation of SnO_2 nano-crystalline by Indoline D 149 via dual chelating and π–π stacking. For the first time in SnO_2 based dye solar cells, we report efficiencies exceeding 3% for the cell consisting with Indolin D-149 dye and unmodified SnO_2 nanocrystallites.

(c) The use of surface plasma resonance of Gold nanoparticles in the efficiency enhancement of DSCs were investigated and significant enhancement is achieved.

(d) In order to replace problematic liquid electrolytes in dye sensitized solar cells, investigations have been carried out in synthesis of new polymer electrolytes. Efficiencies exceeding 5% were obtained with one of the polymer electrolyte.

(e) Optimizations of Natural de sensitized solar cells are being carried out aiming to use them in low cost biosensors. Three sources of natural pigments were identified to employ them in dye solar cells for practical applications in bio-sensors.

COLLABORATIVE RESEARCH:

1. Prof. M.A.K.L. Dissanayake, Prof. M.A. Careem, Dr. P. Ekanayake, Dr. V. Senevirthne, Department of Physics, University of Peradeniya and Prof. A.D.L.C. Perera, Department of Chemistry, University of Peradeniya.

   Physico-Chemical studies of Polymer Elctrolytes suitable for Dye Sensitized Solar Cells and Electrochromic Displays and quantum dot sensitizing solar cells.

2. Prof. Ajith de Alwis, Department of Chemical Engineering, University of Moratuwa, & Nanotechnology Institute of Sri Lanka.

   Optimizations of Natural dye sensitized solar cells are being carried out aiming to use them in low cost biosensors. Three sources of natural pigments were identified to employ them in dye solar cells for practical applications in bio-sensors.

   "Conversion of Solar Energy to Electricity by Natural Dye-Sensitization "
   C.I.F. Attanayake1, B.A.J.K. Premachandra1, A.A.P. De Alwis and G.K.R. Senadeera

3. Dr. V.P.S. Perera, Department of Physics, Open University of Sri Lanka.
   Investigations on Dye solar cells.

Awards and Recognitions

Prof. C.B. Dissanayake - Doctor of Science Degree, awarded by Sabaragamuwa University of Sri Lanka.

Prof. N.S. Kumar - Emeritus Professorship awarded by University of Peradeniya

Prof. U.L.B. Jayasinghe - Visiting Professorship was awarded by Tokyo Institute of Technology, Japan (01.07.2009 – 30.09.2009)

Dr. M. Vithanage - Best Graduate Scientist for Natural Hazards 2009 was awarded by the Natural Hazards Focus Group of the American Geophysical Union

Mr. T. Wansapura won the IUPAC Young Chemist Award 2009. His award winning work was on "Electro degradation of textile colourant Eyosine Y, using Indium Tin Oxide plated conducting glass electrodes".

Mr. M.H. Haniffa was awarded the Kandiah Memorial Award for Basic Chemistry 2009

Patents, Software developments for research, Publications, and Abstracts and Proceedings

1. Patents

Portuguese Patent application No. 104634, Portugal
Patent in Method for perpetrating electrochromic inks, Patent applied by Y-Dreams – Portugal 2009, Madan Parque - Sul, Quinta da Torre, 2825-149 CAPARICA. Portugal By Claudia B. da Costa, **G.K.Rohan Senadeera,** Elvira Maria Correia Fortunato and Ines Domingues da Silva Henriques.

2. Software development for Research

Prof. A. Nanayakkara and his research team developed the main BCI software called **IMTE (*Identification of Mental Tasks through EEG*)** which carried out signal processing and classification of EEG data. IMTE has a Graphical User Interface (GUI) with user friendly features and supports various signal processing techniques

3. Publications

3.1 Publications in refereed journals

i. Ambagahaduwa,I.M., Prasad,N., Gunatilleke,I.A.U.N., **Seneviratne,G.** and Gunatilleke,C.V.S. Estimation of above ground biomass of a *Pinus caribaea* Morelet stand in lower Hantana. ***Journal of National Science Foundation of Sri Lanka 37: 195-201, 2009.***

ii. **Benjamin,S.P.** and Hormiga,G. Phylogenetic placement of the enigmatic genus *Labullinyphia* van Helsdingen, 1985, with redescription of *Labullinyphia tersa* (Simon, 1894) from Sri Lanka (Araneae: Linyphiidae). ***Contributions to Natural History. 12: 161-181, 2009.***

III. Dimitrov, D. Hormiga, G. and **Benjamin,S.P.** A revised phylogenetic analysis for the genus *Clitaetra* Simon, 1889 (Araneoidea, Nephilidae) with the first description of the male of the Sri Lankan species *Clitaetra thisbe* Simon, 1903. ***Bulletin of the Museum of Comparative Zoology 159: 301-323, 2009.***

IV. Edwards, G.B. and **Benjamin,S.P.** A first look at the phylogeny of the Myrmarachninae, with rediscovery and redescription of the type species of *Myrmarachne* (Araneae: Salticidae). ***Zootaxa 2309: 1-29, 2009.***

V. Lohwasser,R.H., **Bandara,J.,** and Thelakkat,M. Tailor-made synthesis of poly(3-hexylthiophene) with carboxylic end groups and its application as a polymer sensitizer in solid-state dye-sensitized solar cells ***Journal of Material Chemistry, 19:* 4126, 2009.**

VI. **Nanayakkara,A.** Semiclassical quantization of non-Hermitian 2-D systems: Classical (Lie Transform) perturbation theory. ***Journal of National Science Foundation Sri Lanka 37: 111, 2009.***

VII. **Seneviratne,G.,** Peyvast, G. A., Olfati, J. A. and Kariminia, A. Rhizobia as biofertilizers for mushroom cultivation. ***Current Science 96: 1559, 2009.***

VIII. **Seneviratne,G.** Collapse of beneficial microbial communities and deterioration of soil health: a cause for reduced crop productivity. ***Current Science 96: 633, 2009.***

IX. **Seneviratne,G.** Effect of forest drought on global warming is enigmatic. ***Current Science 97: 9, 2009.***

X. **Seneviratne,G., Henakaarchchi,M.P.N.K.**, Weerasekara,M.L.M.A.W. and Nandasena, K.A. Soil organic carbon and nitrogen pools as influenced by polyphenols in different particle size fractions under tropical conditions. ***Journal of National Science Foundation of Sri Lanka 37: 67-70, 2009.***

3.2 Chapters in books

I. **Seneviratne,G.,** Thilakaratne,R.M.M.S., Jayasekara,A.P.D.A., Seneviratne, K.A.C.N., Padmathilake, K.R.E. and De Silva,M.S.D.L. Developing beneficial microbial biofilms on roots of non-legumes: A novel biofertilizing technique. In. Khan, M. S., Zaidi, A. and Musarrat, J. (eds.) Microbial Strategies for Crop Improvement. Springer-Verlag, Germany, pp. 51-62, 2009.

II. Gunathilake, KAS (2009). Pulathisipura Sobadaham Urumaya (Wildlife Heritage of Polonnaruwa) (Chapter 1, article 2) In "Pulathi Vamsa" Government of Sri Lanka Press, pages 49-75 ISBN 878-955-9117-18-6

(Mr. Gunathilake is the Research Coordinator on the Primate Biology Program at Polonnaruwa)

4. Abstracts, Poster/Oral presentations and conference Proceedings

I. Attanayake,C.I.F., . Premachandra, B.A.J.K, De Alwis A.A.P., and **Senadeera,G.K.R.** Conversion of Solar Energy to Electricity by Natural Dye-Sensitization. ***15th ERU Symposium, 2009: Faculty of Engineering, University of Moratuwa, 2009.***

II. Becker, K., **Dittus, W.**, Kumarasingha, R., and Nürnberg, P. Assessment of inbreeding avoidance in social groups of toque macaques with non-dispersing males. ***32nd Meeting of the American Society of Primatologists, San Diego, California, USA. (18th-21st September, 2009).***

III. Bernacka-Wojcik,I., **Senadeera,R.,** Jerzy Wojcik,P., Bione Silva,L.B., Doria,G., Baptista, P., Aguas,H., Fortunato,E., Martins, R. Inkjet printed and "doctor blade" TiO_2 photodetectors for DNA biosensors. **NanoBioTech-Montreux 2009, 16th - 18th Nov 2009, Montreux, Swizerland, page 67,2009.**

IV. Bernacka-Wojcik, I., **Senadeera, R.,** Wojcik, P.J., Silva, L.B., Doria, G., Baptista, P., Aguas, H., Fortunato, E., and Martin, R. From gold nanoparticles to "toothpaste" for DNA detection. ***Oral presentation, Workshop Nano 09, 10-11 December 2009, Braga, Portugal .***

V. **Ellepola, S.K.W.** Study of antioxidant properties of red rice (Oryza sativa L.) seeds. ***AG/09/71, Second National Symposium-2009, Faculty of Agriculture, University of Ruhuna, 2009.***

VI. **Jayarathna, I.P.L.,** Weerasooriya, R., Bandara, A. Synthesis and Characterization of Fe_2O_3 Nanoparticles, ***Proceedings of the 42nd IUPAC Congress, UK., Vol 101, Page-013, 2009.***

VII. **Jayasinghe,U.L.B.** - Poster titled "How TITECH – UNESCO Research Fellowship help me to enhance my carrier as a Natural Product Chemist" presented at the ***Tokyo Institute of Technology, Japan, 10th – 11th December, 2009.***

VIII. **Kumara,C.K.,** NG, W.J., Bandara, A., Weerasooriya, R., 2009, Physio-Chemical Properties of Gibbsite Nano-Crystals, ***Proceedings of the 42nd IUPAC Congress, UK. Vol 101, Page-012, 2009.***

IX. **Kumara,C.K.,** Bandara,A., Weerasooriya,R. Progression of Gibbsite Nanocrystals, ***65th Annual session, Sri Lanka Association of Advancement of Science, 2009.***

X. **Kumarathunge,M.D.P.** and **Iqbal,M.C.M.** Biomass estimation in some dry zone forests in Sri Lanka from forest inventory data. ***Proceedings of the International Forestry and Environment Symposium 2009. University of Sri Jayawardenapura, Sri Lanka, 2009.***

XI. **Magana-Arachchi,D.N., Wanigatunge,R.P.** Cyanobacterial diversity and toxin production in Lake Gregory, Sri Lanka. ***Proceedings of the Second Open Science Meeting on HABs and Eutrophication, GEOHAB, 18th -21st , October, Beijing, China. Page 36, 2009.***

XII. Nishantha, M.R., Perera,V.P.S., **Wijayarathna,T.R.C.K., Ariasinghe,Y.P.Y.P.** Electroplated Ni grid for Dye Sensitized Photoelectrochemical solar panel. ***Proceedings of the 65rd Annual Sessions, Sri Lanka Association For the Advancement of Science, page107, 2009.***

XIII. Nishantha,M.R., Perera,V.P.S., **Wijayarathna,T.R.C.K., Ariasinghe, Y.P.Y.P.** Development in dye sensitized electrochemical solar cells with the use of electronic toppingup bath and Ni grid. ***Proceedings of the Annual Academic Sessions of Open University of Sri Lanka, page 209, 2009.***

XIV. Pieris,P.K.D., Weerakoon,S.R., **Iqbal,M.C.M.** and Weerasena,O.V.D.S.J.. Developing low erucic acid and high oleic acid containing genotypes via embryo rescue using mustard (Brassica juncea) germplasm in Sri Lanka. ***International Conference on Frontiers of Molecular Sciences. Colombo, Sri Lanka. 16-18 September, 2009***

XV. **Priyanwada,N.H.N.,** Wanigasekera,W.M.A.P., Dharmaratne,H.R.W., *Setaria italica* revisited; a long time forgotten nutritive food for Human and Ruminants in Sri Lanka. ***Proceedings of the 65rd Annual Sessions, Sri Lanka Association For the Advancement of Science, 2009.***

XVI. **Priyanwada,N.H.N.,** Weihena,S.J., Dharmaratne,H.R.W., and Wanigasekera,W.M.A.P., Preliminary evaluation of some nutritional aspects of *Mucuna pruriens* (Black variety) as a potential animal feed, ***61st Annual Scientific Sessions of Sri Lanka Veterinary Association, 2009.***

XVII. **Ratnayake, R.R., Seneviratne, G., Kulasooriya, S.A.,** (2009). Soil C sequestration in labile organic and stable mineral fractions of natural forests and cultivated lands in Sri Lanka. In Proceedings of the ***International conference on Organic matter Dynamics: Land use, management and global change,*** Colarado, USA, 6pg, July 2009.

XVIII. **Samarasinghe,P., Wijayasinghe,A.** and Dissanayake,L. Synthesis and characterization of lithium transition metal ceramic oxide materials, and their applications in rechargeable lithium ion batteries, ***International Conference on Materials for Advanced Technologies (ICMAT), Singapore, July 2009.***

XIX. **Samrasinghe,P., Wijayasinghe,A.,** Behm,M. and Dissanayke,L. Synthesis and characterization of $Li_{1.1}(Ni_{1/3}Co_{1/3-x}Mn_{1/3}Mg_x)O_2$ *and* $Li_{1.1}(Ni_{1/3}Co_{1/3}Mn_{1/3-x}Mg_x)O_2$ *by Pechini method, for Lithium* ion rechargeable battery (LIB) positive electrode. ***Proceedings, IUPAC 5th International Symposium on Novel Materials and Synthesis (NMS-V) 19th International, 19th International Symposium on Fine Chemistry and Functional Polymers (FCFP-XIX) Shanghi, China, October 2009.***

XX. **Samrasinghe,P.,** Wijayasinghe ,M., and **Wijayasinghe,**A. *Synthesis and electrical characterization of lithium transition($Ni_{1/3}Co_{1/3-x}Mn_{1/3}Zn_x)O_2$* for lithium ion rechargeable battery cathodes, ***64th Annual Sessions of the Sri Lanka Association for the Advancement of Science, December 2009.***

XXI. **Subasinghe,N.D.** Applications of Non-Linear Dynamics in the Production of Functionalised and Sensing Material. (Abstract) ***Proceedings of the International Conference on Functionalized and Sensing Materials (FuSeM 2009). Bangkok, Thailand. Page 50, 2009.***

XXII. **Vithanage,M.** and Obeysekera,J. Effect of climate change on coastal aquifer management in Sri Lanka. ***National Symposium on Natural Resources Management (NRM 2009) Department of Natural Resources, Sabaragamuwa University of Sri Lanka, 2009.***

XXIII. **Vithanage,M.,** Engesgaard,P. and Jensen,K.H.. Modeling assessment of water flow patterns in a coastal aquifer in Sri Lanka. ***National Symposium on Natural Resources Management (NRM 2009) Department of Natural Resources, Sabaragamuwa University of Sri Lanka, 2009.***

XXIV. **Wanigatunge,R.P.** and **Magana-Arachchi,D.N.** Detection of potential microcystin-producing cyanobacteria of order Oscillatoriales, from Mahapelessa hot springs, Hambantota. ***Proceedings of the Sri Lanka Association for the Advancement of Science. 65th Annual Session. Page 89; 424/D, 2009.***

XXV. **Wijayarathna,T.R.C.K. , Ariasinghe,Y.P.Y.P.,** Jayarathna, I. P.L., **Thotawatthage,C. A.,** Nishantha,M.R., **Senadeera, G.K.R.** and Perera, V.P.S. Effect of surface plasmon resonance of Au nano-particle in the TiO_2 films of Dye sensitized photoelectrochemical solar cells. ***Proceedings of the Annual Academic Sessions of Open University of Sri Lanka, page 05, 2009.***

XXVI. **Wansapura P. T. Bandara, J.** Electrochemical destruction of textile colorants using Indium Tin Oxide (ITO) coated conducting glass electrode ***Proceedings of the 42nd IUPAC Congress, UK. 2009.***

XXVII. Wojcik P. J., Bernacka-Wojcik I., **Senadeera R.**, Baptista P., Fortunato E., Martins R.. Inkjet printed titanium dioxide for dye sensitized photodetectors. **Poster in *Plastic Electronics Europe 2009, Maritim Dresden, Dresden, Germany, 27-29 October 2009.***

5. Other Presentations

I. **Iqbal,M.C.M.** Second National Communication on vulnerability and adaptation assessment on climate change. **Presentation at the *NCSP meeting 21-23 July, 2009 Kuala Lumpur Malaysia.***

II. **Jayasinghe,U.L.B.** "Search for environmental friendly bioactive compounds from natural sources" at the Tokyo Institute of Technology, Japan, 2009.

III. **Seneviratne,G.,** Microbial Biofilms as Biofertilizers for Field Crops, ***A presentation made in the Seminar series of the Faculty of Agriculture, Food and Natural Resources, The University of Sydney, Australia, 9 April, 2009.***

IV. **Seneviratne,G.,** Novel Microbial Biofertilizers for Low Cost Agriculture, ***A lecture delivered for the Organization of Professionals Kandy (OPK) at the Garden Club, Kandy, 25 September, 2009.***

V. **Vithanage,M.,** Engesgaard,P. Jensen,K.H. , Obeysekera,J., Villholth,K., and Illangasekare,T.H. Effect of 2004 tsunami on groundwater in a coastal aquifer of Sri Lanka: Tank experiments, field observations and numerical modelling. **Invited talk.** ***American Geophysical Union, Fall Meeting, San Francisco, 2009.***

Postgraduate Degrees 2009

Name:	I.G.C.K. Kumara
Title of the thesis:	Synthesis, properties and application of nano gibbsite Crystal: A substrate for arsenate remediation
Degree:	M. Phil.

Degree awarded by University of Peradeniya

Dissemination of Science

1. RESEARCH EXPOSURE FOR YOUNGER GENERATION

1A. PRE UNIVERSITY STUDENTS-

Name of student	*Name of the Superviser*
Arachchi M.	PROF. J. BANDARA
Palamakumbura S.	PROF. G.K.R. SENADEERA
Rupasinghe S.	PROF. G.K.R. SENADEERA
Wejekoon D.	DR. R. RATNAYAKE

1B. UNIVERSITY UNDERGRADUATES-

1B.1. Abeykoon G.
University of Peradeniya
SUPERVISED BY PROF. U.L.B. JAYASINGHE

1B.2. Anushka P.V.A.
Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka
"Identification & Characterization of Cyanobacterial toxins; Kalawewa & Nacchaduwa "
SUPERVISED BY *DR. D.N. MAGA-ARACHCHI*

1B.3. Chandrasekera P.
Uwa- Wellasa Univerity,
SUPERVISED BY PROF. J. BANDARA

1B.4. De Silva Enosha
Institute of Chemistry, Ceylon
SUPERVISED BY PROF. U.L.B. JAYASINGHE

1B.5. Ekanayake Srimathie
Uwa-Wellassa University
SUPERVISED BY PROF. U.L.B. JAYASINGHE

1B.6. Gallage L.R.
Uwa Wellassa University
SUPERVISED BY PROF. G.K.R. SENADEERA

1B.7. Gunasekera D.N.
Uwa Wellassa University
SUPERVISED BY PROF. G.K.R. SENADEERA

1B.8. Gunasena B.R.D.C.
Dept. of Science and Technology, Uva Wellessa University
SUPERVISED BY DR. M.C.M. IQBAL

1B.9. Herath I.
Dept. of Chemistry, Open University of Sri Lanka, Nawala
SUPERVISED BY DR. M.C.M. IQBAL

1B.10. Herath N.
Uwa- Wellasa Univerity,
SUPERVISED BY PROF. J. BANDARA

1B.11. Jaleel Ziyard
The Open Unversity of Sri Lanka
SUPERVISED BY DR. S.P. BENJAMIN

1B.12. Karunasiri Prasad
Applied Science Program,
Faculty of Science, University of Peradeniya"PC Sound Card Based Data Acquisition System using Visual Basic 6.0"
SUPERVISED BY PROF. A. NANAYAKKARA

1B.13. Kumari M.M.S.K.
Faculty of Science, University of Ruhuna, Matara
"Distribution and PCR analysis of *Bacillus thuringiensis* isolated from Soils"
SUPERVISED BY DR. D.N. MAGA-ARACHCHI

1B.14. Kôkila K.W.A.M.
Faculty of Science, University of Uva –Wellassa
"Isolation & identification of Mycobacteria from water & soil"
SUPERVISED BY DR. D.N. MAGA-ARACHCHI

1B.15. Marasinghe N.
Uwa-Wellassa University
SUPERVISED BY PROF. U.L.B. JAYASINGHE

1B.16. Perera O.S.
Uva Wellassa University
SUPERVISED BY DR. R. RATNAYAKE

1B.17. Pilapitiya H.M.D.D.K.
Faculty of Veterinary Science, University of Peradeniya
SUPERVISED BY PROF. U.L.B. JAYASINGHE

1B.18. Ponnampalam S.
Uwa Wellassa University
SUPERVISED BY PROF. G.K.R. SENADEERA

1B.19. Ranaweera G.
Dept. of Botany, University of Sri Jayewardenapura
SUPERVISED BY DR. M.C.M. IQBAL

1B.20. Samarakoon A. M. R. T
Sabaragamuwa University of Sri Lanka
"The effect of Biofilmed biofertilizers on the soil-plant-microbe interactions in nursery tea"
SUPERVISED BY PROF. G.K.R. SENADEERA

1C. POSTGRADUATE UNIVERSITY STUDENTS-

1C.1. Cmdr. Ivan Attanayake
Ph.D., University of Moratuwa
SUPERVISED BY PROF. G.K.R. SENADEERA

1C.2. Arachchi M.
The Open University of Sri Lanka
SUPERVISED BY PROF.J. BANADARA

1C.3. Igalavithana, A.
"Soil carbon sequestration on tea estates with Biofilmed biofertilizers application".
M.Sc. Thesis, PGIA, University of Peradeniya
SUPERVISED BY PROF.G. SENEVRATNE

1C.4. Kumara N.T.R.N.
M.Phill, Wayamba University of Sri Lanka
SUPERVISED BY PROF. G.K.R. SENADEERA

1C.5. Meegahakotuwai L.
The Open University of Sri Lanka
SUPERVISED BY PROF.J. BANADARA

1C.6. Pradeep U. W.
M.Phil, University of Peradeniya
SUPERVISED BY PROF.J. BANADARA

1C.7. Tennekoon I.
The Open University of Sri Lanka
SUPERVISED BY PROF.J. BANADARA

1C.8. Wagaarachchi J.
M.Sc.,University of Moratuwa
SUPERVISED BY PROF. G.K.R. SENADEERA

2. TRAINING PROGRAMS

2A. Training programmes for (O/L) Science Teacher's

2A.1. *How to teach Science in a simple and enjoyable way – Sinhala medium 19 May, 2009 and 26 May, 2009 by Dr. Kumari Tilakaratne*

This was organized by IFS and The Central Province, Education Department. Hundred teachers actively participated in this training programme. The content of the training programme was as follows:

- How can we understand scientific concepts in a simple manner?
- Introducing simple learning and teaching methods to understand periodic table and reactivity series, electro chemical series
- How to introduce simple methods on chemical reactions, chemical bonding chemicals, mixtures and fluids
- Introducing simple models to present concepts on chemical reactions, chemical bonding, mixtures and fluids.
- Practical sessions

2A.2. *Two day Training programme for (O/L)Tamil Science teacher's in Central Province (Tamil Medium) 27 -28 October, 2009 by Mr. J Akilawasan*

Hundred teachers had the opportunity to participated in this training programme. This was organized by IFS and Central Province, Education Department.

The content of the lecture was as follows:

- How can we understand scientific concepts in a simple manner?
- Introducing simple methods to understand periodic table and reactivity series, electro chemical series
- How to introduce simple methods on chemical reactions, chemical bonding chemicals, mixtures and fluids
- Introducing simple models to present concepts on chemical reactions, chemical bonding, mixtures and fluids.
- Practical sessions

2B. Training programmes for (O/L) Science Student's

How to teach Science in a simple and enjoyable way – Sinhala medium
by Dr. Kumari Tilakaratne

Sixty four students and two teachers from Nugawela Central College, Nugawela, participated in this programme on 17 June, 2009 and Hundred and fifty students and three teachers from Sangamitta Balika Maha Vidyala College, Matale on 23 June, 2009 as well. Our main objective was to popularize science in a simple manner for teachers and school children.

2C. Training Program for Technical offices on Instrumentation
29-30, October 2009
Coordinators: *Prof. N S Kumar, Dr. Kumari Tilakaratne*

Fifteen technical officers from various government institutions were trained. This training Program provided basic theoretical background and hands on experience with simple instrumentation on the following areas.

FT-IR Spectroscopy:
Dr. A. Bandara , University of Peradeniya

UV-VIS Spectroscopy:
Prof. G.K.R. Senadeera, IFS

Laboratory safety, waste disposal etc..:
Prof. H. M. N. Bandara, University of Peradeniya

AAS :
Prof. R. Weerasooriya, University of Peradeniya

PCR/Electrophoretic methods :
Dr. D. Magana-arachchi, IFS

Gas Chromatography (GC):
Prof. J.M.S. Bandara IFS

Environmental sampling methods and analysis:
Dr. S.P. Benjamin, IFS & Ms. B. Perera, IFS

Documentation, preparation of indents etc:

Mr. P. Rajanathan, University of Peradeniya

HPLC:

Prof. U.L.B. Jayasinghe, IFS

In addition to lectures practical sessions were conducted by the lectures.

3. Science web site in Sinhala

Today, in this electronic era, internet (web) is one of the most important resource which we can grasp knowledge. Scientific knowledge and information in the Web is available in English and other foreign languages. Therefore, the people who can only understand these languages have the opportunity to take the advantage from this web based knowledge. Unfortunately, due to the language barrier, most of the Sinhala speaking people are not in a position to benefit from this enormous knowledge.

To share the scientific know-how with Sri Lankans, Prof. Asiri Nanayakkara , Dr. kumari Tilakarane and the Science Dissemination unit of IFS has developed a Sinhala Science web site named as "Vidu Mang Petha". www.vidu.ifs.ac.lk is the address of this web site. On line/downloadable English-Sinhala Science Glossaries, On line/downloadable Dictionaries, E-booklets in Science, methods to build a home laboratory, Chemistry games, Science experiments for kids, information on Terminal illnesses and giving hope for patients/ providing information about new treatment methods are included in it.

Though we are sharing the scientific know-how with Sinhala speaking people, at present we are in the process of making the Tamil translation of this web.

Official web launching by Prof. P.W. Epasinghe, Science Advisor to H.E. the President on 15th July 2009.

4. AWARENESS AND EDUCATIONAL PROGRAMMES FOR STUDENTS AND TEACHERS

4A. School Science Programme: (SSP)

The School Science Programme (SSP) is one of the most important annually conducted programmes for the dissemination of science among the younger generation. We conducts this Programme (SSP) to bring together bright young minds from diverse regions in the country to expose them to a novel intellectual experience designed to promote thinking, imagination, curiosity, wonder and excitement at new ideas discovered. Since the inception of this programme in 1987, a total of 2627 students who have excelled at the GCE (Ordinary Level) examination have participated in this activity. We had hundred and sixty five students for 2009 programme. In bringing together students of varied ethnic, religious and economic backgrounds for this programme encourages them to understand and respect differences between themselves as individuals.

SSP was held on 16,17 & 18 December.

16 December

Physics in Everyday Life:
Prof. K Premaratne, Faculty of Science, University of Peradeniya

Can we use scientific method in daily life?
Prof. A. Nanayakkara, IFS & Dr. K. Tilakaratne, IFS

17 December

Extra terrestrial life; science or scientific fication:
Prof. A. Nanayakkara , IFS

Biological Activity and Natural Products :
Prof. S. Kumar, IFS

18 December

Science & Mathematics for a comfortable Life :
Dr. J. Edirisinghe, Faculty of Engineering, University of Peradeniya

Primate Behavior, Ecology and Conservation:
Dr. W. Dittus, Visiting Scientist, IFS

4B. All island competition on Scientific concepts for students:

The competition was mainly focussed to awake enthusiasm of students to choose science and to make them understand that the complex facts and workload is not a burden but astound and enjoyable path to set their foot in.

Competition on scientific concepts was organized in Sinhala and Tamil medium under two categories (Year 7,8,9, & 10,11). We received about 5000 entries. 1^{st},2^{nd},3^{rd} places and seven highly commendable certificates were awarded for each category in both mediums.

4C. All island competition for Science teachers:

Science should be taught in logical and formal manner. However scientific concepts and knowledge should be presented to the students in an intuitive manner relating to their day to day experience. Therefore the competition was organized for science teachers such that they will use their creativity, scientific knowledge and artistic talents to form poems describing scientific concepts in a simple and an interesting manner.

The success of the competition was evident from the quality and the creative nature of the presentations as well as the feedback received from the teachers.

4D. Educational & Development Exhibition-" Mada Rata Nawodaya"
IFS participated in the above exhibition and received very good comments from students, teachers and general public who have visited our stall.

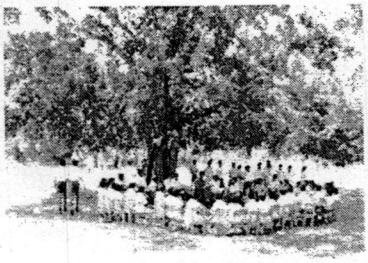
4E. Educational visits

Laboratory visits were organized for school children, teachers, undergraduate and students from other institutions. A Special lecture on IFS and its activities were prepared in advance to enable these students to understand the IFS activities better.

23.01.2009	Undergraduate students from Sabaragamuwa University, Badulla.
13.03.2009	Undergraduate students form University of Peradeniya.
19.03.2009	Teachers from Mahamaya Girls' College, Kandy.
30.03.2009	Teachers and students from Egodawella Kanishta Vidiyalaya, Chilaw.
02.06.2009	Teachers and students from St. Mary's College, Kegalle.
19.06.2009	Teachers and students from G/Opatha Maha Vidiyalaya, Opatha.
22.06.2009	Field excursion of final year food science & technology undergraduate students from Faculty of Applied Sciences, Sabaragamuwa University

4F. Nature Education Outreach

In 2009 staff of the Primate Biology Program conducted 14 nature education programs in Singhala for teachers and students (including 4 for A/L students) at Polonnaruwa, one for undergraduates of the University of Peradeniya, and 8 for the local community. The Program also served as the official resource for the Practical Examinations of 120 Advanced Level Biology Students (Royal College, Polonnaruwa). On 37 occasions the staff intervened directly on behalf of nature conservation problems.



4G. Documentary Film Production:

Primate biology research group dissemination of science impact was global. Dr. W Dittuss and his assistants at Polonnaruwa were key to the production (by NHNZ) of a series of 14 half-hour films about monkey behaviour. The series, entitled "Dark Days in Monkey City," is being broadcast internationally on the Animal Planet, Discovery Channel. They use their scientific discoveries at Polonnaruwa to educate and inspire people world-wide towards nature conservation.

5. Research meetings, research colloquia, and public lectures

Research meetings were conducted by the research assistants of the IFS. These meetings provide a platform to present their research findings and discuss their research problems with the peers. Scientists with expertise in their fields of research were invited to talk to their colleagues at research colloquia. In addition, public lectures were organized to promote the public understanding of science.

RESEARCH MEETNGS

07.01.2009 **FTIR Analysis of Aresenate – Montmorillonite, interactions**
Mr. I G C K Kumara, Research Assistant, IFS

18.02.2009 **Construction of Brain Computer Interface (BCI) using non-invasive methods**
Ms. S S Zahmeeth, Research Assistant, IFS

PUBLIC LECTURE

19.11.2009 Novel Trends in Natural Product and Medicinal Plant Research
Prof. Leslie Gunatilaka, Director, SW Center for Natural Products Research & Commercialization, The University of Arizona, USA

IFS STAFF 2009

DIRECTOR : Prof. C.B. Dissanayake
SECRETARY : Mr. K.T. Waisundara

RESEARCH STAFF

Research Professor

Prof. Bandara J.
Prof. Dissanayake C.B.
Prof. Jayasinghe U.L.B.
Prof. Kumar N.S.
Prof. Nanayakkara A.
Prof. Seneviratne G.

Associate Research Professor

Prof. Senadeera G.K.R

Senior Research Fellow

Dr. Benjamin S.P.
Dr. Iqbal M.C.M.
Dr. Subasinghe D.

Research Fellow

Dr. Ellepola S.*
Dr. Magana-Arachchi D.N.
Dr. Ratnayake R.R.
Dr. Vithanage MS
Dr. Wijayasinghe A.*

Visiting Research Professor

Prof. Kulasooriya S. A.

Visiting Scientist

Dr. Dittus W.

*left IFS during the year 2009

RESEARCH ASSISTANTS GRADE I

De Silva W.C.
Liyanage H.M.
Meegahakumbura M.G.K.M.
Sandamali H.A.J.
Piyasena K.G.N.P.

RESEARCH ASSISTANTS GRADE II

Akilawasan J.
Alakolanga A.G.A.W.
Ariyasinghe Y.P.Y.P
Balangoda B.M.A.R.
Bandara H.M.S.K.H.
Batawita Acharige S.G.
Chanturanga P.K.D.
Gunatilake K.M.D.
Gunatilake W.S.S.
Henakaarachchi M.P.N.K.
Jayaratna I.P.L
Kumara I.G.C.K
Kumaratunge M.D.P.K.
Madanayake M.P.
Perera M.B.U.
Priyanwada N.H.N
Rajapakshe R.M.A.U.
Samarasinghe P.B.
Sandamali P.M.H.
Silva W.S.D.K.
Siriwardhana A.M.D.A.
Subasinghe A.
Thilakaratne R.M.G.N.
Totawattage C. A.
Wanigathunga R.P.
Wasana H.M.S.
Weerasinghe H.A.S.
Wijayarathna T.R.C.K.
Wijethunga S.H.D.P.
Wijeratne W.M.K.T.
Wanigatunge R.P.
Zahmeeth S.S.

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TECHNICAL STAFF

Kulathunga M.N.B.	- Chief Technical Officer
Weerakoon W.M.R.B.	- Chief Technical Officer
Aluthpatabendi D.	- Senior Staff Technical Officer
Athukorale N.P.	- Senior Staff Technical Officer
Herath H.M.A.B.	- Senior Staff Technical Officer
Jayasekara banda W.G.	- Senior Staff Technical Officer
Jayaweera D.S.	- Senior Staff Technical Officer
Karunarathne R.K.C.	- Senior Staff Technical Officer
Lakshmi kumari D.M.K.	- Senior Staff Technical Officer
Opatha S.	- Senior Staff Technical Officer
Pathirana A.K.	- Senior Staff Technical Officer
Perera R.S.M.	- Senior Staff Technical Officer
Sakalasooriya S.S.K.	- Senior Staff Technical Officer
Tumpale I.	- Senior Staff Technical Officer

DIRECTORS' OFFICE

Jeewa Kasthuri M.D.	- Personal Secretary to the Director
Seneviratne O.W.K.	- Stenographer Grade II

COLOMBO OFFICE

Rajapakse M.C.	- Coordinator cum Scientific Officer
Gunawardena A.D.	- Driver cum Karyala Karya Sahayaka

ACCOUNTS DIVISION

Samarakkody P.S.S.	- Senior Assistant Accountant
Sirimalwatta S.	-Senior Staff Assistant (Stenographer)
Nissanka M.K.	- Staff Assistant (Book Keeper)
Palliya Guruge M.P.	- Staff Assistant (Clerical)
Rathnayake R.M.V.P.	- Staff Assistant (Clerical)
Hettiarachchi.S.N.	- Clerk Grade II
Ariyaratne G.	- Store Keeper Grade I
Perera M.A.P.	- Office Machine Operator Grade I

ADMINISTRATION DIVISION

Tilakaratne T.C.P.	- Assistant Librarian
Perera W.D.S.P.	- Laboratery Managers
Ranasinghe C.	- Telephone Operator/ Receptionist Grade I
Chandrakanthi G.W.R.P.	- Senior Staff Assistant (Stenographer)
Hettiarachchi T.P.	- Senior Staff Assistant (Stenographer)
Weerasooriya R.P.M.	- Staff Assistant (Clerical)
Illangakoon C.	- Staff Assistant (Stenographer)
Gunathilake D.G.	- Record Keeper Grade II
Jayasekara D.J.M.W.P.	- Mechanist Special Grade
Hapukotuwa R.B.	- Laboratory Attendant -Higher Grade
Lal M.A.	- Laboratory Attendant -Higher Grade
Kumara A.V.A.P.	- Mechanist Grade I
Dharmasena G.D.	- Electrician Grade II
Dorakumbura D.G.K.	- Mason grade II
Herath Banda H.H.M.	- Painter Grade II

TRANSPORT DIVISION

Rathnayake D.M.	- Transport officer
Ariyawansa K.M.	- Driver-Special Grade
Basnayake G.A.R.	- Driver-Special Grade
Dayasiri M.G.	- Driver-Special Grade
Jayaweera A.B.G.W.	- Driver-Special Grade
Nawarathne Y.G.	- Driver-Special Grade
Somananda M.A.G.	- Driver-Special Grade
Gunasekara .K.G.T.B.	- Driver Grade I
Gunawardena R.S.K.	- Driver Grade I

SCIENCE DESSIMINATION UNIT

Dr. Tilakaratne C.T.K.	- Coordinator
Karunadasa K.K.	- Audio visual Assistant
Samarakoon K.I.K.	- Stenographer Grade II

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