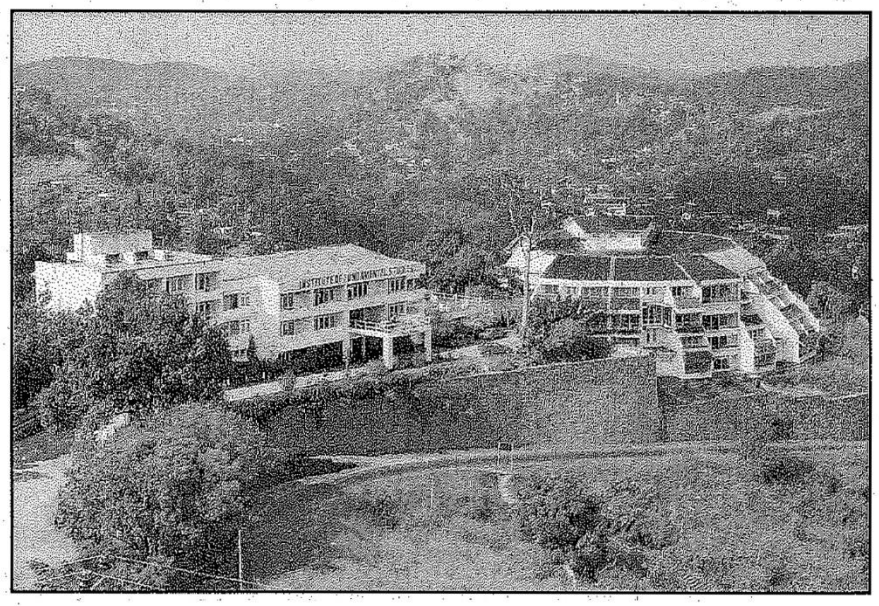
ANNUAL RESEARCH REPORT 2006



INSTITUTE OF FUNDAMENTAL STUDIES
HANTANA ROAD
KANDY

INSTITUTE OF FUNDAMENTAL STUDIES

ANNUAL RESEARCH REPORT 2006

Compiled by
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CONTENTS

PUBLICATIONS IN REFEREED JOURNALS IN 2006

1. Alehandro-Quinones A.A., Bassler K.E., Field M., McCauley J.L., Nicol M., Timofeyev I., Torok A., and **Gunaratne G.H.** A Theory of Fluctuations in Stock Prices, ***Physica A*, 363**: 383-392 (2006)[1,2]

2. **Amarasinghe N.R., Jayasinghe L.,** and Fujimoto Y. Flacourside, a new 4-oxo-2-cyclopentenylmethyl glucoside from the fruit juice of *Flacourtia indica*. ***Food Chemistry,*** 2006 (in press)[1,2].

3. **Balasuriya B.M.G.K.**, Gunawardena G.S.P. de S., Rajapakse R.P.V.J., and **Dharmaratne H.R.W**. Toxicological studies of the water extract of green leafy vegetable Sessile joy weed (*Alternanthera sessilis*). ***Current Science,*** 1517-1520 (2006) [1,2].

4. **Bandara J.** and Pradeep U.W. Variation of flatband potential of oxide nanocrystalline particles with core-shell structured semiconductor-MgO composites. ***Sri Lankan Journal of Physics*, 7:** 1-16 (2006).

5. **Bandara J**. and Weerasinghe H.. Design of high-efficiency solid-state dye-sensitized solar cells using coupled dye mixtures. ***Solar Energy Materials and Solar Cells,* 90:** 864-871 (2006) [1,2].

6. **Bandara J.**, Kuruppu S.S., and Pradeep U.W. The promoting effect of MgO layer in sensitized photodegradation of colorants on TiO_2/MgO composite oxide. ***Colloid and Surface A: Physicochemical Engineering Aspects,* 276**: 197-202 (2006) [1,2].

7. **Bandara W.M.M.S., Seneviratne G.**, and Kulasooriya S.A. Interactions among endophytic bacteria and fungi: effects and potentials. ***Journal of Biosciences,* 31:** 639 (2006) [1,2].

8. Bassler K.E., **Gunaratne G.H.**, and McCauley J.L. Markov Processes, Hurst Exponents, and Nonlinear Diffusion Equations, ***Physica A,* 369**: 343-353 (2006) [1,2].

9. **Dharmaratne H.R.W**. and Marasinghe G.P.K. New methylethers of cordatolides from *Calophyllum cordato-oblongum* and their synthesis. ***Natural Product Research,*** 2006 (in press) [2].

10. **Dharmaratne H.R.W.,** Tennakoon S.B., and Napagoda M.T. Xanthones from root bark of *Calophyllum thwaitesii* and their Bioactivity. ***Natural Product Research,*** 2006 (in press) [2].

11. ***Dias H.V.R.** and Diyabalanage H.V.K. Trimeric silver(I) pyrazolates with isopropyl, bromo and nitro substituents: Synthesis and characterization of $\{[3,5\text{-}(i\text{-}Pr)_2Pz]Ag\}_3$, $\{[3,5\text{-}(i\text{-}Pr)_2,4\text{-}(Br)Pz]Ag\}_3$, and $\{[3,5\text{-}(i\text{-}Pr)_2,4\text{-}(NO_2)Pz]Ag\}_3$, ***Polyhedron,* 25:** 1655-1661 (2006) [1,2].

12. **Ellepola S.W.** and Ma C.Y. Conformational study of globulin from rice (*Oryza sativa*) seeds by Fourier-transform infrared spectroscopy. ***International Journal of Biological Macromolecules***, 2006 (in press)[1,2].

13. ***Ellepola S.K.W.,** Choi S.M., and Phillips D.L. Raman spectroscopic study of rice globulin. ***Journal of Cereal Science*, 43:** 85-93 (2006)[1,2].

14. ***Ellepola** S.W. and Ma C.Y. Thermal properties of globulin from Rice (*Oryza sativa*) seeds. ***Food Research International*, 39:** 257-264 (2006)[1,2]

15. Fernando J.M.R.C. and **Senadeera G.K.R.** Photoresponses of copolymers based on derivatives of thiophene units. ***Ceylon Journal of Science (Physical Sciences)*** 2006 (in press).

16. Hu S., Nathan G., Kouri D.J., Hoffman D.K., and **Gunaratne G.H.** Statistical Characterizations of Spatio-temporal Patterns Generated in the Swift-Hohenberg Model, ***Chaos*, 15**: 043701 (2006)[1,2].

17. **Iqbal M.C.M.**, Weerakoon S.R., and Pieris P.K.D. Variability of fatty acid composition in interspecific hybrids of mustard *Brassica juncea* and *Brassica napus*. ***Ceylon Journal of Science* (Bio. Sci.), 35(1):** 17-23 (2006).

18. **Jayasinghe L.**, Abbas H.K., Melissa R.J., Herath W., and Nanayakkara N.P.D. New N-Methyl-4-hydroxy-2-pyrididone analogs from *Fusarium oxysporum*. ***Journal of Natural Products*, 69**: 439-442 (2006)[1,2].

19. **Jayasinghe L.**, Rupasinghe G.K., Hara N., and Fujimoto Y. Geranylated phenolic constituents from the fruits of *Artocarpus nobilis*. ***Phytochemistry*, 67**:1353-1358 (2006)[1,2].

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21. **Jayasinghe U.L.B.**, Ratnayake R.M.S., Medawala M.M.W.S., and Fujimoto Y. Dihydrochalcones with radical scavenging properties from the leaves of *Syzygium jambos*. ***Natural Product Research*,** 2006 (in press)[2].

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25. Jayasinghearachchi H.S., **Seneviratne G.**, and Weerasinghe H.M.S.P.M. A polyacrylamide gel electrophoretic approach of fingerprinting soil polyphenols. ***International Journal of Soil Sciences,* 1**: 53-57 (2006).

26. *Jayatissa L.P., **Silva E.I.L.**, McElhiney J., and Lawton L.A. Risk of toxigenic cyanobacterial blooms in freshwaters of Sri Lanka. ***Systematic and Applied Microbiology,* 29** : 156-164 (2006) [1,2].

27. ***Kehelpannala K.V.W** and Collins A. The role of Sri Lanka and Associated Continental Blocks in the Assembly and Break-up of Rodinia and Gondwana. Special Issue. ***Journal of Asian Earth Sciences,* 28(1):** 1-115 (2006) [2].

28. **Kehelpannala K.V.W.**, Wada H., **Ranaweera L.**, and Hamana N. Cataclastic rocks from the granulite terrain of Sri Lanka: evidence for younger brittle deformation of the exhumed lower crust. ***Geoscience Reports of Shizuoka University*, 33**: 9-19 (2006).

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32. Nath U.K., **Iqbal M.C.M.,** and Möllers C. Early, non-destructive selection of microspore derived embryo genotypes in oilseed rape (*Brassica napus* L.) by molecular markers and oil quality analysis. ***Molecular Breeding***, 2006 (in press) [1,2].

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35. **Ramanayake S.M.S.D.** Flowering in bamboo: an enigma! ***Ceylon Journal of Science (Bio. Sci.),*** **35:** 95-106 (2006).

36. **Ramanayake S.M.S.D.**, Meemaduma V.N., and Weerawardene T.E.. In vitro shoot proliferation and enhancement of rooting for the large-scale propagation of yellow bamboo (*Bambusa vulgaris* 'Striata'). ***Scientia Horticulturae,*** **110:** 109-113 (2006) [1,2].

37. Ringuedé A., **Wijayasinghe A.**, Albin V., Lagergren C., Cassir M. and Bergman B. Solubility and electrochemical studies of $LiFeO_2$-$LiCoO_2$-NiO materials for the MCFC cathode application. ***Journal of Power Source,*** **160**: 789 (2006) [1,2].

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40. **Senadeera G.K.R.,** Kitamura T., Wada Y., and Yanagida S. Enhanced photoresponses of polypyrrole on surface modified TiO_2 with self-assembled monolayers. ***Journal of Photochemistry and Photobiology A: Chemistry,*** **184:** 234-239 (2006) [1,2].

41. **Senevirathna M.K.I.**, **Pitigala P.K.D.D.P.,** and **Tennakone K.** High quantum efficiency Pt/TiO_2 catalyst for sacrificial water reduction. ***Solar Energy Materials and Solar Cells,*** **90:** 2918-2923 (2006) [1,2].

42. **Senevirathna M.K.I., Pitigala P.K.D.D.P.,** and **Tennakone K.** Stability of the SnO_2/MgO Dye-sensitized Photo-electrochemical Solar Cell. ***Solar Energy Materials and Solar Cells,*** 2006 (in press) [1,2].

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44. **Seneviratne G.**, Kuruppuarachchi K.A.J.M., Somaratne S., and Seneviratne K.A.C.N. Nutrient cycling and safety-net mechanism in the tropical homegardens. ***International Journal of Agricultural Research,*** **1:** 169-182 (2006).

45. ***Seneviratne G.**, Tennakoon N.S., **Weerasekara M.L.M.A.W.**, and Nandasena K.A. Polyethylene biodegradation by a developed *Penicillium-Bacillus* biofilm. ***Current Science,*** **90:** 20-21 (2006) [1,2].

46. **Silva E.I.L.** Hypertrophic-eutrophic alteration in an urban water body, following an outbreak of a *Microcystis* Bloom. ***Sri Lanka Journal of Aquatic Sciences,*** **12**: 2006 (in press).

47. **Sirimanne P.M.** and Tributsch H. Generation of inhomogeneous photocurrent in solid-state TiO_2|dye|CuI cells and effect of ligands attached to the surfactant on the morphology of CuI films. ***Solar Energy,*** 2006 (in press) [1,2].

48. **Sirimanne P.M., Premalal E.V.A., Pitigala P.K.D.D.P.,** and **Tennakone K.** Utilization of MEH-PPV as sensitizer in titana based photovoltaic cells. ***Solar Energy Materials and Solar Cells,*** **90**: 1673-1679 (2006) [1,2].

49. ***Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A., Pitigala P.K.D.D.P, Sivakumar V.** and **Tennakone K.** Utilization of natural pigment extracted from pomegranate fruits as a sensitizer in solid-state solar cells. ***Journal of Photochemistry and Photobiology: A Chemistry,*** **177**: 324 -327 (2006) [1,2].

50. **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A.,** and **Pitigala P.K.D.D.P.** A solid state-cell sensitized with mercurochrome. ***Current Science,*** **(90)5**: 639-640 (2006) [1,2].

51. **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A.,** and **Pitigala P.K.D.D.P**. An enhancement of photoproperties of solid-state TiO_2|dye|CuI cells by coupling of two dyes. ***Semiconductor Science and Technology,*** 21: 818-821 (2006) [1,2].

52. **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A. Pitigala P.K.D.D.P., Tennakone K.,** and **Sivakumar V.** Utilization of cyanidin 3-glucoside as a sensitizer in a solid-state solar cell and enhancement of photo-properties of TiO_2|cyanidin 3-glucoside|CuI cell by coupling mecurocrome with cyanidin 3-glucoside. ***Ceylon Journal of Chemistry,*** 2006 (in press).

53. Song Y. and Gunaratne G.H. A Method for Vibrational Assessment of Solid Bone, ***Chaos,*** 16: 033102 (2006) [1,2]

54. **Tennakone K.** Ball lightning: elusive behaviour depending on proton conductivity ***Current Science,*** **90**: 9 (2006) [1,2].

55. Tennakoon S.B., Wickramasinghe C.S., Ekanayake E.W.M.A., Thevanesam V., and **Dharmaratne H.R.W.** Antibacterial activity studies of *Garcinia mangostana against* Methicillin-Resistant *Staphylococcus aureus* (MRSA). ***Asian Coordinating Group for Chemical Research Communications,*** **20**: 8-10 (2006).

56. *Vithanage M., Chandrajith R., Bandara A., and **Weerasooriya R.** Mechanistic modeling of arsenic retention on natural red earth. ***Journal of Colloid and Interface Science,*** **294**:265-272 (2006) [1,2].

57. *Vithanage M., **Senevirathne W.**, Chandrajith R., Bandara A., and **Weerasooriya R.** Arsenic binding mechanisms on natural red earth; A potential substrate for pollution control. ***Science of the Total Environment,*** 2005 (in press) [1,2].

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60. **Weerasooriya R.**, Senewirathne, Kasthuriaarachi H., and Tobschall H.J. Thermodynamic assessment of Hg(II)-gibbsite interactions. ***Journal of Colloid and Interface Science*** (2006) in press[1,2].

61. ***Wijayasinghe A.**, Bergman B., and Lagergren C. $LiFeO_2$-$LiCoO_2$-NiO materials for Molten Carbonate Fuel Cell cathodes. Part I: Powder synthesis and material characterization. ***Solid State Ionics*, 177**: 165-173 (2006) [1,2].

62. ***Wijayasinghe A.**, Bergman B., and Lagergren C.. $LiFeO_2$-$LiCoO_2$-NiO materials for Molten Carbonate Fuel Cell cathodes. Part II: Fabrication and characterization of porous gas diffusion cathodes. ***Solid State Ionics*, 177**: 175-184 (2006) [1,2].

63. Yuranova T., Mosteo R., **Bandara J.**, Laub D., and Kiwi J. Self-cleaning cotton textiles surfaces modified by photoactive SiO_2/TiO_2 coating. ***Journal of Molecular Catalysis A: Chemical*, 88**: 341-350 (2006) [1,2].

Total number of publications for year 2006- 43
Twenty articles appeared as "in press" in the Annual Research Report 2005

Names of the IFS staff members are in bold letters
* ***Reported as 'in press' in Annual Report 2005***
[1] *Listed in the Science Citation Index in 2006*
[2] *Listed in the Science Citation Index-expanded in 2006*

IMPACT FACTORS OF JOURNALS IN WHICH, THE ARTICLES ARE PUBLISHED

(Impact factors are computed to an accuracy of three decimal places, X-Impact Factor not computed for the year 2005)

JOURNAL	IMPACT FACTOR
A.C.G.C.Research Communications	-
Applied Physics Letters	4.127
Ceylon Journal of Science (Bio. Sci.)	-
Ceylon Journal of Chemistry	-
Ceylon Journal of Science (Physical Sciences)	-
Chaos	1.760
Colloids and Surfaces A	1.449
Current Science	0.728
Food Chemistry	1.811
Food Research International	1.256
Geosciences Reports of Shizuoka University	-
International Journal of Agricultural Research	-
International Journal of Biological Macromolecules	1.684
International Journal of Soil Sciences	-
Journal of Cereal Science	1.946
Journal of Colloid and Interface Science	2.023
Journal of Material Science and Technology	0.175
Journal of Molecular Catalysis A: Chemical	2.348
Journal of Asian Earth Sciences	0.969
Journal of Biosciences	1.031
Journal of Natural Products	2.267
Journal of Photochemistry and Photobiology A: Chemistry	2.286
Journal of Power Source	2.770
Journal of the National Science Foundation	-
Molecular Breeding	1.866
Natural Product Research	0.572
Physica A	1.332
Phytochemistry	2.780
Polyhedron	1.957
Progress in Photovoltaics	3.409
Research Journal of Microbiology	-
Science of the Total Environment	2.224
Scientia Horticulturae	0.583
Semiconductor Science and Technology	1.222
Soil Biology and Biochemistry	2.414
Solar Energy	0.868
Solar Energy Materials and Solar Cells	2.002
Solid State Ionics	1.571
Sri Lanka Journal of Aquatic Sciences	-
Sri Lankan Journal of Physics	-
Systematic and Applied Microbiology	2.293

PROJECT: **APPLIED MATHEMATICS**

COMMENCEMENT: 1999

INVESTIGATORS (2006):

Gunaratne G.H., *Visiting Research Professor* **(Project Leader)**
Tennakone K., *Senior Research Professor*

PROJECT OUTPUT 2006:

An extremely simple system demonstrating oscillatory and chaotic behavior was discovered. The flame of a candle burning inside a chimney of appropriate dimensions was found to undergo oscillatory as well as chaotic changes in the intensity, provided the entry of air below is suppressed. Time series analysis is being conducted confirm periodic doubling and chaotic behavior. Mathematical analysis of this extremely and reproducible system was noted highly complex.

Other research conducted during the year involved a study of random walks, with generalizations motivated by analysis of financial markets. Prices of stocks experience regular movements that depend on future expectations on the underlying commodity as well as random fluctuations. The valuation of options on the stocks depend on these fluctuations. The classical theory describing them (Black-Scholes-Merton theory) assumes that successive movements in the "return" (i.e., a normalized logarithm of the price) x(t) can be represented by a fixed-step random walk. Hence, the distribution of fluctuations for a time interval t is a Gaussian distribution. The options on the stock can be valued from this distribution.

Recent investigations of bond and foreign exchange markets have clearly shown that the distribution of returns, $W(x,t)$, deviates significantly from a normal distribution, especially far from the mean. In fact, to a very good approximation, intra-day fluctuations in currency and bond markets lie on an exponential distribution. It is also known that currency traders do not assign values for options according to the Black-Scholes-Merton theory. In the last few years, there have been several elaborate proposals to explain these discrepancies.

During the last year, we recognized that most novel characteristics of Financial Markets are a result of our observation that the properties of the random behavior depend on the time of day. Specifically, Fluctuations at the beginning of the day are much larger than those at the end of a trading day. Furthermore, the level of fluctuations can be seen to exhibit scaling. We are currently extending the standard random walk theories (including the Fokker-Planck and Langevin formalism) to this case.

PUBLICATIONS IN REFEREED JOUNRALS IN 2006:

1. *Title:* A Theory of Fluctuations in Stock Prices
   Authors: Alehandro-Quinones A.A., Bassler K.E., Field M., McCauley J.L., Nicol M., Timofeyev I., Torok A., and **Gunaratne G.H.**
   Journal: ***Physica A*, 363**: 383-392 (2006)[1,2]

2. *Title:* Statistical Characterizations of Spatio-temporal Patterns Generated in the Swift-Hohenberg Model
   Authors: Hu S., Nathan G., Kouri D.J., Hoffman D.K., and **Gunaratne G.H.**
   Journal: ***Chaos*, 15**: 043701 (2006) [1,2]

3. *Title:* Markov Processes, Hurst Exponents, and Nonlinear Diffusion Equations
   Authors: Bassler K.E., Gunaratne G.H., and McCauley J.L.
   Journal: ***Physica A*, 369**: 343-353 (2006) [1,2]

4. *Title:* A Meth.od for Vibrational Assessment of Solid Bone
   Authors: Song Y. and **Gunaratne G.H.**
   Journal: ***Chaos*, 16**: 033102 (2006) [1,2]

[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

BOOKS AND MONOGRAPHS 2006:

1. *Title:* Empirical Modelling of Economics and Finance Data
   In the book: Dynmamics of Complex Interconnected Systems, Networks and Bioprocesses
   Authors: McCauley J.L., **Gunaratne G.H.**, and Bassler K.E.
   Editors: Skjeltorp A.T.and Belyushkin A.
   Publisher: Springer, NY, 2006.

PROJECT: **COMPUTATIONAL MATHEMATICS AND PHYSICS**

(I) BRAIN COMPUTER INTERFACE

COMMENCEMENT: 2006 (July)

Nanayakkara A., *Associate Research Professor* **(Project Leader)**
Zaraaff Zahmeeth, *Research Assistant*

PROGRESS ACHIEVED (*Since inception*):

Scope of the Project:

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).

Overview:

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 outcome 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.

In the first part of this project, we will develop 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.
The project is carried out in two stages:

- Collect EEG signals from human subjects.
- Process and analyze EEG signals, to identify features, which are corresponding to specific thoughts. Processing and analyzing of data are achieved by using signal processing and other computational methods.

Since we do not have a EEG system, we have been mainly working in the signal processing part of the project. During last six months, we studied existing signal processing methods in this area and their short comings. Also we developed software for analyzing EEG data with Short time Fourier transforms and Linear predicting coding techniques. Currently we are implementing various Wavelet transform techniques to our software. From the internet, large amount of event specific EEG data has been down loaded and used for testing the software which we are developing. Also we used these data sets for testing our new ideas in signal processing. Our aim here is to find new computational methods for identifying features in EEG signals correctly and efficiently and hence developing a working BCI system for Sri Lankan community. Also data collection methods and new signal processing methods which we develop in this BCI project will be publishable.

OTHER CONTRIBUTIONS (2006):

- **Electronic English-Tamil Science glossary (Vinghana Padangal "விஞ்ஞான பதங்கள்)** with an intelligent search engine was developed and published in Compact disk form jointly with Science Dissemination unit/IFS. This contains 45,000 words in the fields of Biology, Chemistry, Computer Science, Physics, and Mathematics.

- **Sinhala Science Web"විදු ම‍ං ගෙත":**
  Tilakaratne C.T.K. and **Nanayakkara A.** Designed/developed a Sinhala Science WEB site (**www.sbwcatkan.org**) which is being developed for sharing latest scientific knowledge in Sinhala (THIS WEB SITE CONTAINS OVER 150 WEB PAGES, AND THIS IS THE FIRST WEB SITE IN SRI LANKA OF THIS NATURE).

  This web includes information on

  1. Latest cure for terminal illnesses which may otherwise not be available to Sinhala speaking readers.

  2. Electronic (on-line) scientific glossaries in English-Sinhala and English-Tamil for the subjects such as Chemistry, Physics, Mathematics, Zoology and Botany.

  3. Information on interesting and timely scientific events and News items (in Sinhala) on recent significant Scientific discoveries and inventions.

PROJECT: **COMPUTATIONAL MATHEMATICS AND PHYSICS**

(II) COMPUTER AIDED DESIGNING OF NEW MATERIALS

COMMENCEMENT: 2004

INVESTIGATORS (2006):

Nanayakkara A., *Associate Research Professor* **(Project Leader)**
Senadeera G.K.R., *Senior Research Fellow*
Seneviratne S.B.M.S., *Research Assistant*
Udathasan T., Research Student *(NSF funded)*

PROGRESS ACHIEVED (*Since inception*):

Scope of the Project:
Aim of this project is to use computer aided techniques to design new materials with desirable electronic and physical properties which can be used for practical applications.

Overview:
As the first step we are concentrating on materials which are useful in solar cell development. We use ab initio and semi-empirical methods for obtaining electronic band structures. In this long term project, we are addressing the problem of calculating electronic structure properties of materials from three different fronts. They are

(1) Calculation of electronic structure properties using molecular based Density Functional theory and other electronic structure methods.

(2) Calculation of electronic structure properties using Crystal molecular orbital based methods.

(3) Development of new theoretical methods to incorporate electronic exchange and correlation effects more accurately in Density Functional Theory.

A new method was developed for predicting band gaps of polymers using HOMO-LUMO gaps of finite size oligomer chains. Various types of conducting polymers were investigated using the above method.

Preliminary calculations based on Molecular Density Functional Theory were carried out for several conducting polymers and calculated both electronic band gaps and band positions of them. The calculated values are in fairly good agreement with the experimental values. We also predicted electronic band gaps and band positions of few new conducting polymers which have not yet been studied experimentally. **The manuscripts based on these results have already been submitted for publication in appropriate journals.**

PROJECT OUTPUT 2006:

In order to test our new theoretical methods, a software package, **MOLDF** is being developed. This package is based on Density Functional Theory and new exchange correlational functionals. We have completed the Major part of the MOLDF code and currently we are introducing efficient and accurate numerical algorithms to the package. When this is completed, we will add new computational techniques to exploit the symmetries which are specific to polymer chains for optimizing the calculations.

We have developed a method to calculate band positions theoretically using nearly free electron model based on electrostatic potentials along the double bond and single bond pairs of polymer chains. These electrostatic potentials are calculated using Density functional based ab initio molecular structure methods. **The manuscripts based on these results will be submitted for publication in the near future.**

PROJECT: **COMPUTATIONAL MATHEMATICS AND PHYSICS**
(III) QUANTUM CHAOS

COMMENCEMENT: 2000

INVESTIGATORS (2006):

Nanayakkara A., *Associate Research Professor* **(Project Leader)**

PROGRESS ACHIEVED (*Since inception*):

Scope of the Project:
This is purely a theoretical project to investigate the peculiar behavior of multi dimensional systems in the semiclassical limit. (i.e. limit between quantum mechanics and classical mechanics)

Overview:
In recent years, the manifestation of chaos in quantum mechanics have been of great interest. In particular, quantum systems which are classically chaotic have been investigated intensively. In order to study signature of chaos in quantum mechanics, we have been developing various theoretical and computational methods for multidimensional systems which bridge classical mechanics with quantum mechanics in a transparent manner. Also we have been investigating quantum mechanical quantities which contain information on chaos in the corresponding classical system. Major achievements of this project since its inception (till end of the year 2005) can be summarized as follows:

(1) A new powerful asymptotic energy expansion method was developed for 1-D systems. This method is based on power series expansion of the quantum action variable J in energy and can be applied to a wide range of potentials. Contour integrals involved in the method are much simpler than that in WKB methods.

(2) A new quantization condition was developed for 1-D systems. This new method is a computational method which can be applied to large number of 1-D systems.

(3) The semi-classical concepts and methods which are normally used for studying semi-classical chaos in real phase-space were extended to complex phase-space for studying both PT-symmetric and pseudo Hermitian systems. It is found that most of the semi-classical methods which have been developed for quantizing multi-dimensional real Hermitian Hamiltonian systems can be successfully employed for complex non-Hermitian PT-symmetric systems with suitable extensions

(4) Several 1-D and 2-D pseudo Hermitian Hamiltonian systems have been studied. The Lyapunov exponents and classical phase space trajectories were used to distinguish regular motion from chaotic ones. The quantum energy

level statistics were used to identify quantum signatures of classically chaotic motion.

(5) A new analytical method was developed for locating zeros of wave functions. In this method locating zeros of the wave function is converted to finding roots of a polynomial whose coefficients are obtained as analytical expressions.

(6) Distribution of zeros of quantum wave functions and second differences of energy at avoided crossings were investigated. We developed new approximation and numerical methods for locating zeros of wave functions. Hermitian systems have been studied to establish a connection between classical chaos and behavior of quantum eigen states at avoided crossings. Applicability of very high order non-degenerate perturbation theory for studying energy levels of multidimensional systems near avoided crossings were also investigated.

(7) Non-PT symmetric systems were studied with non-perturbative action angle theoretical methods. Semiclassical Lie transformation methods were modified for complex non-Hermitian systems. Results were surprisingly good although some systems have no periodic trajectories in the complex phase space and hence action variables cannot be defined in usual sense.

PROJECT OUTPUT 2006:

In 2005, results obtained for non-Hermitian systems with non-perturbative methods and Lie transform methods were surprisingly good. However, the reasons for the success of these methods were not known. Therefore, during the year 2006, deep and very thorough investigation was carried out on classical mechanical behavior of various non-Hermitian systems in the context of Hamilton Jacobi theory and classical action variable theory. These investigations revealed that when one applies above mentioned transforms to non-Hermitian systems, hidden complex time scaling is introduced unintentionally making the non periodic complex trajectories periodic. Several papers on the outcome of this investigation will be published in the near future.

Also in 2006, asymptotic energy expansions of general cubic polynomial complex potentials were derived using new integration techniques. Both complex and real eigen values of the above system are obtained using the asymptotic energy expansion. Quantum eigen energies obtained by the above method are found to be in excellent agreement with the exact eigen values. Using the asymptotic energy expansion, analytic expressions for both level spacing distribution and the density of states are derived for the above cubic system. (a paper based on this work is being revived)

This project has produced 20 research papers and 3 research communications during last six years.

PROJECT: **PARTICLE PHYSICS AND QUANTUM FIELD THEORY (THEORETICAL PHYSICS)**

COMMENCEMENT: 1997

INVESTIGATORS (2006):

Wijewardhana L.C.R., *Visiting Research Professor* **(Project Leader)**

PROJECT OUT 2006:

For the past two years I was unable to visit IFS and conduct research owing to the busy schedule at the University of Cincinnati. During a short visit to IFS in August 2006, a discussion was conducted with Prof. K. Tennakone on the problem of mass in particle physics and extra–dimensions and a popular lecture on the same subject was given IFS and Sri Lanka Association for the Advancement of Science.

PROJECT : CONDENSED MATTER PHYSICS

COMMENCEMENT: 1987

INVESTIGATORS (2006):

Tennakone K. *Senior Research Professor* **(Project Leader)**
Perera V.P.S., *Visiting Scientist*
Wijayantha K.G.U., *Visiting Senior Research Fellow*
Bandaranayake K.M.P., *Research Assistant*
Jayaweera P.V.V., *Research Assistant*
Pitigala P.K.D.D.P ., *Research Assistant*
Seneviratne M.K.I., *Research Assistant*
Premalal E.V.A., *Research Assistant*

PROGRESS ACHIEVED (*Since inception*):

This project was established in mid nineteen eighties to conduct original research in Condensed Matter Physics. The choice of topics depended on resources available, existing fashions and sustainability of theme in the local context. In the first few years, a considerable effort was diverted to high temperature superconductivity, an active area of research pursued in many laboratories at that time. Subsequently, the project shifted more towards semiconductor physics and fundamental research in the area of solar energy conversion. The project continues to conduct investigations on semiconductor films and nanostructures and dye-sensitization covering both experimental and theoretical aspects. Dye-sensitized solid-state solar cells and photoelectrochemical cells based on composite nanocrystalline materials , the use of crystal growth inhibitors to improve nanocrystallinity of the hole collecting materials and studies on recombination in dye-sensitized solar cells are important developments of the project which receive international recognition. The project work has given rise to nearly 175 publications in international journals.The project has gained acclaim as focus activity in this field and some of the papers published are widely cited.

PROJECT OUTPUT 2006:

A series of experiments conducted to assess the stability of the dye-sensitized SnO_2 based cells against dye-degradation was completed and efforts were made to improve the sealing of these cells. The technique developed for deposition of nanoparticles of platinum was utilized to demonstrate high quantum efficiency sacrificial photo-reduction of water. Having heard of carrier generation in semiconductor quantum dots via impact ionization an investigation was carried out determine whether this effect could be utilized to construct photo-electrochemical solar cells where quantum dots are used as the sensitizer. The collaborative work with the Georgia State University on infrared photon detectors was continued and an International Conference organized by the Department of Physics, Georgia State University and IFS was held in Kandy.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1*. *Title*: Dye-senzitized solar cell sensitized with the Shiso leaf pigment
Authors: Kumara G.R.A., Kaneko S., Konno A., Okuya M., and **Tennakone K.**
Journal: ***Solar Energy Materials and Solar Cells*, 90**: 1220-1226 (2006) [1,2]

2*. *Title*: Large area dye-sensitized solar cells: Material Aspects of Fabrication
Authors: Kumara G.R.A., Kaneko S., Konno A., Okuya M., Murakami K., Onwona-agyeman B., and **Tennakone K.**
Journal: ***Progress in Photovoltaics*, 14(7)** : 643-647 (2006) [1,2]

3. • *Title:* Utilization of natural pigment extracted from pomegranate fruits as a sensitizer in solid-state solar cells
Authors: **Sirimanne P.M., Seneviratana M.K.I., Premalal E.V.A., Pitigala P.K.D.D.P., Sivakumar V.**, and **Tennakone K.**
Journal: ***Photochemistry and Photobiology: A Chemistry*, 177**: 324-327 (2006) [1,2]

4. • *Title*: An enhancement of photo-properties of solid-state TiO2/dye/CuI cells by coupling of two dyes
Authors: **Sirimanne P.M., Seneviratne M.K.I., Premalal E.V.A.,** and **Pitigala P.K.D.D.P.**
Journal: ***Semiconductor Science and Technology*, 21**: 818-821 (2006) [1,2]

5. • *Title*: A Solid state-cell sensitized with mercurochrome
Authors: **Sirimanne P.M., Seneviratne M.K.I., Premalal E.V.A.**, and **Pitigala P.K.D.D.P.**
Journal: ***Current Science*, 90(5)**: 639-640 (2006) [1,2]

6. *Title:* High quantum efficiency Pt/TiO_2 catalyst for sacrificial water reduction
Authors: **Senevirathna M.K.I., Pitigala P.K.D.D.P.**, and **Tennakone K.**
Journal: ***Solar Energy Materials and Solar Cells*, 90**: 2918-2923 (2006) [1,2]

7. *Title:* Ball lightning: elusive behaviour depending on proton conductivity
Authors: **Tennakone K.**
Journal: ***Current Science*,90**: 9 (2006) [1,2]

8. *Title:* Stability of the SnO_2/MgO Dye-sensitized Photo-electrochemical Solar Cell
Authors: **Senevirathna M.K.I., Pitigala P.K.D.D.P.**, and **Tennakone K.**
Journal: ***Solar Energy Materials and Solar Cells***, 2006 (in press) [1,2]

- ***These publications are included in the publication list of the project Nano Science (chemistry and physics)***

* ***Reported as "in press" in Annual Report 2005***
[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Tennakone K.**
   Photon detection using dye-sensitized semiconductor eterostructures (Abstract)
   Proceedings, QWIP 2006, International Workshop on Quantum Well Infrared Photodetectors, June 18-24, 2006, Kandy, Sri Lanka

2. **Jayaweera P.V.V.**, Matsik S.G.,.**Tennakone K** and **Perera A.G.U.**
   High Operating Tempreature Split-off Band IR Detectors (Abstract)
   Proceedings, QWIP 2006, International Workshop on Quantum Well Infrared Photodetectors, June 18-24, 2006, Kandy, Sri Lanka

3. **Jayaweera P.V.V., Pitigala P.K.D.D.P., Senevirathna M.K.I., Perera A.G.U.** and **Tennakone K.**
   1/f Noise in Dye-sensitized Solar Cells and NIR Photon Detectors (Absract)
   Proceedings, QWIP 2006, International Workshop on Quantum Well Infrared Photodetectors, June 18-24, 2006, Kandy, Sri Lanka

4. **Perera V.P.S.** and Liyanage L.S.G
   Deposition of Pt. and Au quantum dots on TiO_2 nanoparticles: A study of ballistic electron transport with dye-sensitization
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 108, 2006

5. **Senevirathne M.K.I.**, Liyanage L.S.G., and **Perera V.P.S.**
   The effect of $Cu_{2-x}O$ quantum size particles on TiO_2 films of dye-sensitized solar cells
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 109, 2006

BOOKS AND MONOGRAPHS 2006:

1. *Title:* Dye-sensitized Semiconductor Nanostructures
   In the book: Handbook of Semiconductor Nanostructures and Nanodevices
   Author: **Tennakone K.**
   Editors: Balandin A.A. and Wang K.L.
   Publisher: American Scientific Publishers, California 2006 pp. 437-454.

INVITED LECTURES/CONFERENCES ATTENDED IN 2006:

1. **Tennakone K.**
   Proton conductivity in condensed phases of water: Implications on Linear and Ball Lightning (Invited Lecture)
   Proc. 10th Asian Conference on Solid State Ionics, 12-16 June 2006, Postgraduate Institute of Science, Peradeniya

2. **Tennakone K.**
   Pigment based nanocrystalline solar cells: Their limitations and possibilities of improvement (Invited Lecture).
   Proc. 10th Asian Conference on Solid State Ionics, 12-16 June 2006, Postgraduate Institute of Science, Peradeniya

   Proc. Asian Conference on Solar Cells and Solar Energy Materials, 12-14, June 2006, Postgraduate Institute of Science, Peradeniya

OTHER CONTRIBUTIONS IN 2006:

1. Nanoscience and Nanotechnology: Emerging Frontier and the Next Revolution, The Island 9th and 16th May 2006

2. Why we should pursue fundamental studies, Daily News, 11 th November 2006.

PROJECT: **PHOTOCHEMISTRY**

COMMENCEMENT: 1999

INVESTIGATORS:

Bandara J., *Senior Research Fellow* **(Project Leader)**
Yasomanee S., *Research Assistant*
Senevirathne S.., *Research Assistant (NSF funded)*
Wansapura T.P., *Volunteer Student*

PROGRESS ACHIEVED (*Since inception*):

The project successfully demonstrated the use of n-p junction electrode for the control of charge recombination in dye-sensitized solar cells and shown how the insulating barrier layer could increase the photocatalytic activity by coating thin insulating layers on photocatalysts. The mechanistic aspects of these processes were established.

Number of Publications during 1999 - 2006 in refereed international journals: 27
Total number of citations for the above articles: 228

PROJECT OUTPUT 2006:

Solid-state dye-sensitized solar cells with p-type oxide semiconductors as hole conductors were successfully fabricated and the advantages/disadvantages of p-type oxide as hole conductors were investigated. The investigations on photocatalytic conversion of solar energy into chemical energy (i.e.water splitting and photodegradation of pollutants) are being continued.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title:* Self-cleaning cotton textiles surfaces modified by photoactive SiO_2/TiO_2 coating
   Authors: Yuranova T., Mosteo R., **Bandara J.**, Laub D., and Kiwi J.
   Journal: ***Journal of Molecular Catalysis A: Chemical***, **88:** 341-350 (2006)[1,2]
   (This article has been among the top25 hottest artciles of the journal in 2006.)

2. *Title:* The promoting effect of MgO layer in sensitized photodegradation of colorants on TiO_2/MgO composite oxide
   Authors: **Bandara J.**, Kuruppu S.S., and Pradeep U.W.
   Journal: ***Colloid and Surface A: Physicochemical Engineering Aspects***, **276**: 197-202 (2006)[1,2]

3. *Title:* Design of high-efficiency solid-state dye-sensitized solar cells using coupled dye mixtures
   Authors: **Bandara J.** and Weerasinghe H.
   Journal: ***Solar Energy Materials and Solar Cells*, 90**: 864-871 (2006) [1,2]
   (This article has been among the top25 hottest artciles of the journal in 2005.)

4. *Title:* Variation of flatband potential of oxide nanocrystalline particles with core-shell structured semiconductor-MgO composites
   Authors: **Bandara J.** and Pradeep U.W.
   Journal: ***Sri Lankan Journal of Physics*, 7:** 1-16 (2006)

[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Yasomanee J.P.** and **Bandara J.**
   Use of p-type $CuAlO_2$ and NiO hole collectors in dye-sensitized solid state solar cells
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 131, 2006

2. Wansapura P.T. and **Bandara J.**
   Electrodegradation of textile colorants using Indium Tin Oxide coated conducting glass electrodes
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 130, 2006

3. **Yasomanee J.P.** and **Bandara J.**
   p-type NiO and $CuAlO_2$ hole collectors for dye-sensitized solid-state solar cells.
   Asian conference on solar energy materials and solar cells, June 14-16, 2006, 34 (2006).

PROJECT : **SOLID STATE CHEMISTRY**
(Chemistry, preparation and characterization of semiconducting materials, conducting organic solids and polymers)

COMMENCEMENT : 1999

INVESTIGATORS (2006):

Senadeera G.K.R., *Senior Research Fellow* **(Project Leader)**
De Silva N., *Research Assistant*
Fernando J.M.R.C., *Research Assistant* (*NSF funded*)

PROGRESS ACHIEVED (*Since inception*):

The continuing world- wide search for new and useful materials, which have the potential for new devices and applications, has ensured that the solid -state as one of the major growth areas of Chemistry and Physics. Generally the solid -state chemistry is concerned with the synthesis, structure, properties and applications of solid materials. The Solid State Chemistry Project at IFS, which was initiated in 1999 deals with the investigations on the determination of fundamental physico -chemical aspects that are centered to electrically conducting polymers and conventional semiconductors, which have been the object of increasing academic and technological interest during the last 10-15 years. The chemical aspects of the project specifically targeted at novel ways of synthesising, new organic, inorganic, layered or porous semiconducing solids, and hybrid organic –inorganic compounds which were synthesized either in the bulk or as thin films or nano particles. The structural and the surface properties will be addressed both from *in situ and ex situ* experimental methods in the physical aspects of the project. A particular emphasis is paid on electrical (metallic or semiconductors, ionic and mixed conductors) features associated with the microstructures of these solids. The Standard characterization methods such as (CV) cyclic voltametry, SEM, TEM, XPS, FTIR, AC impedance and photocurrent techniques are being used to characterize the materials involved in these investigations.

Some of the major achievements are:

(a) 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)*** **.**

(b) Pentacene as promising materials suitable for positive charge collection in solid-state dye sensitized photo cells.

(c) Discovery of a new method for deposition of CuSCN on dye coated TiO_2 films and a simple model system, where the broadening of the spectral response, enhanced charge separation and the consequent increase in the energy and incident photon to current efficiencies in photoelectrochemical cells by ionic linkage of some complexes of dyes.

(d) Construction of a fully automated spray pyrolysis unit (equipment) to prepare homogenous nanocrystalline ox ide semiconducting thin films.

(e) 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).***

(f) For the first time in the field of polymer sensitized solid s tate solar cells, novel, volatile solvent free, solar cells were fabricated with mesoporous TiO_2 electrodes sensitized using thiophene derivatives containing carboxyl groups and in situ electropolymerized poly(3,4 -ethylenedioxythiophene) as a holetransporting material together with the onic liquid 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)amide and lithium bis(trifluoromethanesulfone)imide as additives for charge tran sport promotion.***(Chem.Com. Royal Society of Chemistry UK, 2005,17,2259).***

(g) Apart from that we were successful in obtaining a research grant from National Science Foundation, Sri Lanka and also a Fellowship/Grant from the government of Japan, during 2002/20 03 period to carry out a collaborative research work with a research group headed by Prof. Shozo Yanagida in Osaka University of Japan.

Total No. of articles published (since inception, 1999-)

(a) In refereed journals cited in Science Citation Index + expanded = 21

(b) In other refereed journals = 4

(c) Abstracts and conference proceedings: 21

(d) ***Conference proceedings full papers: 9***

(e) ***Patents : (1) Sri Lankan Patent No. 11982,***

(2) International Patent No. **NKS 2624-2003-36805**

(f) ***Presidential Awards for Research Publications in Science Citation Index- 1999, 2000, 2001 and 2002***

PROJECT OUTPUT 2006:

(a) Conjugated conducting polymers, a new class of semiconducting materials, have attracted considerable interest nowadays, for use as active component (sensitizer) in solar cells due to their high absorption coefficients in the visible part of the spectrum and the high mobilities of charge carriers. The ideal sensitizer for a single junction photocell should be firmly grafted to the semiconductor oxide surface and inject el ectrons to the conduction band of the semiconductor. Therefore, to use these polymeric materials effectively as sensitizers in these devices, rigid bondings, such as carboxylic moieties in ruthenium based dyes with inorganic semiconductors are required. Ho wever, due to the difficulties encountered in the synthesis of these materials with

suitable carboxylic moieties, it is generally accepted that self-assembled monolayers are highly promising to construct such a molecular architecture on metals and semiconducting surfaces. This approach has several advantages such as; it permits the fabrication of highly ordered, appropriatively oriented 2D and 3D structures at a fraction of the cost over traditional band-gap engineering like molecular beam epitaxy. In this context, recently we have succeeded in fabrication of organic solvent free polymer (polyaniline) /TiO_2 heterojunction with enhanced photovoltaic properties by covalently grafting polymer via sialane-bearing aniline compound. However, there the polymer was connected to the semiconductor surface via nitrogen molecules with no or poor conjugated chain (single and double bonding). Apart from polyaniline, another conducting polymer polypyrrole (PPY), with band-gap of approximately 2–2.5 eV in its neutral state appears to be better photo-conducting candidate possessing strong intrinsic absorption in the visible range. Further, PPY could be connected to the metal oxide surfaces via meta position of the monomer and connecting the rest of the polymer chain with good π- conjugation. Therefore, we have attempted to explore the possibilities of fabricating PPY/TiO_2 heterojunction using less expensive self-assembled monolayers of 3-(trimethoxysilyl) propyl methacrylate and obtained enhanced photo responses in polymer sensitized solar devices. *[J. Photochem. Photobiol. A: Chemistry 184 (2006) 234–239].*

Further, in order to introduce suitable conducting polymers for solar devices with aforementioned properties, several 3-substituted thiophene and pyrole bearing polymers were synthesized and investigated their photoresponses by fabricating solar devices with mesoporous TiO_2 electrodes. Monomers of 3-thiophene acetic acid (3TAA), 3-thiophene malonic acid (3TMA), thiophene (T), 3-acetyl thiophene (3AT) and pyrrole (PY) were used as starting materials to obtain their co-polymers. Moreover, Polypyrrole-3,4-dicarboxylic acid (PP34DCA),poly (N-pyrrolecarboxylic acid) (PPNCA), poly (3-thiophenecarboxylic acid) (P3TCA) were also synthesized, characterized and tested their suitability and the photresonses by fabricating polymer solar devices.

(b) Improving the efficiency of photovoltaic cells composed of TiO_2/ MEH-PPV polymer with organo-chalcogen donor molecules BEDT-TTF

Investigations were carried out to asses the feasibility of organo-chalcogen donor molecules, BEDT-TTF *(bisethylenedithio-tetrathiafulvalene (ET)-building block of organic super conductors)* as a dopant material in the enhancement of the photo responses of the solar devices comprising with conducting polymer, poly[2-methoxy-5-(28-ethyl-hexyoxy)-1,4-phenylene vinylene] (MEH-PPV). In this context, several polymer–ET blends were prepared and tested their suitability in photocells. Blending MEH-PPV with ET up to 3% resulted in a significant increase in short circuit current density and power conversion efficiency of the solar devices.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title*: Polymer Sensitized Quasi Solid-State Photovoltaic Cells Using Derivatives of Polythiophene
   Authors: **Senadeera G.K.R.** and Fernando J.M.R.C.
   Journal: ***Journal of Material Science and Technology,* 22 (6):** 811 (2006)[1,2]

2. *Title:* Enhanced photoresponses of polypyrrole on surface modified TiO_2 with self-assembled monolayers
   Authors: **Senadeera G.K.R.**, Kitamura T., Wada Y., Yanagida S.
   Journal: ***Journal of Photochemistry and Photobiology A: Chemistry,* 184:** 234–239 (2006) [1,2]

3. *Title:* Efficient quasi –solid dye sensitized solar cells employing molten salt electrolyte
   Authors: **Senadeera G.K.R.** and **de Silva N.**
   Journal: ***Sri Lankan Journal of Physics,* 7:** 2006 (in press)

4. *Title:* Photorsponses of copolymers based on derivatives of thiophene units
   Authors: Fernando J.M.R.C. and **Senadeera G.K.R.**
   Journal: ***Ceylon Journal of Science (Physical Sciences),*** 2006 (in press)

[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/ CONFERENCE PROCEEDINGS IN 2006:

1. Fernando J.M.R.C. and **Senadeera G.K.R.**
   Photo-responses of copolymers based on derivatives of thiophene units
   Proceedings of the Asian Conference on Solar Energy Materials and Solar Cells, p19, 2006.

2. Fernando J.M.R.C. and **Senadeera G.K. R.**
   Polymer sensitized quasi solid-state photovoltaic cells
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 89-90, 2006

3. Fernando J.M.R.C., Rajapakse R.M.G., and **Senadeera G.K.R.**
   Synthesis and Characteriztion of region-regular conducting polymers and their application in low cost solar devices.
   10th Anniversary celebrations of the Post Graduate Institute of Science,Peradeniya – Poster Session - Abstracts, p 13, 2006.

4. **de Silva N** and **Senadeera G.K.R.**

Effect of organo-chalcogen donor molecule: BEDT-TTF, on the efficiency enhancement of the polymer sensitized solar cells
Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 89, 2006

PROJECT: **SEMICONDUCTOR OPTOELECTRONICS**

COMMENCEMENT:

INVESTIGATORS (2006):

Perera A.G.U., *Visiting Research Professor* **(Project Leader)**
Tennakone K., *Senior Research Professor*
Jayaweera P.V.V., *Research Assistant*

PROJECT OUTPUT 2006:

The International Workshop on Quantum Well Infrared Photodetectors (QWIP2006) was held in Kandy from 18th to 23rd June 2006 with 63 participantsfrom 16 countries. Workshop was supported by Georgia State University, Institute of Fundamental Studies, National Science Foundation Sri Lanka,United States Army, United States Air Force, NASA Jet Propulsion Laboratory, U.S. National Science Foundation, and EPRI Technologies USA.Six papers originating from GSU-IFS collaboration presented at the workshop are in press (Infrared Physics and Technology).

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title:* High Operating temperature split-off band infrared detectors
   Authors: **Perera A.G.U.**, Matsik S.G., **Jayaweera P.V.V.**, **Tennakone K.**, Von Winckel G., Stintz A., Liu H.C., Buchanan M., and Krishna S.
   Journal: ***Applied Physics Letters*** , **89:** 131118 (2006)[1,2]

Listed in the Science Citation Index in 2006
Listed in the Science Citation Index-expanded in 2006

PROJECT : **NANO-SCIENCE (CHEMISTRY AND PHYSICS)**

COMMENCEMENT : 2006

INVESTIGATORS :

Sirimanne P.M., *Senior Research Fellow* **(Project Leader)**

PROGRESS ACHIEVED (*Since inception*):

This project was initiated in year 2005. Properties of nano-structured oxide films and their applications in dye-sensitized solid-state and photo-electrochemical cells were studied. The work conducted has raised 08 publications in referred journals (07 in international journals and 01 in local journal) and 03 proceedings local and international symposiums.

The project leader won a JSPS post-doctoral fellowship from Japanese Government for a period of two years.

PROJECT OUTPUT 2006:

A natural pigment (Cyanadin 3-glucoside) is extracted from pomegranate fruits. Cyanadin 3-glucoside, organic polymer [2-methoxy-5-(2-ethyl-hexyloxy)-p-phenylene vinylene], (MEH-PPV) and metal free organic dye mercurochrome are used as sensitizers in dye sensitized solid-state cells. Coupling of cyanadin 3-glucoside with mercurochrome is found to increase the performance of TiO_2|dye|p-semiconductor solid state cells compare to that of cells sensitized individually by cyanadin 3-glucoside or mercurochrome. A metal centered dye cis-dithiocyanate-bis (2-2′ bipyridyl-4-4′-dicarboxylate) ruthenium (II) exhibited the highest performance in this type of dye sensitized solid-state cells. Photo-properties of TiO_2|mercurochrome|cyanadin 3-glucoside|CuI system are found comparable with the cells sensitized with cis-dithiocyanate-bis (2-2′ bipyridyl-4-4′-dicarboxylate) ruthenium (II).

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1.* • *Title:* Utilization of natural pigment extracted from pomegranate fruits as sensitizer in solid-state Solar Cells

Authors: **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A., Pitigala P.K.D.D.P., Sivakumar V.,** and **Tennakone K.**

Journal: ***Journal of Photochemistry and Photobiology,A:Chemistry,*** **177:** 324-327 (2006) [1,2]

2. • *Title:* Utilization of MEH-PPV as sensitizer in titana based photovoltaic cells
Authors: **Sirimanne P.M., Premalal E.V.A., Pitigala P.K.D.D.P.,** and **Tennakone K.**
Journal: ***Solar Energy Materials and Solar Cells,* 90:** 1673-1679 (2006) [1,2]

3. • *Title:* A solid state-cell sensitized with mercurochrome
Authors: **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A.,** and **Pitigala P.K.D.D.P.**
Journal: ***Current Science,* 90(5):** 639-640 (2006) [1,2]

4. • *Title:* An enhancement of photoproperties of solid-state TiO_2|dye|CuI cells by coupling of two dyes
Authors: **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A.** and **Pitigala P.K.D.D.P.**
Journal: ***Semiconductor Science and Technology,* 21**: 818-821 (2006) [1,2]

5. *Title:* Generation of inhomogeneous photocurrent in solid-state TiO_2|dye|CuI cells and effect of ligands attached to the surfactant on the morphology of CuI films
Authors: **Sirimanne P.M.** and **Tributsch H.**
Journal: ***Solar Energy,*** 2006 (in press) [1,2]

6. *Title:* Utilization of cyanidin 3-glucoside as a sensitizer in a solid-state solar cell and enhancement of photo-properties of TiO_2|cyanidin 3-glucoside|CuI cell by coupling mecurocrome with cyanidin 3-glucoside
Authors: **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A. Pitigala P.K.D.D.P., Tennakone K.,** and **Sivakumar V.**
Journal: ***Ceylon Journal of Chemistry,*** (in press)

• ***These publications are included in the publication list of the project Condensed Matter Physics***

* ***Reported as "in press" in Annual Report 2005***
[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Yoshida T., Iwai H., Sirimanne P.M., Mizuta K., and Minoura H.**

Electrodeposition of zinc oxide thin films modified with rare-earth metal complexes for luminescence devices

Electrochemical society of Japan, Kyoto, Japan, pg 22, 14th-15th Sep. 2006

2. **Sirimanne P.M., Senevirathna M.K.I., Premalal E.V.A., Pitigala P.K.D.D.P., Sivakumar V.**, and **Tennakone K.**

Utilization of flavylium as a sensitizer in a solid-state solar cell and enhancement of photo-properties of TiO_2|flavylium|CuI cell by coupling mecurocrome with flavylium

Asian conference on solar energy materials and solar cells, Kandy, Sri Lanka, June, 2006

3. **Sivakumar V., Senevirathna M.K.I., Premalal E.V.A., Pitigala P.K.D.D.P., Sirimanne P.M.**, and **Tennakone K.**

Hybrid density functional theory for the prediction of vibrational properties of cyanidin used as sensitizer in solid state solar cells
Asian conference on solar energy materials and solar cells, Kandy, Sri Lanka, June, 2006

PROJECT: **ELECTROCHEMICAL MATERIALS**

(Materials Science, synthesis and characterisation of inorganic materials, materials for electrochemical energy conversion, batteries and fuel cells)

COMMENCEMENT: 2005

INVESTIGATORS (2006):

Wijayasinghe H.W.M.A.C., *Research Fellow* **(Project Leader)**
Samarasinghe P.B., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)*:

Synthesis and characterization of materials for the electrochemical energy conversion applications, such as batteries and fuel cells, are being mainly carried out under this project. At present, this project engages with the materials research and development work under five sub-projects involving three types of fuel cells and two types of batteries.

Novel chemical synthesis techniques are employed to synthesize new materials, and shape forming techniques, such as tape-casting and pressing, are used to fabricate cell components out of the synthesized materials. Calcination and sintering studies are performed in order to find the optimum conditions for calcination and sintering of the new materials. XRD, SEM, EDX, FTIR, DSC, BET, Porosimetry, Pycnometry and Particle size analysis techniques are used for material characterization. Moreover, electrochemical characterizations of the synthesized materials are performed employing a.c. impedance spectroscopy, d.c. 4-probe, Seebeck and polarization techniques. Finally, in-cell testing of the fabricated cell components is performed, assembling them in standard laboratory cells and performing Voc, charge-discharge and cyclic-life measurements.

Some of the achievements;

(a) The cathode development and cell study performed on NiO-$LiCoO_2$-$LiFeO_2$ materials for Molten Carbonate Fuel Cell (MCFC) showed in significant improvements of electrical conductivity, electrochemical performance and stability of the materials. This study resulted in novel materials fulfilling the requirements to be used in the cathode of commercial MCFC and the cell development with these materials is now under way.

(b) The electrode development work with Li-transition metal based oxides for the rechargeable Li-ion batteries (LIB) using novel low-cost synthesis techniques, resulted in a very promising $Li(Co_{1-2x}Ni_x\ Mn_x)O_2$ series of materials. Electrochemical study with the $Li(Co_{1/3}Ni_{1/3}\ Mn_{1/3})O_2$ material showed an excellent improvement of cell performance and the cell development with these materials are now under way.

(c) Work on super-ionic conductors as electrolyte materials for low-cost Silver-ion Batteries (AIB) resulted in very promising CuI-doped Silver Borate-Vanadate Glassy System with high Silver-ionic conductivity. Cell performance of these materials is now being investigated.
(d) Synthesis of novel solid electrolyte materials based on Sr and Mg doped lanthanum galates for the Intermediate Temperature Solid Oxide Fuel Cell (ITSOFC) revealed the promising characteristics of the investigated system of La-Sr-Ga-Mg-Ni oxides.
(e) A novel idea of devising a '' Biological Fuel Cell'' has been initiated. The preliminary work of assembling this Microbial Fuel Cell (MBFC) using the microbes developed at the Biological Nitrogen Fixation (B.N.F.) project of IFS, are now under way.
(f) Under the material characterization and cell component fabrication work, a new high temperature 4-probe specimen holder and hand tape-caster has been designed and fabricated at IFS.

Total number of articles published (since inception, April 2005);
(a) In refereed journals cited in Science Citation Index = 3
(b) Conference proceedings (full papers) = 2
(c) Conference proceedings (abstracts) = 2

'ROJECT OUTPUT 2006:

'ainly *electronic conductors* and *ionic conductors* are being investigated under this oject for the application in electrochemical energy conversion in fuel cells and tteries. At the moment, this project involves with materials research on three types fuel cells and two types of batteries.

der the fuel cell research,

1. Development and cell testing of electrodes for the Molten Carbonate Fuel Cell (MCFC) based on NiO-$LiCoO_2$-$LiFeO_2$ materials are being carried out by performing collaborative research work with the Department of Materials Science and Engineering, and Department of Chemical Engineering and Technology of Royal Institute of Technology (KTH), Stockholm, Sweden.

2. Development of electrolytes for the Intermediate Temperature Solid Oxide Fuel Cell (ITSOFC) based on La-Sr-Ga-Mg-Ni oxides are being carried out by performing collaborative research work with the Department of Materials Science and Engineering of Royal Institute of Technology (KTH), Stockholm, Sweden.

3. Cell development of Microbial Fuel Cell (MBFC) has been started using the microbes developed at the Biological Nitrogen Fixation (B.N.F.) project of IFS.

Altogether, these three sub-projects on fuel cells have so far resulted in six manuscripts submitted to refereed journals (three published so far) and three conference proceedings.

Under the battery research,

1. Development and cell testing of electrodes for the re-chargeable Lithium-ion batteries (LIB) are being carried out by performing collaborative research work with the Department of Chemical Engineering and Technology of Royal Institute of Technology (KTH), Stockholm, Sweden and Solid State Ionics Research Group of University of Peradeniya.

2. Development of super-ionic electrolytes for the Silver-ion Batteries (AIB) is being carried out by performing collaborative research work with the Department of Materials Science and Engineering of Royal Institute of Technology (KTH), Stockholm.

Altogether, these two sub-projects on batteries have so far resulted in three manuscripts submitted to refereed journals and one conference proceeding.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1*. *Title:* $LiFeO_2$-$LiCoO_2$-NiO materials for Molten Carbonate Fuel Cell cathodes. Part I: Powder synthesis and material characterization
Authors: **Wijayasinghe A.**, Bergman B., and Lagergren C.
Journal: ***Solid State Ionics,*** **177:** 165-173 (2006)[1,2]

2*. *Title:* $LiFeO_2$-$LiCoO_2$-NiO materials for Molten Carbonate Fuel Cell cathodes. Part II: Fabrication and characterization of porous gas diffusion cathodes
Authors: **Wijayasinghe A.**, Bergman B., and Lagergren C.
Journal: ***Solid State Ionics,*** **177:** 175-184 (2006) [1,2]

3. *Title:* Solubility and electrochemical studies of $LiFeO_2$-$LiCoO_2$-NiO materials for the MCFC cathode application
Authors: Armelle Ringuedé, **Athula Wijayasinghe**, Valérie Albin, Carina Lagergren, Michel Cassir and Bill Bergman
Journal: ***Journal of Power Source,*** **160:** 785-789 (2006) [1,2]

* ***Reported as "in press" in Annual Report 2005***
[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACT/CONFERENCE PROCEEDINGS IN 2006:

1. **Wijayasinghe A.** and Bergman B.
Synthesis and Electrical Characterization of $LiFeO_2$, $LiCoO_2$ and NiO Compositions (***full length paper)***
Proceedings of 10th Asian Conference on Solid State Ionics, 2006, 345-352

2. **Samarasinghe P.** and **Wijayasinghe A.**
Synthesis and Electrical Characterization of $Li(Co_{1/3}Ni_{1/3}\ Mn_{1/3})$ (Abstract)
Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 104-105, 2006

3. **Wijayasinghe A.**
Synthesis and Electrical Characterization of $LiFeO_2$, $LiCoO_2$ and NiO Binary Compositions (Abstract)
Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 105, 2006

INVITED LECTURES/CONFERENCES ATTENDED IN 2006:

1. **Wijayasinghe A.** and Bergman B.
Synthesis and Electrical Characterization of $LiFeO_2$, $LiCoO_2$ and NiO Compositions, Oral Presentation, 10th Asian Conference on Solid State Ionics, Peradeniya, Sri Lanka, 12 – 16th June 2006.

PROJECT: **METAL COORDINATION CHEMISTRY**

COMMENCEMENT: 1999

INVESTIGATORS (2006):

Dias H.V.R., *Visiting Research Professor* **(Project Leader)**

PROJECT OUTPUT 2006:

Metal complexes are widely used in a variety of applications ranging from catalysis, materials chemistry to medicine. Properties of metal complexes are directly related to the nature of ligands around the metal site. Ligands enable us to fine tune the chemical reactivity and physical properties of metal complexes. Thus the development of new ligands with useful steric/electronic properties is of particular interest. Current efforts are focused on the design, synthesis and applications of nitrogen and oxygen based ligands such as tris(pyrazolyl)borates, pyrazolates, and triazapentadienyl systems. We are using these new ligands to prepare metal catalysts for small molecule activation, isolate reaction intermediates, develop transition metal containing drugs, and to control photochemical processes of metal coordination compounds.

We have investigated the coordination chemistry, catalytic properties and antimicrobial properties of metal adducts obtained using fluorinated tris(pyrazolyl)borate and triazapentadienyl ligands. For example, silver complexes of fluorinated tris(pyrazolyl)borate ligands were used as catalysts in the rearrangement reactions and in C-H activation processes. They also show excellent antimicrobial properties. Copper complexes based on non-fluorinated tris(pyrazolyl)borates were used as oxidative polymerization catalysts. For example, they allow the synthesis of conducting polyaniline ("organic-metal") via a greener route. We have also prepared polypyrrole and various composites based on these conducting polymeric materials. A convenient route to highly fluorinated triazapentadienyl ligands has been developed. These ligands enabled the isolation of thermally stable, copper-carbonyl and copper-ethylene complexes. We have also explored the photo-physical properties of copper, silver, and gold pyrazolyl adducts. They show bright luminescence under a variety of conditions.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1*. *Title:* Trimeric silver(I) pyrazolates with isopropyl, bromo and nitro substituents: Synthesis and characterization of {[3,5-(*i*-$Pr)_2Pz]Ag\}_3$, {[3,5-(*i*-$Pr)_2$,4-(Br)Pz]Ag$\}_3$, and {[3,5-(*i*-$Pr)_2$,4-$(NO_2)Pz]Ag\}_3$

Authors: **Dias H.V.R.** and Diyabalanage H.V.K.

Journal: ***Polyhedron*, 25:** 1655-1661 (2006)[1,2]

* *Reported as "in press" in Annual Report 2005*
[1] *Listed in the Science Citation Index in 2006*
[2] *Listed in the Science Citation Index-expanded in 2006*

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. Gamage C.S.P., and **Dias H.V.R.**
   Structural diversity of Ag_3N_6 metallacycles: Effect of pyrazole ring substituents on the silver pyrazolates chemistry", 62nd Southwest Regional Meeting of the American Chemical Society, Houston, Texas, October 2006

2. **Dias H.V.R.**
   Coinage Metal Complexes of Highly Fluorinated Scorpionates", Invited talk at the 2006 Inorganic Gordon Research Conference, Salve Regina University, Newport, Rhode Island, July 2006

3. Eldabaja M.G., Elbjeirami O., **Dias H.V.R.**, Omary M.A., Manal A., and Rawashdeh-Omary
   Brightly Phosphorescent Trinuclear Coinage Metal Complexes of Pyrazolates and Binary Adducts Thereof with Organic Aromatic Compounds", ACS Meeting-in-Miniature of the DFW Section, Denton, TX, April 2006

4. Flores J.A, Shreeyukta Singh, and **Dias H.V.R.**
   Fluorinated triazapentadienyl ligands in the synthesis of carbonyl and ethylene complexes of Copper(I)", ACS Meeting-in-Miniature of the DFW Section, Denton, TX, April 2006

5. Fianchini M., Gamini Rajapakse R.M., and **Dias H.V.R.**
   Conductive polypyrrole from water: another step towards mass production, ACS Meeting-in-Miniature of the DFW Section, Denton, TX, April 2006

6. Hudson J. M., Chammi S. Palehepitiya Gamage, **Dias H.V.R.**, and Omary M. A.
   Phosphorescent Copper Chandeliers: A New Class of Luminescent Macromolecular Materials with a "Metallocalixarene" Structure", ACS Meeting-in-Miniature of the DFW Section, Denton, TX, April 2006

7. Chammi S. Palehapitiya Gamage and **Dias H.V.R.**
   Synthesis and structural properties of supramolecular stacking complexes of trimeric coinage metal pyrazolates and organic π systems", ACS Meeting-in-Miniature of the DFW Section, Denton, TX, April 2006

8. Fajdetica I., Fianchinib M., Kappella A.D., and **Dias H.V.R.** Lorraine G. van Waasbergen, "Sting of the Scorpionates: Antimicrobial Properties of Fluorinated Silver(I) Tris(pyrazolyl)borates", UTA Research day, October 2006

PROJECT: **NATURAL PRODUCTS CHEMISTRY I**

Chemistry, biological activity and structure-activity relationship studies of natural products and plant extracts of Sri Lankan flora

COMMENCEMENT: 1994

INVESTIGATORS (2006):

Dharmaratne H.R.W., *Associate Research Professor* **(Project Leader)**
Piyasena K.G.N.P., *Research Assistant*
Premaratne S.R., *Research Assistant*
Haroon M.H. *Lecturer, South Eastern University*
Jayaweera D.S., *Staff Technical Officer*

PROGRESS ACHIEVED *(Since inception)*

Scope of the Project:

The scope of the above project is the search of new biologically active compounds from seaweeds and terrestrial plants of Sri Lanka to be used as new pharmaceuticals and pesticides.

Anti HIV, antibacterial [anti methicillin-resistant *Staphylococcus aureus* (MRSA) and anti vancomycin-resistant *Entrococci* (VRE)], anti fungal and antioxidant natural products have been isolated from Sri Lankan plants and their chemical structures were elucidated using spectroscopic methods and partial synthesis. Further, their structure activity relationship studies were investigated. Other than the biologically active compounds, a number of new natural products have been isolated and their structures were elucidated.

Above research findings and other collaborative research work paved the way to twenty-five international publications, forty one research communications, five national awards including the prestigious Institute of Chemistry Gold Medal (2004) and following postgraduate degrees.

Piyasena K.G.N.P. - Chemistry and Bioactivity Studies of *Garcinia Mangostana.*
M. Phil, University of Peradeniya (2005).

Napagoda M. T. - Chemistry and Bioactivity Studies of some Sri Lankan flora and isolation of bioactive xanthones from *Calophyllum thwaitesii*
M. Phil, University of Peradeniya (2005).

Marasinghe G.P.K. - Chemistry and antiviral/anti-HIV activity of family Clusiaceae.
M. Phil, University of Peradeniya (2000).

Wijesinghe W.M.N. - Chemistry and antimicrobail activity of *Calophyllum moonii* M. Phil, University of Colombo (1999).

Wanigasekera W.M.A.P. - Chemistry and search for antiviral/anti-HIV activity of some Sri Lankan *Calophyllum* species. M. Phil, University of Peradeniya (1996).

As recognizance of our work, following awards have been received by members of our research group.

1. **Kandiah Memorial Award** (III) 2005, for the best piece of post graduate research carried out by a postgraduate student in Sri Lanka. **Napagoda M. T.**

2. The presentation titled "*Xanthones from roots of Calophyllum thwaitesi and their biological activities*" was awarded as **the best scientific paper in Medicine** at the Proceedings of University of Ruhuna Annual sessions(2005).

3. Visiting Scholar, Institute for Molecular Bio-organic Chemistry, George-August University, Gottingen, Germany (2006, July – August) - **Dharmaratne H.R.W.**

4. Institute of Chemistry **Gold Medal 2004**, for outstanding contribution in the use of Chemical Sciences for the development or innovation in industry or for national development in Sri Lanka. **Dharmaratne H.R.W.**

5. Visiting Scholar, National Canter for Natural Products Research University of Mississippi, University, MS, USA 2000/2001 - **Dharmaratne H.R.W.**

6. **Kandiah Memorial Award** (II) 1999, for the best piece of research carried out by a postgraduate student in Sri Lanka. **Wijesinghe W.M.N.M**

7. **Kandiah Memorial Award** (II) 1997, for the best piece of research carried out by a postgraduate student in Sri Lanka. **Wanigasekera W.M.A.P.**

8. **TWAS/NARESA award** 1996, for the best young scientist of the year (Chemistry Award). **Wanigasekera W.M.A.P.**

PROJECT OUTPUT 2006:

Methanol extract of the common seaweed *Ulva lactuca* was subjected to antibacterial, antifungal, antioxidant and cytototoxicity assays. Column chromatography of the above extract followed by PTLC gave seven metabolites including (Z)-stigmasta-5,24(28)-dien-3-ol, Oleic acid, a triglyceride with two linoleic acid molecules and one stearic acid molecule and a new diterpenoid.

The scope of the project below is discovering weedicides from indigenous plants, for weed control in Sri Lanka.

Lettuce seed germination bioassay is widely used in the detection of allelochemicals, throughout the world and seaweed extracts were tested for seed germination inhibitory activity. In the present study, the normal lettuce seed germination assay was slightly modified to suit our needs. Out of 16 extracts tested, *Ulva fasciata, Caulerpa racemosa, Caulerpa sertularioides, Amphiroa anceps, Garcilaria hikkaduwensis, Jania* spp. and *Cladophora* spp have shown statistically significant seed germination inhibitory activities, probably due to the Allelochemicals present in seaweeds. Interestingly in the case of the methanol extract of *Caulerpa racemosa*, percentage seed germination enhancement and increased root length compared to the control (distilled water) was observed. Further studies are in progress with the hope of isolating natural products that are responsible for the above allelopathic effect of the seaweed extracts.

A new project on Chemistry and biological activity studies of endophytic fungal strains isolated from seaweeds and terrestrial plants is in progress. Adenine, Uridine, phenylaceticacid and an unidentified compound was isolated from an endophytic strain isolated from *Sargassum nightii.*

Fellowships and Awards:

1. Visiting Scholar, Institute for Molecular Bio-organic Chemistry, George-August University, Gottingen, Germany (2006, July – August) - **Dharmaratne H.R.W.**

2. **Kandiah Memorial Award (III) 2005,** for the best piece of post graduate research carried out by a postgraduate student in Sri Lanka. Napagoda M. T.

3. The presentation titled "*Xanthones from roots of Calophyllum thwaitesi and their biological activities*" was awarded as **the best scientific paper in Medicine** at the Proceedings of University of Ruhuna Annual sessions(2005).

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title:* Xanthones from root bark of *Calophyllum thwaitesii* and their Bioactivity
   Authors: **Dharmaratne H.R.W.**, Tennakoon S.B. and Napagoda M.T.
   Journal: ***Natural Products Research,*** 2006 (in press)[2]

2. *Title:* New methylethers of cordatolides from *Calophyllum cordato-oblongum* and their synthesis
   Authors: **Dharmaratne H.R.W.** and Marasinghe G.P.K.
   Journal: ***Natural Product Research,*** 2006 (in press)[2]

3. *Title:* Antibacterial activity studies of *Garcinia mangostana against* Methicillin- Resistant *Staphylococcus aureus* (MRSA)
   Authors: Tennakoon S.B., Wickramasinghe C.S., Ekanayake E.W.M.A., Thevanesam V.and **Dharmaratne H.R.W.**
   Journal: ***Asian Coordinating Group for Chemical Research Communications,*** **20:** 8-10 (2006)

[2] ***Listed in the Science Citation Index-expanded in 2006***

PATENTS

Mangostin against antibiotic-resistant bacteria. Sakagami, Yoshikazu; Iinuma, Munekazu; Piyasena, K. G. N. P; Dharmaratne, H. R. W. (E.A.G K. K., Japan). Jpn. Kokai Tokkyo Koho (2005), 12 pp. CODEN: JKXXAF JP 2005075791 A2 20050324 . Application: JP 2003-309613 20030902.

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1 Haroon M.H., **Premaratne S.R.**, Napagoda M.T., and **Dharmaratne H.R.W.** Chemistry and biological activity studies of green algae *Ulva lactuca* *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 117, 2006*

2 **Dharmaratne H.R.W., Piyasena K.G.N.P.**, and Tennakoon S.B. A. new cycloartane derivative from *Garcinia mangostana* *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 118, 2006*

3 **Premaratne S.R.**, Haroon M.H., and **Dharmaratne H.R.W**. Allelopathic activity studies of Sri Lankan seaweed extracts *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 66, 2006*

4 Napagoda M.T., Tennakoon S.B., Thevanasem V., **Dharmaratne H.R.W.** Xanthones from roots of *Calophyllum thwaitesi* and their biological activities *Proceedings of the 3rd Annual sessions, University of Ruhuna, 2005.*

INVITED LECTURES/CONFERENCES ATTENDED IN 2006:

1. Chemistry and Bioactivity studies of Medicinal plants of Sri Lanka Institute for Molecular Bio-organic Chemistry, George-August University, Gottingen, Germany (21-07-2006)

2. Search for Bioactive molecules from Sri Lankan Flora Department of Chemistry, Paderborn University, Paderborn, Germany (24-08-2006)

3. Persisting Organic Pollutants- Dioxins and Furans In service Training Center, Department of Agriculture, Gannoruwa.

4. Persisting Organic Pollutants- Dioxins and Furans General Hospital, Nuwara Eliya (26-05-2006)

PROJECT: **NATURAL PRODUCT CHEMISTRY II**

Search for bioactive compounds from Sri Lankan plants as potential resources for treatment and control of diseases

COMMENCEMENT : 1992

INVESTIGATORS (2006):

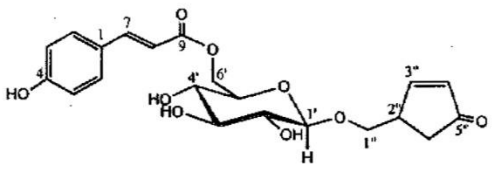
Jayasinghe U.L.B., *Associate Research Professor* **(Project Leader)**
Amarasinghe N.R., *Research Assistant*
Gunawardena D.C., *Research Assistant*
Ariyarathna R.A.Y.K., *Research Assistant*

PROGRESS ACHIEVED (*Since inception*):

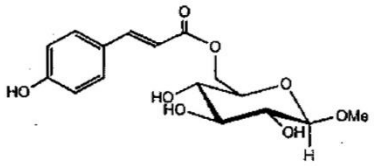
During the past thirteen years we have been doing research on various parts of following plants: *Pometia eximia* and *Filicium decipiens* (Sapindaceae), *Sarcococca brevifolia* (Buxaceae), *Uncaria elliptica* (Rubiaceae), *Terminalia catappa* (Combretaceae), *Diploclisia glaucescens* (Menispermaceae), *Bridelia retusa* and *Ageratum conyzoides*(Euphorbiaceae). This work led to the isolation and structure elucidation of hederagenin saponins, quinovic acid saponins, phytolaccagenic acid saponins, serjanic acid saponins, oleanolic acid saponins, norneohopane ester of caffeic acids, flavonoid glycosides, flavone C-glycosides, steroidal alkaloids, indole alkaloids, ecdysteroids, bisabolane sesquiterpenes and phenolic compounds etc. Some of these isolates showed strong antibacterial, antifungal, molluscicidal and insecticidal activity. In addition, we have identified a number of antifungal, antibacterial, nematicidal and antifeedant active extracts from some Sri Lankan plants. All these results led to 35 publications, 50 communications, 03 book chapters and and 02 M. Phil. Degrees.

PROJECT OUTPUT 2006:

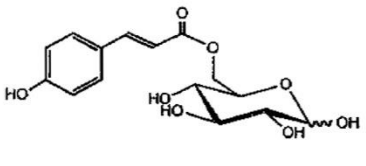
Flacourtia indica (*sinh.* uguressa) of the family Flacourtiaceae is a moderate size tree growing in Sri Lanka. Its fruits are edible and very popular in Sri Lanka. No chemical work has been reported on the fruits of this plant. Chemical investigation of the *n*-butanol extract of the fruit juice of *Flacourtia indica* furnished a new glucoside ester named Flacouriside, 4-oxo-2-cyclopentenylmethyl 6-*O*-(*E*)-*p*-coumaroyl-*β*-*D*-glucopyranoside (**1**) together with a rare natural product methyl 6-*O*-(*E*)-*p*-coumaroyl glucopyranoside (**2**) and 6-*O*-(*E*)-*p*-coumaroyl glucopyranose(**3**). This the first natural product which contains 4-oxo-2-cyclopentene-methanol unit. All these compounds showed strong radical scavenging properties towards the DPPH radical by spectrophotometry method.



1

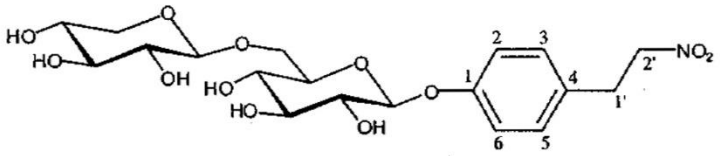


2

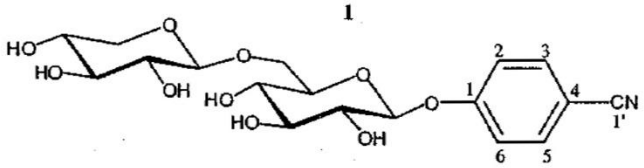


3

Chemical investigation of the highly polar compounds fraction of the methanol extract of the fruits of *Diploclisia glaucescens* furnished two new phenyl glycosides, 4-(2-nitro ethyl)phenyl β–D-xylopyranosyl-(1→6)-β-D-glucopyranoside (**1**) and 4-cyanophenyl β-D-xylopyranosyl-(1→6)-β-D-glucopyranoside (**2**) from the methanol extract of the fruits of *D. glaucescens* .



1



2

Further we have identified some plant extracts with phytotoxic, antioxidant and antifungal properties. Chemical and bioassay investigations on those extracts are in progress.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1* *Title:* (2-Nitro Ethyl) Phenyl and cyanophenyl glycosides from the fruits of *Diploclisia glaucescens*
Authors: **Jayasinghe U.L.B.**, Hara N. and Fujimoto Y.
Journal: ***Natural Product Research***, 2005 (*in press*)[2]

2. *Title:* New N-Methyl-4-hydroxy-2-pyrididone analogs from *Fusarium oxysporum*
Authors: **Jayasinghe L**, Abbas H.K., Melissa R.J., Herath W. and Nanayakkara N.P.D.
Journal: ***Journal of Natural Products***, **69**: 439-442 (2006)[1,2]

3. *Title:* Geranylated phenolic constituents from the fruits of *Artocarpus nobilis*
Authors: **Jayasinghe L.**, Rupasinghe G.K., Hara N., and Fujimoto Y.
Journal: ***Phytochemistry***, **67**: 1353-1358 (2006)[1,2]

4. *Title:* Flacourside, a new 4-oxo-2-cyclopentenylmethyl glucoside from the fruit juice of *Flacourti indica*
   Authors: **Amarasinghe N.R., Jayasinghe L.** and Fujimoto Y.
   Journal: ***Food Chemistry***, 2006 (*in press*) [1,2]

5. *Title:* Dihydrochalcones with radical scavenging properties from the leaves of *Syzygium jambos*
   Authors: **Jayasinghe U.L.B.**, Ratnayake R.M.S., Medawala M.M.W.S., Fujimoto Y.
   Journal: ***Natural Product Research,*** 2006 (*in press*)[2]

* ***Reported as "in press" in Annual Report 2005***
[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Jayasinghe, U.L.B.**
   New phenyl glycosides from the fruits of *Diploclisia glaucescens* *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 115-116, 2006*

2. Arundathie B.G.S., Rupasinghe G.K., Jayathilake M.H.A.N. and **Jayasinghe U.L.B**
   Flavonol glycosides from *Elaeocarpus serratus* and *Filicium decipiens* *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 198-199, 2006*

3. Ratnayake R.M.S., Medawala M.M.W.S. and **Jayasinghe U.L.B.**
   Antioxidant dihydrochalcones from the leaves of *Syzygium jambos* *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 197-198, 2006*

4. **Amarasinghe N.R.** and **Jayasinghe U.L.B.**
   A new 4-oxo-2-cyclopentenyl methyl glucoside from *Flacourtia indica* *Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 116, 2006*

5. **Amarasinghe N.R.** and **Jayasinghe U.L.B**.
   Chemistry and bioactivity of *Artocarpus altilis* and *Flacourtia indica* *Annual sessions, Postgraduate Institute of Science, Peradeniya,* April, 2006.

AWARDS:

1. **Jayasinghe U.L.B.**
   Visiting Scientist, University of Milan, Italy, 1st Oct. -30th Nov. 2006.

PROJECT: **BIOCHEMISTRY**

COMMENCEMENT: 1997

INVESTIGATORS (2006):

Dharmaratne H.R.W., *Associate Research Professor* **(Project Leader)**
Balasuriya B.M.G.K., *Research Assistant*
Fernando W.I.T., *Research Assistant*
Priyanwada N., *Research Assistant*
Perera S.M., *Technical Officer*

PROGRESS ACHIEVED *(Since inception)*:

Enzymic and structural characterization of nepenthesin, a unique member of a novel subfamily of aspartic proteinases from the juice of *Nepenthes distillatoria* pitcher was completed.

The scope of this project is discovering plant based crude drugs for farm animals of Sri Lanka. Efficacy and toxicological studies of herbal remedies in veterinary practice in Sri Lanka were investigated using *in-vitro* and *in-vivo* bioassays. Crude extracts of *Areca catechu* (areca-nut) unripe fruit kernel and *Adhatoda vasica* (Pavatta) leaves were found to be highly active against gastrointestinal nematodiasis in goats. Our toxicological studies and field trials (short term and long term) showed above extract can be used to control gastrointestinal nematodiasis in goats in Sri Lankan farms.

Toxiccological and pharmacological activity studies of vegetable greens consumed in Sri Lanka were investigated, and the water extract of *Alternanthera sessilis* (Mukunuwenna, Ponnakani), showed a significant cytotoxicity. Therefore, further studies were conducted on histopathological, haematological and serum biochemical changes after oral administration of *Alternanthera sessilis* water extracts in Wistar rats. Our results concluded that oral administration of water extract of *A. sessilis* in different doses lead to hepato and renal toxicities which are dose and duration of exposure dependent. Therefore, it can be stated that frequent consumption of larger quantities of *A. sessilis* could leads to hepatic and renal toxicities, especially for patients with chronic hepatic and renal diseases. However, further investigations are necessary in order to understand the long-term effects of the consumption of cooked *A. sessilis* in lesser quantities.
Our findings paved the way to three publications, thirteen research communications, an M.Phil. degree and two awards.

Postgraduate Degrees:

Rajapakse R.G.S.C. Purification and characterization of Acid Proteinases from *Nepenthes distillatoria* L., M. Phil., University of Peradeniya (2002).

Awards:
The abstract titled "*A*nthelmintic efficacy of long term treatment with plant extracts in naturally infected goats" was awarded **the best presentation** at the 57th annual scientific session of the Sri Lanka Veterinary Association (2005)

The abstract titled "*In vitro* anthelmintic activity of some indigenous plant extracts against caprine gastrointestinal parasites" was awarded as a **Commendable presentation** at the Proceedings of University of Peradeniya (2003).

PROJECT OUTPUT 2006:

Toxicity of vegetable greens: *Alternanthera sessilis* is a popular green vegetable consumed in Southeast Asia. Following preliminary toxicological studies, histopathological, heamatological and serum biochemical changes after oral administration of *A. sessilis* water extracts in Wistar were investigated. Significant elevations ($p< 0.05$) in the levels of AST and ALT were found in the treatment of animals after 21 days. Significant changes were also observed in the AST, ALT, ALP, urea, creatinine, magnesium and albumin levels in all treatment groups, after 42 days of feeding. Histopathological changes characterised by congestion and mild degenerative lesions were observed after 21 days in the liver and kidneys of the rats that received the higher doses. The histological lesions indicative of mild to moderate hepatocyte degeneration and/or necrosis and mild degenerative changes in the kidney tubules were found in the rats of all treatment groups after 42 days of feeding, while both control groups were devoid of significant histopathological changes. On the other hand, there were no significant changes in heamatological parameters, viz., total RBC and WBC counts, PCV and hemoglobin concentration. Our present findings indicated that, the oral administration of fresh *A. sessilis* extract leads to hepatic and renal toxicities in male Wistar rats. Hence, it can be concluded that *A. sessilis* in high doses leads to hepato and renal toxicities.

A new research project on Experimental evaluation of essential fatty acid rich plants to increase the conjugated fatty acid content in animal products was initiated.

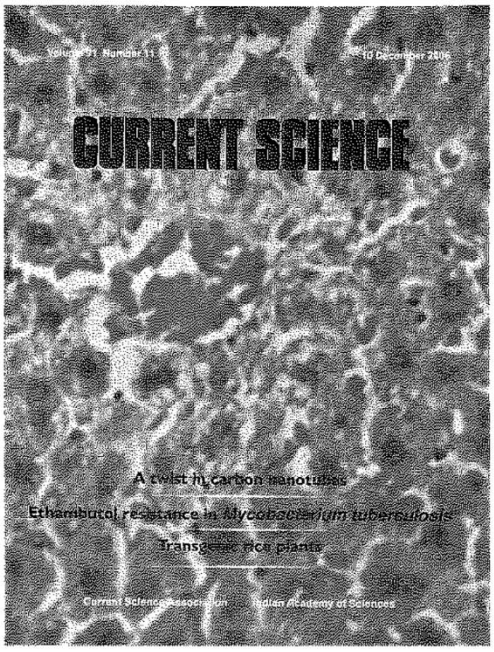
The scope of this new project is the search for nutritive and economical alternatives from plants as farm animal feed.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title:* Toxicological studies of the water extract of green leafy vegetable Sessile joy weed (*Alternanthera sessilis*)
   Authors: **Balasuriya B.M.G.K.**, Gunawardena G.S.P. de S., Rajapakse R.P.V.J. and **Dharmaratne H.R.W.**
   Journal: ***Current Science***, 1517-1520 (2006)[1,2]

[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

A figure from above publication ~~was~~ appeared in the cover page of the *Current Science* 2006, **91, 10 December issue (see below).**



ABSTRACTS /CONFERENCE PROCEEDINGS IN 2006:

1. Fernando W.I.T., Rajapakse R.P.V.J., **Dharmaratne H.R.W.**
   In vivo effects of *Areca catechu* and *Adathoda vasica* extracts on goats infected with gastrointestinal nematodes.
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 9-10, 2006

2. **Balasuriya B.M.G.K.**, Gunawardena G.S.P. de S., **Dharmaratne H.R.W.**
   Histopathological, haematological and serum biochemical changes in Wistar rats after oral administration of *Alternanthera sessilis* water extracts.
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 10, 2006

3. **Balasuriya B.M.G.K.** and **Dharmaratne H.R.W.**
   Screening vegetable greens for antioxidant activity: a comparative study on three cooking methods.
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 199, 2006

PROJECT: **PLANT BIOTECHNOLOGY**

COMMENCEMENT: 1988

INVESTIGATORS (2006):

Ramanayake S.M.S.D., *Senior Research Fellow,* **(Project Leader)**
Kovoor A., *Honorary Research Professor*
Vitarana M., *Research Assistant*
Maddegoda M., *Research Assistant*
Chaturani G.D.G., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)*:

Problems associated with the recalcitrance to in vitro responses in selected woody perennials were investigated.

Bamboo: These belong to the family of grasses but unlike other grasses are woody, and different from other woody trees. Unlike other flowering plants their flowering and seeding rhythm are unpredictable and some flower after long intervals of many years. With all these unorthodox characteristics they are valuable. The objective of this project is to use tissue culture techniques to investigate the unique behavior in bamboos, develop protocols for propagule production and taxonomically identify different Sri Lankan species.

Different plant parts from field grown clumps of the two species, *Dendrocalamus giganteus* and *Bambusa vulgaris* were used to study their responses to in vitro manipulations. The phenology and development of selected clumps of these species were studied to correlate the in vitro responses of plant parts of mother clumps with developmental stages and phenology.

Plantlets were produced from seedling explants that responded to axillary shoot proliferation in the species *D. giganteus* (M. C. Rajapakse, M.Phil. thesis) and in *D. asper*.

The axillary shoot proliferation for plantlet production with the use of explants from 6-year old and a 70-year old field grown clumps was achieved. In vitro flowering was also induced in these axillary shoots. The factors that may have contributed to in vitro flowering were studied. Callus, which exhibited an embryogenic potential, was also induced from explants of the adult clump. It was possible to regenerate a few plantlets. Although seedlings are reported to respond to such behaviour in vitro, this is the first time an adult bamboo of over 70-years behaved in this manner.

The problems that have led to recalcitrance in rhizogenesis in *D.giganteus* were identified and overcome by the use of certain treatments.

Axillary shoots of *Bambusa atra , B. vulgaris and D. hookeri* were proliferated continuously. Rooting of the axillary shoots yielded plantlets that were acclimatized

to field conditions. This could be used for large-scale plantlet production in this species.

It is now possible to apply these findings in the commercial applications for propagule production in these species. We have given away over 1000 plantlets of all species, which were produced during experiments. The field performance of these show that they grow faster than plants raised by classical methods due to early rhizome development.

In vitro shoot cultures were established this year in *D. giganteus* and a variegated mutant of this species raised by tissue culture, *D. hookeri, B. atra, B. vulgaris* and *Gigantocloa atroviolacea.* These are presently used to study the exogenous and endogenous auxin patterns in the rooting zone, related to various chemical and physical treatments. Studies on induction of in vitro flowering in these species have commenced. Shoot cultures of *D. hookeri* have started to flower. This was used for taxonomic studies in the species.

Cutures were also established from seeds of giant bamboo collected from three clumps that flowered in Kandy, Pilimatatawa and Daulagala. Studies in callus induction and somatic embryogenesios have commenced.

A green house was constructed with funds received from the National Agribusiness Council estimated for Rs.490,000/-. This is an essential requirement for studies related to plants which was lacking in the IFS.

Genetic distances computed and dendrograms denveloped using the RAPD markers that were generated.from 130 individuals of *D. giganteus* and 25 related species of bamboo. The data have been analyzed and will be used in identification and characterization and determine their phylogeny. Most of these Sri Lankan species have not been taxonomically defined.

Interestingly, *Melocanna baccifera*, a species of bamboo introduced from India, in the Botanic gardens, Peradeniya flowered in synchrony with the impended flowering of this species in Mizoram India. The event was used to study the flowering behaviour and taxonomy of this species.

The species *Mormodica dioica* (thumbakarawila) was used in studying callogenesis and regeneration of shoots and rooting. This is a perennial climber that responded well to plant regeneration from callus unlike bamboo and therefore possibly be utilized in studies in bamboo.

Commercial application of the findings related to bamboo: I was released to the Riverine Bamboo Project, under the Mahaweli Authority, to micropropagate giant bamboo and other related species of bamboo using the findings generated by the Plant Biotechnology Project, for one year commencing February 2004. Due to financial constraints and other bureaucratic problems it was not possible to successfully carry out the intended work. However I was able to design and develop the tissue culture laboratory in a building allocated to the Project in Mawatura, Kotmale. Although the other essential chemicals and minor equipment were identified, they could not be purchased due to lack of funds. I also maintained some shoots of giant bamboo under

in vitro conditions at the IFS laboratory, in order to use them for propagation once the lab was developed. These were used to train a technician in the project in tissue culture techniques. I gave my resignation in November 2004, as the Mahaweli Authority was unable to sustain the Project further. At the same period a private tissue culture laboratory, Ceylinco Biotech Pvt Ltd., was able to apply the findings developed by us, to produce over 100,000 bamboo plants, *D. hookeri and B. vulgaris*, when Ms. Vindya Meemaduma, who was a research Assistant at the IFS joined this laboratory at the end of her contract at the IFS. Therefore there is practical evidence that IFS findings are commercially feasible.

Rattan: In vitro requirements for a high germination percentage of excised embryos of four species of rattan, *Calamus zeylanicus*, *C. ovoideus*, *C. rotang* and *C. thwaitesii* were determined. It was also possible to induce multiple shoots in all four species. *C. zeylanicus* and *C. thwaitesii* showed rapid and continuous shoot proliferation while it was slow in the other two species. The origin of these shoots was studied. Root induction in the proliferated shoots of *C. thwaitesii* was possible and plants have been established in the nursery. The rooting response of *C. zeylanicus* was slow and sufficient plant were not available to carry out rooting experiments in these species due to accidental contamination of cultures. Excised embryos of *Calamus thwaitesii* and *C. rotang* were cultured to study their responses under limited growth conditions either in encapsulated form or as naked embryos.

The study on bamboo and rattan received funding from NORAD for the period October 1993 – May 1994 (Rs. 160, 000/-) and from May 1994 – October 1997 (Rs 1,406,650/-). These funds were utilized to purchase chemicals and for purchase of equipment and improving the laboratories.

In vitro micrografting and compatibility studies: This study was suspended in 1994 and revived in 1997. Culture conditions for the establishment of in vitro cultures required for grafting were determined for selected species, *Anacardium occidentale, A.microcarpum, Garcinia mangostana, Pentadesma butyracea, Durio zebethius* and *Adansonia digitata*. A technique of in vitro micrografting cashew was determined. It was also possible to achieve multiple shoot proliferation and rooting of cashew and establishment of plantlets in the nursery. After revival of this study in 1997 seeds of *Loranthus* were cultured in vitro for inducing germination but complete plant development did not take place. Mangosteen seeds were induced to produce multiple shoots. Seeds of *Feronia, Citrus, Adansonia digitata* and *Camellia sinensis* were germinated in vitro. Various plant parts of these in vitro plantlets as well as from field grown plants *of Pentadesma* and *Loranthus* were cultured to induce callus that will be used to study the compatibility between selected scion and root stock species.

PROJECT OUTPUT 2006:

Somatic embryogenesis in *D. giganteus* has been possible. A few plants that were regenerated were soil established. Histological studies are ongoing on development of somatic embryos are ongoing.

Morphological, anatomical and physiological changes that take place during acclimatization of in vitro raised *D.giganteus* and *D. hookeri* were investigated.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title:* In vitro shoot proliferation and enhancement of rooting for the large-scale propagation of yellow bamboo (*Bambusa vulgaris* 'Striata')
   Authors: **Ramanayake S.M.S.D.**, Meemaduma V.N. and Weerawardene T. E.
   Journal: ***Scientia Horticulturae*, 110:** 109-113 (2006)[1,2]

2. *Title:* Flowering in bamboo: an enigma!
   Author: **Ramanayake S.M.S.D.**
   Journal: ***Ceylon Journal of Science(Bio. Sci.),* 35:** 95-106 (2006)

[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Maddegoda K.M.M.N**.and **Ramanayake S.M.S.D.**
   Callus induction and plant regeneration in *Dendrocalamus giganteus* (giant bamboo). Abstract.
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 18, 2006

2. **Ramanayake S.M.S.D.**, Witharana M.C. and. **Maddegoda K.M.M.N.**
   In vitro rooting of axillary shoots of three bamboos, *Dendrocalamus giganteus, D. hookeri* and *Bambusa atra* for clonal propagation.
   abstracts of Presentations at the International Conference on Humid Tropical Ecosystems, Changes, Challenges and Opportunities. 4th – 9th December 2006, Kandy, Sri Lanka.

BOOKS AND MONOGRAPHS 2006:

1. *Title:* Micropropagation of Tropical Bamboos
   In the book: *Floriculture, Ornamental and Plant Biotechnology: advances and topical issues* (1st Edition) Pp 540 – 550 (2006)
   Author: **Ramanayake S.M.S.D.**
   Editors: Jaime A. Teixiera da Silva
   Publisher: Global Science Books, London, UK

PROJECT: PLANT REPRODUCTIVE BIOLOGY

COMMENCEMENT: 1997

INVESTIGATORS (2006):

Iqbal M.C.M., *Senior Research Fellow* **(Project Leader)**
Late Kovoor A., *Honorary Research Professor*
Weerasinghe H.A.S., *Research Assistant*
Wijesekera K.B., *Research Assistant*
Wijesekara T.P., *Research Assistant*
Kulasekara L., *Research Assistant (NSF scholar)*
Medagoda N., *Technical Assistant (NSF project)*

PROGRESS ACHIEVED (*Since inception*):

Androgenesis: In *Datura metel,* androgenesis was increased by applying a temperature shock in the form of a heat gradient. A combination of warm and cool temperatures in quick succession, for a total duration of 1 min, significantly enhanced androgenesis.

Pollen development: In *Gordonia* species, we observed the differentiation of parenchyma cells in the connective tissue of anthers into sterile pseudopollen. They are large pollen like cells with a distinct surface architecture and migrated into the pollen sacs. Their role in reproductive biology remains speculative. They have been reported in some members of the Theaceae family.

Primary and secondary embryogenesis: The basic embryo body organization was studied using abnormal haploid embryos of *D. metel,* which manifested deletion patterns, and were characterized histologically. The absence of meristems were associated with secondary embryogenesis. This was confirmed by excising meristems from normal embryos.

Secondary metabolism: Glucosinolates, a secondary metabolite accumulated in the seeds of Brassica species, was shown to be transported against a concentration gradient into the embryos as an active process (with Dr. C. Möllers, University of Göttingen).

Lipid emulsions were formulated from the oil of *Adenanthera pavonina,* which indicate a potential use in pharmaceutical and medical fields as carriers for active ingredients of drugs and cosmetics (with Dr. Zarnowski, Poland).

Antifungal activity was observed in vitro in common weed species. A bioactive compound against plant pathogenic fungi was isolated from the weed *Ageratum conyzoides*. The compound was identified as precocene II inhibiting the growth of some fungi at 80 – 100 ppm.

Aquatic plants: *Cryptocoryne wendtii* is a popular plant in the aquatic export industry. Indiscriminate harvesting from the wild has accorded it a "Threatened Status" in the IUCN 2000 Red list. We developed a protocol for *in vitro* propagation for this species.

PROJECT OUTPUT 2006:

1. Interspecific hybridization of Brassica species.
(with, Dr. Shyama Weerakoon, Open University, Sri Lanka)

   The objective is to transfer the canola quality fatty acids from *Brassica napus* to mustard *B. juncea*, the latter having a high content of the undesirable eruc ic acid. The hybrid interspecific embryos are rescued and cultured *in vitro* to recover fertile plants. Experimental techniques for gas chromatographic analysis of fatty acids were developed. The seeds from the hybrid plants showed a reduction in erucic acid and an increase in linolenic and linoleic acids, towards canola quality.

2. *In vitro* shoot regeneration from indigenous rice *Oryza sativa*.

   The indica sub-species of *O. sativa* is recalcitrant to *in vitro* culture which is a prerequisite for biotechnological applications such as transformation. Callus induction and shoot regeneration was achi eved in the variety BG 94-1 by changes in amino-acid composition of nutrient media. Experiments are continuing to extend this to other genotypes and determine their reproducibility.

3. Serpentine ecology: Serpentine soils originate from serpentinite and ultra-mafic rocks and have a high concentration of heavy metals. Thus a unique flora capable of tolerating toxic concentrations o f metals develop on these soils. The soil characteristics showed a high variability in the Ca/Mg ratio.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1. *Title:* Variability of fatty acid composition in interspecific hybrids of mustard *Brassica juncea* and *Brassica napus*
   Authors: **Iqbal M.C.M.**, Weerakoon S.R., and Pieris P.K.D.
   Journal: ***Ceylon Journal of Science (Bio. Sci.),* 35 (1):**17-23 (2006)

2. *Title:* Early, non-destructive selection of microspore derived embryo genotypes in oilseed rape (*Brassica napus* L.) by molecular markers and oil quality analysis.
   Authors: Nath U.K., **Iqbal M.C.M.** and Möllers C.
   Journal: ***Molecular Breeding***, 2006 (in press)[1,2]

[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Iqbal M.C.M.**, Kulasekara L., Rajakaruna N. and Iqbal S.S.
   Plant Soil relations of a serpentintine site in the Southern coast of Sri Lanka
   Vth International Conference on Serpentine Ecology, Siena 9-13, 2006

2. **Wijesekara T.P**, Jayasena M.K.A.S., Medagoda M.N. and **Iqbal M.C.M.**
   Rapid plantlet regeneration from callus of *Oryza sativa* ssp. *indica* cultivated in Sri Lanka
   Proceedings of the 11th International Association of Plant Tissue Culture and Biotechnology, Beijing China August 13-18, 2006

3. **Weerasinghe H.A.S.** and **Iqbal M.C.M.**
   Plant diversity, its importance and conservation: a preliminary study of a serpentine site at Ussangoda, Sri Lanka
   International Conference on Humid Tropical ecosystems: Changes, Challenges and Opportunities. 4-9, December 2006, Kandy Sri Lanka

4. Wimalasuriya W.S.R., Weerakoon S.R., Somarathna S.,R. and **Iqbal M.C.M.**
   Characterization and differentiation of local mustard (*Brassica juncea* L.) germplasm in Sri Lanka
   Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 77, 2006

PROJECT: PLANT CELL BIOLOGY

COMMENCEMENT: 2001

INVESTIGATORS (2006):

Magana-Arachchi D.N., *Research Fellow* **(Project Leader)**
Kovoor A., *Honorary Research Professor*
Jeyanandarajah P., *Former Research Fellow*
Wanigatunge R.P., *Research Assistant*
Lal M.A., *Work Assistant*

PROGRESS ACHIEVED (*Since inception*):

Scope of the project:

- Isolation and identification of cyanobacteria to ascertain their biodiversity; investigation of the biological activities terrestrial and aquatic cyanobacterial forms.
- Development of assays for water-borne toxicants; identification of microorganisms capable of degrading toxins; characterisation of microbes present in bio films in aquatic systems.
- Study of aspects of mycotrophy and formulation of me thodologies for the introduction of microorganisms, including mycorrhizal fungi, for optimisation of plant growth.
- Investigation of mechanism of antagonism, synergism and toxicity of rhizoplane and spermoplane microorganisms.

Phytoplankton: Several members of Chlorophyceae, Cyanophyceae and Bacillariophyceae were detected in the samples collected from fresh water expanses/bodies. Several members of toxigenic cyanobacteria were detected in the samples collected from Beira Lake, Colombo. The microorganism p revalent in the surface scum and water were *Microcystis*. Thin layer chromatography and high performance liquid chromatography were employed for separation and identification of toxins. Microcystin-LR, known to be heptatoxic cyclic heptapeptide, was detecte d in the samples of surface water and cells of the scum.

Mycotrophy: A fungus was isolated from snake gourd (*Trichosanthes cucumerina*) by plating plant tissue onto potato dextrose agar (PDA) medium. Based on the morphological characteristics, it was iden tified as *Didymella bryoniae*. Three isolates from different locations were studied further.

Phylloplane fungi were isolated from leafy vegetables by plating leaf tissues onto PDA. Fungi identified are *Alternaria alternata, Aspergillus flavus, Aspergillus niger, Cladosporium cladosporioides, Fusarium pallidoroseum, Fusarium solani, Fusarium equiseti, Myrothecium roridum, Myrothecium verrucaria, Penicillium spp., Rhizoctonia solani, Trichoderma spp.*. Isolations from the rhizosphere samples of

leafy vegetable plot were done by dilution plate methods and wet sieving methods. In dilution plate method: *Alternaria tenuis, Aspergillus* spp., *Chaetomium globossum, Cladosporium* sp., *Fusarium solani, Fusarium oxysporum, Mucor* sp., *Penicillium* spp., *Rhizopus stolonifer, Sordaria fimicola* and *Trichoderma* spp were identified and wet sieving revealed *Glomus* and *Gigaspora* in plots where *Centella asiatica* was growing. In dual culture studies, isolate TPJ5' showed prominent antagonistic properties against a number of fungi.

From 2005, project focused mainly on first two objectives. On the basis of published 16S rRNA sequences a PCR procedure was developed for the selective retrieval of cyanobacterial rRNA gene fragments from a variety of natural and artificial settings. In many eutrophic fresh water lakes, cyanobacteria frequently form toxic mass occurrences. A PCR procedure was optimised to identify the microcystin producing genera with the Genus specific *mcyE* primers.

PROJECT OUTPUT 2006:

The studies started in previous year were continued. 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 *Chroococcus, Synechococcus, Nostoc, Gleotheca, Phormidium, Microcoleus, Cylindrospermum, Oscillatoria, Merismopedia, Lyngbya, Schizothrix, Anabaena, Gloeocapsa, Microcystis, Westiellopsis, Fischerella, Aphanizomenon, Xenococcus, Spirulina* and *Gomphosphaeria/Coelosphaerium*. DNA extractions and amplifications to determine the phylogenetic relationship using the 16S rDNA sequences were completed from the tentatively identified cultured cyanobacterial species. Funds are being awaited to confirm the species identification through gene sequencing. Microcystin producing *Microcystis aeruginosa* were identified from the water samples collected from Beira Lake using the optimized protocol with *mcy* E primers and gene sequencing. The nucleotide sequences were deposited in GenBank under accession numbers **EF051238** and **EF051239**.

OTHER CONTRIBUTIONS IN 2006:

Dissemination of knowledge:

Magana-Arachchi D.N

Through Special lectures

(a) School Teachers from Kegalle District, IFS - February 2006; "Molecular biology"

(b) Research Colloquia, IFS – March 2006; "Diagnosis of Tuberculosis by DNA amplification".

(c) School Science Programme – 12th December 2006; "Molecular biology – The study of the cell at molecular level"

PROJECT: BASIC FOOD CHEMISTRY

COMMENCEMENT: 2005

INVESTIGATORS (2006):

Ellepola S.K.W., *Research Fellow* (**Project Leader**)
Banneheka N.M.S., *Research Assistant*

PROGRESS ACHIEVED (*Since inception*):

This project was initiated in 2005. The project was mainly directed towards the understanding of fundamental physicochemical properties, structure and chemistry of rice grains. In year 2005, a considerable effort was diverted towards identification and characterization of rice seed proteins and the preliminary in vestigations were initiated with the collaboration of University of Hong Kong, China. Subsequently, the project moved in the direction of fundamental studies of other constituents of rice grain. Three projects have been successfully conducted on various as pects of rice grain during the year 2006. The overall work conducted has given rise to 04 publications in international journals.

PROJECT OUTPUT 2006:

1. Antioxidant properties of red rice (*Oryza sativa* L.) in relation to interaction with soluble iron

The objective of this study was to determine the antioxidant properties of red rice pigment (proanthocyanidin) and to evaluate its Fe^{2+} binding ability in acidic and neutral conditions. Free radical scavenging activity, reducing power, and ferrous ion chelating ability of red and white rice varieties were compared with synthetic antioxidants, L-ascorbic acid and ethylenediaminetetraacetic acid (EDTA). The findings of the study revealed that red raw rice varieties possessed greater antioxidant activities than white raw rice. The Fe^{2+} absorption of red rice did not significantly affect the bioavailability of iron in the acidic medium. The manuscript based on these results has been submitted for publication in SCI journal, *Food Chemistry* (2006).

2. Study of quality changes in rice (*Oryza sativa* L.) during storage

The objective of this investigation was to evaluate the physicochemical properties, nutritional, structural and sensory properties of rice during storage and thereby, ascertaining the influence of st orage on final quality of rice. The findings of this study revealed that storage led to substantial deterioration of the physicochemical properties, nutritional & sensory properties of rice grain constituents. Structural changes of seed proteins and starch will be investigated by Fourier-transform infrared spectroscopy.

3. Effect of cooking methods on physicochemical and sensory properties of rice *(Oryza sativa* L.*)*

The aim of this study was to determine the effect of different household cooking methods on physicochemical and sensory characteristics of rice varieties popularly consumed in Sri Lanka. The work on nutritional characteristics, textural and sensory attributes have been initiated and are in progress now. This study is conducted for the partial fulfillment of M.Sc. degree of Ms. N.M.S. Banneheka, in association with Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1.* *Title:* Raman spectroscopic study of rice globulin
Authors: **Ellepola S.K.W.,** Choi S.M., and Phillips D.L..
Journal: ***Journal of Cereal Science*, 43:** 85-93 (2006)[1,2]

2.* *Title:* Thermal properties of globulin from Rice (*Oryza sativa*) seeds
Authors: **Ellepola S.W.** and Ma C.Y.
Journal: ***Food Research International,* 39:** 257-264 (2006)[1,2]

3. *Title:* Conformational study of globulin from rice (*Oryza sativa*) seeds by Fourier-transform infrared spectroscopy
Authors: **Ellepola S.W**. and Ma C.Y.
Journal: ***International Journal of Biological Macromolecules** (in press)*[1,2]

**** Reported as 'in press' in Annual Report 2005***
[1]Listed in the Science Citation Index in 2006
[2]Listed in the Science Citation Index-expanded in 2006

PROJECT: **BIOLOGICAL NITROGEN FIXATION**

COMMENCEMENT: 1986

INVESTIGATORS (2006):

Seneviratne G., *Senior Research Fellow* **(Project Leader)**
Bandara W.M.M.S., *Research Assistant*
Ratnayake R., *Research Assistant*
Weerasekara M.L.M.A.W., *Research Assistant*
Zavahir J.S., *Research Assistant*
Sandamali H.A.J., *Research Assistant (NSF grant)*

PROGRESS ACHIEVED (*Since inception):*

The original aim of the project was to improve livelihood of rural Sri Lankan farmers through improved soil fertility by biological nitrogen fixation and balanced nutrient application. A variety of research programs were conducted during this period. However, present objective is to conduct basic research on biological nitrogen fixation and related topics.

a) A *rhizobium* inoculant (bacterial fertilizer) was produced for grain legumes and leguminous trees, based on a substrate made of a special mixture of organic waste materials. The inoculant could increase soybean yield by at least 26%, even up to over 100% under different soil conditions in the dry zone of Sri Lanka. A similar inoculant increased plant growth of *Albizia,* a nitrogen fixing leguminous tree by 84% on tea estates. This inoculant is now used for grain legumes in Sri Lanka, and is also being tested in Bangladesh.

b) Thirteen leaf isozymes were assessed by gel electrophoresis for identification of elite trees in a heterogeneous population of *Pericopsis mooniana* (Nadun). Such an identification is important in efficient management of reforestation programmes with slow growing, high quality timber species like the tree under consideration. Out of the isozymes tested, formate dehydrogenate showed promising results.

c) Foliar application of chelated micronutrients to rice and tea showed potential for increasing their yields. A mixture of micronutrients when applied to farmers' fields in the dry zone increased panicle and grain formation of rice by 25% and 32%, respectively. Hundred seed weight was increased by 18%. The same mixtures increased tea yields by about 30% in tea estates over a year with a net extra benefit of around 30,000 Rs/ha.

d) Polyphenols are known as disinfectants and act as bactericides. Soil polyphenols therefore affect the growth and activity of rhizobia in soils,

threatening their survival. In a study of polyphenolic inhibition of rhizobia, a method for fractionation and identification of polyphenols in soils was developed using One Dimensional Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (1 D SDS PAGE).

e) Interactions between phenolic compounds and rhizobia, and the effect of phenolic acid affected rhizobia on rhizobial-legume symbiosis were studied. Phenolic acids were found to be possible agents of modifying N_2 fixing symbiosis through rhizobial alteration. A paper was published.

f) Studies on litter turnover in ecosystems led to discover that soil surface mulch application mitigates soil N_2O emission. This was published and established now. Underlying mechanisms of this mitigation were also identified.

g) A study on rhizobial-fungal biofilms was completed, where the effects of the biofilm formation on the survival and effectiveness of rhizobia under adverse conditions were examined. The biofilms were successfully developed *in vitro*, observed and reported in a research paper. This is the first observation of such biofilms.

h) Different biofilms were developed for various applications. A rhizobial-fungal biofilm was developed for rock phosphate solubilization. A *Pseudomonas* spp.-*Pleurotus* spp. biofilm was formed for the transfer of *Pseudomonas fluorescens* to tomato plant tissues. A *Bacillus* spp.-*Penicillium* spp. biofilm was formulated to degrade polythene biologically. Biological nitrogen fixation in mushrooms was tested and understood. These findings were published in refereed journals.

i) Soil organic matter decomposition was studied under different land-use patterns of Sri Lanka. Soils were collected and analyzed for a number of soil parameters and soil respiration, CH_4 and N_2O emissions. Soil organic carbon contents of the land-use patterns were predicted using artificial neural network (ANN) analysis and a paper was published in a refereed journal.

j) An experiment was conducted to examine soil carbohydrate controls on nutrient dynamics. Soil litter and clay-bound organic matter were found to control soil carbohydrates, which govern the availability of some macro and micronutrients. Manuscripts were sent for publication to refereed journals.

NUMBER OF PUBLICATIONS IN REFEREED JOURNALS: 28

PROJECT OUTPUT 2006:

1. Studies were conducted to examine associative nitrogen fixation in the rice rhizosphere, with special reference to *Azorhizobium caulinodans*, an efficient nitrogen fixer in the rhizosphere. The effect of *A. caulinodans* as a monoculture on rice was evaluated and found that there is no significant effect on growth etc. Studies are now being carried on to examine its effect when it is in microbial communities or biofilms. Further, endophytic microbes of rice plant were also isolated and tested in the biofilm formation. A paper was published on this. The goal of this study is to develop a microbial fertilizer technique for rice.

2. A study was started to investigate the survival and ecological function of nodule forming rhizobia before the emergence of nodulating legumes in the life history. Literature survey is under way for developing a hypothesis for this. Laboratory studies will then be started.

3. A study was started to examine the potential of the use of microbial biofilms for enhanced monosaccharide production for the monosaccharide-based drug production. Microbial cultures were grown, and exudates were isolated and analysed. A manuscript was submitted to a refereed journal.

4. A study was started to examine the potential of the use of microbial biofilms for biofuel production, based on cellulose waste materials. Microbes are now being tested to select potential candidates.

5. A study was started to examine the potential of the use of microbial biofilms as a microbial fertilizer technology for tea. Microbes are now being tested with tea for improved plant growth.

6. A study was started to develop an improved rice production system using present and past cultural practices. This is funded by the NSF, Sri Lanka. Rice field studies were started at Naula.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1.* *Title:* A mushroom-fungus helps improve endophytic colonization of tomato by *Pseudomonas fluorescens* through biofilm formation
Authors: Jayasinghearachchi H. S. and **Seneviratne G.**
Journal: ***Research Journal of Microbiology,* 1:** 83-89 (2006)

2.* *Title:* Polyethylene biodegradation by a developed *Penicillium-Bacillus* biofilm
Authors: **Seneviratne G.**, Tennakoon N.S., **Weerasekara M.L.M.A.W.**, and Nandasena K.A.
Journal: ***Current Science,* 90:** 20-21 (2006)[1,2]

3.* *Title:* Fungal solubilization of rock phosphate is enhanced by forming fungal-rhizobial biofilms
Authors: Jayasinghearachchi H. S. and **Seneviratne G.**
Journal: ***Soil Biology and Biochemistry,* 38:** 405-408 (2006) [1,2]

4. *Title:* Tannin interactions with legume-rhizobial N_2 fixing symbiosis
Authors: Jayasinghearachchi H.S., **Seneviratne G.** and Weerasinghe H. M.S.P.M.
Journal: ***International Journal of Agricultural Research*, 1:** 1-7 (2006)

5. *Title:* Nutrient cycling and safety-net mechanism in the tropical homegardens
Authors: **Seneviratne G.,** Kuruppuarachchi K.A.J.M., Somaratne S. and Seneviratne K.A.C.N.
Journal: ***International Journal of Agricultural Research*, 1:** 169-182 (2006)

6. *Title:* A polyacrylamide gel electrophoretic approach of fingerprinting soil polyphenols
Authors: Jayasinghearachchi H.S., Seneviratne G. and Weerasinghe H. M.S.P.M.
Journal: ***International Journal of Soil Sciences*** **1**: 53-57 (2006)

7. *Title:* Interactions among endophytic bacteria and fungi: effects and potentials
Authors: **Bandara W.M.M.S., Seneviratne G.** and Kulasooriya S.A.
Journal: ***Journal of Biosciences*** **31:** 639-643 (2006) [1,2]

8. *Title:* Nitrogen fixation in lichens is important for improved rock weathering
Authors: **Seneviratne G.** and Indrasena I. K.
Journal: ***Journal of Biosciences*** **31:** 645-650 (2006) [1,2]

**** Reported as 'in press' in Annual Report 2005***
[1] Listed in the Science Citation Index in 2006
[2] Listed in the Science Citation Index-expanded in 2006

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Ratnayake R.R., Seneviratne G.,** and Kulasooriya S.A.
Land use and soil carbohydrates in different ecosystems under tropical conditions
International Conference on Humid Tropical Ecosystems: Changes, Challenges and Opportunities, Kandy, Sri Lanka, 4-9 December 2006, 16

2. Ekanayake E.M.S., Perera G.A.D., Wijesundara D.S.A., and **Seneviratne G.**
Spatial heterogeneity of montane rain forest vegetation of Dotalugala at the Knuckles conservation area, Sri Lanka
International Conference on Humid Tropical Ecosystems: Changes, Challenges and Opportunities, Kandy, Sri Lanka, 4-9 December 2006, 78

3. Wijesooriya S.M., Perera G.A.D., Abeywardena M.D.E.J. and **Seneviratne G**
Ecology of natural grassland vegetation at Pitawala patana of the Knuckles region
International Conference on Humid Tropical Ecosystems: Changes, Challenges and Opportunities, Kandy, Sri Lanka, 4-9 December 2006, 80

4. Perera G.A.D., Wijesooriya S.M., Abeywardena M.D.E.J. and **Seneviratne G.**
Ecology of grassland communities at the Knuckles conservation ares of Sri Lanka
International Conference on Humid Tropical Ecosystems: Changes, Challenges and Opportunities, Kandy, Sri Lanka, 4-9 December 2006, 106

5. **Bandara W.M.M.S.** and **Seneviratne G.**
Importance of interactions among endophytes for plant growth.
Proceedings of the 62nd Annual Sessions of Sri Lanka Association for Advancement of Science, Part I, Abstracts, pp. 79, 2006

POSTGRADUATE DEGREES COMPLETED IN 2006:

1. *Name:* **Ratnayake R.R.**
Thesis Title: Effect of soil organic matter on nutrient availability under different land use patterns with special emphasis on the role of carbohydrates
Degree: Ph.D.
Degree awarded by the University of Peradeniya.

TECHNICAL ASSISTANCE:

1. R.C.K. Karunaratne
2. K.K. Karunadasa

VOLUNTEER RESEARCHERS:

1. L.A.W. Liyanarachchi
2. K.A.J.M. Kuruppuarachchi

PROJECT: **ECOLOGY AND ENVIRONMENTAL BIOLOGY**

COMMENCEMENT: 1989

INVESTIGATORS (2006):

Silva E.I.L., *Associate Research Professor* **(Project Leader)**
Weerasinghe W.M.D, *Research Assistant*
Kangara K.M.W.S.B., *Research Assistant (Project funded)*
Thumpela I., *Staff Technical Officer*
Athukorale N., *Staff Technical Officer*

PROGRESS ACHIEVED *(Since inception)*:

The project initiated as Ecology and Conservation in 1989, was renamed in 1992 as Ecosystem Analysis and Impact Assessment. The name was changed again in 1996 as Ecology and Environmental Biology with a view to restructuring the studies towards fundamental aspects of ecological studies in aquatic science. Although this project is broadly named as Ecology and Environmental Biology with an intention of future expansion, studies were primarily focused on aquatic environment with special emphasis on aquatic ecology of inland and coastal marine ecosystems.

At the beginning, a study was carried out on the limnological aspects and the fisheries of the Mahaweli river basin. Since 1989 with special emphasis on colonization of exotic fish species in the Victoria Reservoir, water chemistry of the Nilambe Oya, nutrient loading into Kotmale Reservoir, trophic characteristics reservoirs in the Mahaweli basin. Limnology and water quality of the Kandalama tank were studied during pre-construction, construction and operational phases of the hotel complex to determine whether it has effects on ecosystem processes and functions of the tank environment. A study was also carried out to determine the rainwater chemistry and buffer intensities of surface water in Sri Lanka. Further, commercially important fresh water fish species were analyzed for bio-accumulation of trace elements while several species of pelagic blood fishes were analyzed for the levels of histamine. A study was also launched to determine the impact of operational activities of shrimp farms in the north western province on brackish water ecosystem including Mundel Lake. In 1995, an intensive study was carried out to determine the levels of organic and inorganic pollution along course of the Meda Ela in Kandy.

Towards the end of 1996, a systemic limnological study was launched in the Kandy Lake with view to identifying the eutrophic process of a tropical urban water body. This study was intensified from May 1999, with the emergence of a cyanobacteria bloom (*Microcystis aeruginosa*) in Kandy Lake. A parallel study was also started in the Hulu Ganga, the major tributary of the Mahaweli River in the central Mahaweli Valley to determine the ecological processes and functioning of a tropical stream draining and intensively exploited watershed. A broad limnological study was commenced in August 1998 to compare the primary productivity and nutrient dynamics of three morphologically and functionally different reservoirs namely

Victoria, Minneriya and Udawalawe. This was a component of the research project launched to determine the ecological processes and dynamics of Asian reservoirs and lakes funded by the European Union. In addition, studies were conducted on retention of silica behind the dams of Sri Lankan reservoirs, which is currently being considered as an important issue of land-ocean nutrient fluxes. In 2003, detail studies on material fluxes in three adjacent river basins namely Maha Oya, Deduru Oya and Mi Oya was carried out. This study was extended to Kala Oya, Malwathu Oya and Mahaweli basins. Intensive investigations on Kandy Lake was conducted on daily basis from August to December, 2003. Studies conducted on Rekawa lagoon under European Union funded project on Mangrove Resilience in Coastal Zones in East India and Southwest Sri Lanka were completed for a period of two years. Investigation on nutrient loading into the Kandy Lake via perennial and seasonal inflows was commenced in January 2004 while Heen Ganga which drains the northeast slope of the Knuckles Range was examined monthly to determine aspects of its ecology since May 2004. An intensive survey was conducted during August-September 2004 on phytoplankton systematic in 34 major reservoirs in Sri Lanka.

Investigations on nutrient loading into Kandy Lake via perennial and seasonal inflows were continued till December 2005. Studies on Heenganga tributaries in the knuckles range were also continued till December 2005. The field studies conducted on Kala Oya basin were completed in July 2005. A study was initiated to determine water chemistry of Rajangana irrigation scheme on a request made by Irrigation Secretariat. This study was continued up to May 2006 and results are being analyzed for the preparation of a manuscript to be submitted to a SCI journal. On a request made by Water Supply and Drainage Board, several reservoirs (Kurunegala, Unachchai, Nallachchiya, Eppawela, Kekirawa tanks and Nuwarawewa, Kalawewa, Parakrama Samudra, Kantale, Senanayake Samudra, Konduwatuwana and Hmidurawa tanks in Amapara distric) were examined for toxigenic phytoplankton. The results of the above studies that are ecologically significant and scientifically important were published in refereed journals and monographs and in the proceedings of local, regional and international meetings.

PROJECT OUTPUT 2006:

Although I (Project Leader) was granted sabbatical leave for a period of one year with effect from January 1, 2006 to accept a position as a technical expert to Provincial Environmental Authority of Northwestern Province, I reassumed duties on August 1, 2006 due to health problems. Consequently, I was not in a position to carry out intensive work for a couple of months. Emphasis was paid mainly on compilation of data and correction of two postgraduate theses. In addition, a two manuscripts were prepared from the work carried out on primary productivity of Rekawa lagoon and Impact of Rajangana irrigation scheme on Kala Oya source water. Further, presentations were made at ACEMON regional workshop held Phuket, Thailand in September and International meeting held in Kandy on Humid Tropical Ecosystems in December.

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1.* *Title:* Risk of toxigenic cyanobacterial blooms in freshwaters of Sri Lanka
Authors: Jayatissa L.P., **Silva E.I.L.**, McElhiney J., and Lawton L.A.
Journal: ***Systematic and Applied Microbiology,*** 29 : 156-164 (2006) [1,2]

2. *Title:* Hypertrophic-eutrophic alteration in an urban water body, following an outbreak of a *Microcystis* Bloom.
Authors: **Silva E.I.L.**
Journal: ***Sri Lanka Journal of Aquatic Sciences,*** **12**: 2006 (in press)

* ***Reported as "in press" in Annual Report 2005***
[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. **Silva E.I.L.** and Kangara K.M.W.S.B.
Trophic alteration in reservoirs of Sri Lanka – an outcome of monsoon driven seasonal hydrology In: Srikantha Herath and Weerakone S.B. (eds.)
Proceedings of the Pre- Symposium on Water in the Humid Tropics held in Kandy, December 2006 (in press)

INVITED LECTURES/CONFERENCES ATTENDED IN 2006:

1. **Silva E.I.L.**
Lecture conducted on Water at Trinity College, Kandy on Science Day (12.11.2006).

BOOKS AND MONOGRAPHS 2006:

1.* *Title:* Bibliography of Scientific Research on Fisheries and Aquatic Sciences in Sri Lanka, 1900-2004
Author **Silva E.I.L.**
Publisher: Sri Lanka Association for Fisheries and Aquatic Resource, 117 pp.

2.* *Title:* Macro and micro chemical constituents in groundwater of Sri Lanka –an over view
Authors: **Silva E.I.L.**
In the Book: Status of Groundwater in South and Southeast Asia
Editor: Ramanathan L.
Publishers: Capital Publishing Company, New Delhi (in press)

3.* *Title:* Current status of taxonomy and ecology of freshwater phytoplankton in Sri Lanka
Authors: **Silva E.I.L.,** Rott E., and Thumpela I.
In the Book: Low plants in Sri Lanka
Editor: Wijesundara C.
Publishers: Ministry of Environment of Sri Lanka (in press).

4. *Title:* Regulation of photosynthesis in cyanobacteria dominant irrigation reservoirs in Sri Lanka
Authors: **Silva E.I.L.**
In the Book: Cyanobacterial and Algal Photosynthesis in Tropical Waters
Editors: Prasanna Mohanty and Nath Bagchi
Publishers: Science Publishers, Inc., USA (in press).

Reported as "in press" in Annual Report 2005

PROJECT: **CHEMICAL MODELING OF AQUATIC SYSTEMS**

COMMENCEMENT: 1992

INVESTIGATORS (2006)

Weerasooriya R., *Research Professor* **(Project Leader)**
Nanayakkara A., *Associate Research Professor*
Atula Bandara, *Visiting Scientist*
Seneviratna H.R.W.U., *Research Assistant*
Jayarathna I.P.L., *Research Assistant*
Aluthpatabendi D., *Technical Officer*
Makehelwala M., *Volunteer Post Graduate Candidate*

Collaborating Laboratories (2006)

X-ray spectroscopy and molecular modeling (1995 – to date)
Heniz J. Tobschall, University of Erlangen (Germany)
M.M. Mieander University of Mainz, Germany

FTIR Spectroscopy (1999-to date)
Atula Bandara, University of Peradeniya

PROGRESSED ACHIEVED *(Since inception)*:

Overall aim Mechanistic, spectroscopic and molecular definition of solid-water interfacial interactions

1. Modeling interactions of tributyl-Sn (TBT) onto clays
2. Quantification of As(V) and As(III) retention mechanism of gibbsite with the aid of mechanistic and molecular modeling
3. Quantification of the activation state of monochlorophenol – pyrite interface
4. Calculations of essential thermodynamic parameters of MCP/pyrite interface
5. Reaction pathway modeling of 4-CP/pyrite interactions
6. Reactive site determination of kaolintie-TBT interface by molecular modeling methods
7. Retention mechanism of lead, cadmium, and arsenic on gibbsite
8. Site heterogeneity assessment of gibbsite by macroscopic methods
9. Mechanistic model development for quantification of chromate-goethite interfacial processes
10. Characterization of kaolintite – water interface probing with fluoride
11. Kinetic modeling of copper-fulvate complexation
12. Kinetic modeling of copper-organic polymer complexes
13. Determination of near surface solid composition of goethite copper system with X-ray photon spectroscopy

14. Development of novel unit processes of drinking water treatment for fluoride, nitrate, and selected organic-Cl (Project objectives were revised to meet the current IFS focus)
15. Development of N-nitrosoamine formation pathways in natural systems (Project objectives were revised to meet current IFS focus)

PROGRESS ACHIEVED 2007:

As discrete particles and/or as surface coatings on other minerals in natural systems, aluminum hydroxide are efficient sinks for Hg(II). The Hg(II) adsorption on gibbsite was determined as a function of temperature(T), pH and the type of background electrolytes, i.e. $NaNO_3$, $NaClO_4$, and NaCl. When the equilibration time, $t_E \sim 2$ h, the Hg(II) retention on gibbsite was found to be reversible process, which was ascribed to adsorption. The Hg(II) adsorption capacity, i.e. $\Gamma_{Hg(II)}$ varied with the type of electrolyte used in accordance with the following order; $\Gamma^{NO_3}_{Hg(II)} \geq \Gamma^{ClO4}_{Hg(II)} > \Gamma^{Cl}_{Hg(II)}$. In all cases, the estimated thermodynamic parameters showed that the Hg(II) adsorption on gibbsite was endothermic and spontaneous. The Hg(II) adsorption data were quantified with the Langmuir or Hill, and Dublin-Radushkevick (D-R) isotherms at all temperatures and acidity levels examined. Always, the Hg(II) adsorption data were in compliance with the D-R model. However, the Hg(II) adsorption in $NaNO_3$ or $NaClO_4$ was interpreted in terms of Langmuir model. When NaCl was used as electrolyte, the Hg(II) adsorption was modeled well with Hill equation. The mean free energy values calculated from D-R plots concluded that Hg(II)-gibbsite interactions are a result of chemical bonding.

Number of publications 43

PUBLICATIONS IN REFEREED JOURNALS 2006:

1* *Titlte:* Pyrite-water interactions:effects of pH and pFe on surface charge
Authors: **Weerasooriya R.** and Tobschall H.J.
Journal: ***Colloids and Surfaces*** , **264**: 68-74 (2006) [1,2]

2* *Title:* Thermodynamics of monochlorophenol pyrite complexes at activation state
Authors: **Weerasooriya R.**, Makehelwela M., Mieander M.M., and Tobschall H.J.
Journal: ***Journal of Colloid and Interface Science***, **297**: 31-37 (2006) [1,2]

3* *Title:* Mechanistic modeling of arsenic retention on natural red earth
Authors: Vithange M., Chandrajith R., Bandara A., and **Weerasooriya R.**
Journal: ***Journal of Colloid and Interface Science***, **294**: 265-272 (2006) [1,2]

4.* *Title:* Arsenic binding mechanisms on natural red earth; A potential substrate for pollution control
Authors: Vithanage M., **Senevirathne W.**, Chandrajith R., Bandara A., and **Weerasooriya R.**
Journal: ***Science of the Total Environment,*** 2005 (in press) [1,2]

5. *Title:* Thermodynamic assessment of Hg(II)-gibbsite interactions
Authors: **Weerasooriya R.**, Senewirathne, Kasthuriaarachi H. Tobschall H.J.
Journal: ***Journal of Colloid and Interface Science,*** 2006 (in press)[1,2]

**** Reported as "in press" in Annual Research Report 2005***
[1] Listed in the Science Citation Index in 2006
[2] Listed in the Science Citation Index-expanded in 2006

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2006:

1. Amarasinghe P.H.W.K.P., Rupasinghe M.S., and **Weerasooriya R.** (2006) Natural coir dust as a starting substrate to de-pollute chromium(VI) contaminated waters, Sessions IV
Natural Resources Program, NR 19, 8th Annual Sessions of Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, pp.19.

2. Makehelwala M., Bandara A., and **Weerasooriya R.** (2006) Monochlorophenol –pyrite interactions at TS, PURSE-2006
Annual Sessions University of Peradeniya

3. Kastriarachchi H.A., **Seneviratna W.**, Bandara A., **Weerasooriya R.** Examinations of the thermodynamic assessment of Hg(II)-gibbsite interactions
PURSE-2006 Annual Sessions University of Peradeniya

BOOKS AND MONOGRAPHS 2006:

1.* *Title:* 1-pK modeling strategies for the adsorption of some trace elements onto gibbsite
In the book: Surface Complexation Modeling Series Interface Science and Technology
Authors: Mieander M.M., **Weerasooriya R.**, and Tobschall H.J.
Editors: Lutzenkirchen J.
Publisher: Elsevier Publications (in press)

2. *Title:* Role of natural red earth in arsenic removal from drinking water-comparison with synthetic gibbsite and goethite
In the book: Trace Elements and Other Contaminants
Authors: Vithanage M., Chandrajith R., and **Weerasooriya R.** (2006)
Editors: Series editor: J.O. Nriagu
Publisher: Elsevier Publ., Netherlands (in press)

****Reported as "in press" in Annual Report 2005***

PROJECT: STRUCTURAL GEOLOGY

COMMENCEMENT: 1995

INVESTIGATORS (2006):

Kehelpannala K.V.W., *Senior Research Fellow* **(Project Leader)**
Prof. A. Kröner, *Visiting Senior Professor*
Ranaweera L.V., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)*:

The Structural Geology project was started in 1995 with a view to study (i) the origin of structures and mineral deposits in the lower crust, (ii) the behaviour of lower crustal rocks during ductile deformation, (iii) the mechanisms of plate movements during Proterozoic, (iv) possible mechanisms of assembly and break-up of supercontinents, (v) deformation- and fluid-controlled lower crustal processes, such as migmatization, charnockitization, retrogression and metasomatism, (vi) vein graphite mineralization, and (vii) brittle deformation, neotectonics and seismic activities in an exhumed section of the lower crust exposed in Sri Lanka.

During the last eleven years, the Structural Geology project contributed to the structural evolution of the lower crust exposed in Sri Lanka and to understanding the significance of mantle-derived fluids on the precipitation of post-metamorphic vein graphite. The data so far gathered led us to established that the middle to lower crust exposed in Sri Lanka has been formed by the amalgamation of three different plates collided at two separate stages during the final assembly of the Gondwana supercontinent at about 610-550 Ma. The most intensely developed and easily visible ductile structures in the basement rocks of Sri Lanka have been formed by the above two collisions. The main amphibolite-granulite facies metamorphism in the western (Wanni Complex) and central (Highland Complex) crustal units was related to the first collision, while the amphibolite facies metamorphism of the eastern crustal unit (Vijayan Complex) was resulted from the second collision. Geological and structural studies carried out along the boundary shear zones of the major crustal blocks in Sri Lanka led us to identify them as parts of major suture zones. EPMA study of Th-U-Pb isotopic system of the mineral monazite in metamorphic rocks of Sri Lanka, especially taken from some important rocks across the boundary between the Wanni Complex and the Highland Complex, led to identification of new type of monazite. We have been able to recognize some structures formed even before the above collisions, probably related to the accretion and break-up of the supercontinent Rodinia that existed before 750 Ma ago. Some results obtained in relation to deformation-controlled migmatization and sheared-controlled charnockitization, retrogression and metasomatism are important in understanding these lower crustal processes. In addition, the project made a valuable contribution to understand neotectonics and seismic activity in Sri Lanka that makes part of the exhumed lower crust.

With limited resources, important results obtained during the last eleven years were published in refereed journals, in the Second Edition of the National Atlas of Sri Lanka (three chapters), in international and local proceeding volumes and in the form of abstracts. The Project Leader co-edited a special issue of the international Elsevier Journal of Asian Earth Sciences (Issue 1 of Volume 28, 2006) on "The role of Sri Lanka and Associated Continental Blocks in the Assembly and Break-up of Rodinia and Gondwana".

In recognition of our work, the Project Leader has been honoured by awarding two DAAD Invitation Research Fellowships from the German Academic Exchange Service to carry out research in Germany and a JSPS Invitation Research Fellowship from the Japan Society for Promotion of Science to Japan. The Project Leader was a Visiting Professor at the Shizuoka University, Japan during January-March 2006 under a JSPS programme. The Project Leader had been invited by foreign universities and international organizations to participate in about sixteen international symposia and workshops held in India, China, Singapore, Japan, Hong Kong, USA and Sri Lanka to present some of the results of the project. Since 1995, the Project Leader has delivered about 55 invited/public/special lectures in Sri Lanka, India, Singapore, Hong Kong, China, Japan and the USA. Out of these, about 26 invited lectures are at international levels. Further, the Project Leader has been appointed as a Fellow of the Geological Society of India and as a member of the Steering Committee of the International Association for Gondwana Research, Japan and has been the Sri Lankan convenor/researcher of the following international projects:

1. UNESCO-International Geological Correlation Programme (IGCP 368) project on "Proterozoic Events in East Gondwana".

2. UNESCO- International Geological Correlation Programme (IGCP 440) project on "Rodinia Assembly and Break-up".

3. International project on "Structure, Composition and Evolution of the South Indian and Sri Lankan Granulite Terrains from Deep Seismic Profiling and other Geophysical and Geological Investigations: A LEGENDS Initiative".

The Project Leader's work on seismic activity in Sri Lanka and in the Indian Ocean led him to predict violent tsunamis in the Indian Ocean affecting Sri Lanka, and he is the only person who had previously predicted Indian Ocean violent tsunamis striking Sri Lanka. In his news feature article appeared in Midweek Mirror of 21 April 1999 and in the article on "Seismicity & Earthquakes" submitted in November 2004 to the Second Edition of the National Atlas of Sri Lanka (in press) he predicted violent tsunamis striking Sri Lanka.

After the devastating tsunami of 26th December 2004, the Project Leader was invited by both state as well as private media institutions to conduct awareness programmes on tsunamis and earthquakes. He has conducted about 16 television programmes and nine radio programmes. He has also published several news paper articles on natural disasters such as tsunamis, earthquakes and landslides. Immediately after the Indian Ocean tsunami of 26th December 2004, a detailed research was undertaken. The effect of the tsunami on the coastal areas of Sri Lanka, coastal erosion, the nature of the

tsunami waves, their wave heights, arrival times and evidence for palaeotsunamis were also studied.

The Structural Geology Project intervened in finding scientific solutions to problems related to some natural disasters and other nationally important geological problems. Under this, causes and mechanisms of major landslides occurred in Sri Lanka were studied, and several public awareness programmes were conducted by the Project Leader to help the people in affected areas. The studies on landslides led the Project Leader to make aware the public on potential landslides, especially along some of the major roads, before their occurrence. In addition the cracks developed along the Kotmale rock-filled dam were investigated, and the relevant authorities were informed about the measures that should be taken.

PROJECT OUTPUT 2006:

The work started in the previous year was continued. In addition the following studies were carried out in the year 2006.

1. Stable carbon isotopic composition and zonations in graphite crystals collected from a vein in a metapelitic rock from the Highland Complex were analysed at the Department of Geosciences, Shizuoka University, Japan. This work is being continued.

2. Radio carbon dating of charcoal, corals and shells exposed at many places along the coastal belts by the tsunami of 26 December 2004 was carried out at the Department of Geosciences, Shizuoka University and Nagoya University, Japan. This work is being continued.

3. Scanning Electron Microscopic (SEM) study of different types of graphite crystals was carried out at the Department of Geosciences, Shizuoka University, Japan.

4. Some major brittle faults and fracture zones in central Sri Lanka were analysed and studied, and samples from fault rocks were collected for further studies. This work is being continued (This work is funded by the NSF and is being continued).

5. XRD and SEM analyses of cataclastic rocks collected from one of the major faults in Sri Lanka were carried out at the Department of Geosciences, Shizuoka University, Japan.

6. The seismic activity in the Indian Ocean around Sri Lanka was monitored by studying earthquakes reported in the USGS website. (I am a subscriber of the USGS National Earthquake Information Centre.). This work is being continued.

7. The earth tremor occurred near Ulapane, SW of Kandy on 27.04.2006 was investigated. This study showed that an earth tremor with a possible magnitude of around 3 on the Ritcher scale has occurred along a local fault near Ulapane. An analysis of satellite images from the Gampola-Ulapane-Kothmale area show that a large number of brittle fracture zones occur in the area studied.

8. A large number of houses that have developed cracks in the walls and floors in the Matale, Kengalla, Menikhinna and Kotmale areas were studied with a view to understand the causes for the development of cracks. Models developed for understanding of the development of cracks indicate that they are not caused by any natural disasters, but mainly due to the following causes.

   (i) Poor preparation of the ground,
   (ii) Settling of the filled up ground,
   (iii) Poor construction of foundations and walls,
   (iv) Contraction of the clayey soil under the floors of the houses during dry seasons
   (v) Poor drainage system
   (vi) Low quality building materials
   (vii) Slope failures especially on filled up ground and in colluvium

9. Potential landslides areas in the Kotmale region and along the Kandy-Nuwara Eliya, Kandy-Colombo and Teldeniya-Hasalaka roads were identified and predicted their occurrence. Although the public was made aware of some of these landslides through the media, no serious attention was paid. Several such identified areas underwent landslides, killing people and destroying property. The best example of such predicted landslide was the one occurred on 10.11.2006 at Paradeka, which killed 6 people, along the Kandy-Nuwara Eliya road.

10. Preliminary study of the Ussangoda serpentine deposit was carried out with a view to understand its origin and economic potential of such deposits. The work so far carried out indicates that the deposit is located at a major tectonic boundary showing characteristics of a subduction zone. (This work is funded by the NSF and is being continued).

PUBLICATIONS IN REFEREED JOURNALS IN 2006:

1.* *Title:* The role of Sri Lanka and Associated Continental Blocks in the Assembly and Break-up of Rodinia and Gondwana. Special Issue
Editors: **Kehelpannala K.V.W** and Collins A.
Journal: ***Journal of Asian Earth Sciences (Elsevier International Journal),*** **28(1)**: 1-115 (2006)[2]

2.* *Title:* The role of Sri Lanka and associated continental blocks in the assembly and break-up of Rodinia and Gondwana. Introduction
Authors: **Kehelpannala K.V.W** and Collins A.
Journal: ***Journal of Asian Earth Sciences,*** **28:** 1-2 (2006)[2]

3.** *Title:* Metamorphic evolution of high-pressure and ultrahigh-temperature granulites from the Highland Complex, Sri Lanka
Authors: Osanai Y., Sajeev K., Owada M., **Kehelpannala K.V.W.**, Prame W.K.B.N and Nakano N.
Journal: ***Journal of Asian Earth Sciences,*** **28:** 20-37 (2006)[2]

4. *Title:* Cataclastic rocks from the granulite terrain of Sri Lanka: evidence for younger brittle deformation of the exhumed lower crust
Authors: **Kehelpannala K.V.W.**, Wada H., **Ranaweera L.**, and Hamana N
Journal: ***Geoscience Reports of Shizuoka University*, 33:** 9-19 (2006)

* ***Reported as "in press" in Annual Research Report 2005***
** ***Reported as "in press" in Annual Research Report 2004***
[1] ***Listed in the Science Citation Index in 2006***
[2] ***Listed in the Science Citation Index-expanded in 2006***

OTHER ARTICLES:

1. **Kehelpannala K.V.W.**
Report of the Institute of Fundamental Studies on Geo-Hazards
Proceedings of the Seminar on "Current Geo-Hazards and Remedial Measures", Geological Survey & Mines Bureau, Colombo, 8th December 2006, 41-46.

ABSTRACTS/CONFERNECE PROCEEDINGS IN 2006:

1. **Ranaweera L.** and **Kehelpannala K.V.W.**
Geological and structural evolution of deep part of a boundary between two Precambrian plates in Sri Lanka
10th Anniversary Celebrations of the Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka, 28, 28th April 2006

2. Jackson, K.L., Amelung, F., Andres, M. S., Eberli, G. P., Peterson, L.C., Jayasena, H.A.H., **Kehelpannala, K.V.W.**, Peter, K. S. and Rankey, E.
Tsunami sediments in coastal lagoons, Sri Lanka: Implication for paleotsunamis
Association for American Petroleum Geologists Annual Meeting, Houston, Texas, USA, 9-12 April 2006

3. **Kehelpannala, K.V.W.**, The geodynamic evolution of Sri Lanka – A review. American Geophysical Transactions
AGU *Fall Meeting 2006, San Francisco, USA, 11-15 December 2006*

4. Jackson, K.L., Rankey, E. C., Eberli, G. P., Amelung, F., Andres, M. S., Peterson, L.C., Swart, P. K., Jayasena, H.A.H. and **Kehelpannala, K.V.W.**
Paleotsunami deposits in coastal lagoons, Sri Lanka: Can we use paleotsunamis to estimate recurrence intervals? American Geophysical Transactions. AGU Fall Meeting 2006, San Francisco, USA, 11-15 December 2006.

INVITED LECTURES/CONFERENCES ATTENDED IN 2006 (INTERNATIONAL):

1. Invited lecture on "Recent Advancements of the Geological Evolution of the Basement of Sri Lanka" at the **Kyushu University, Kyushu, Japan**, on 25th February 2006.

2. Invited lecture on "The Effect of The Indian Ocean Tsunami on Sri Lanka" at the **Kyushu University, Kyushu, Japan**, on 25th February 2006.

3. Invited lecture on "The Geological Evolution of Sri Lanka: Relevance for Rodinia and Gondwana Supercontinent Formation" at the International Symposium on "Material Science and History of Earth and Sister Planets", **Okayama, Japan**, 29-31 March 2006.

4. Invited talk on "Geodynamic Evolution of Sri Lanka: A Review" at the International American Geophysical Union Fall Meeting, **San Francisco, USA**, 11-15 December 2006.

5. Invited participant at the Press Conference organized by the American Geophysical Union at the Fall Meeting, **San Francisco, USA**, 15th December 2006.

6. Invited panellist at the Discussion on "Earth Science in Conflicted Terrane" at the American Geophysical Union Fall Meeting, **San Francisco, USA**, 15th December 2006.

INVITED LECTURES/CONFERENCES ATTENDED IN 2006 (NATIONAL):

1. Presentation on "What is Happening in Matale and Kotmale, and the Safety of Hydropower Dams in Sri Lanka" at the Ministry of Disaster Management & Human Right, Colombo, 11.07.2006.

2. Presentation on "Cracks developed in the Kengalla-Hurikaduwa area" at the Ministry of Disaster Management & Human Right, Colombo, 21.08.2006.

3. Invited guest lecture on "The effect of the Indian Ocean tsunami in Sri Lanka, and causes of development of cracks in houses in Sri Lanka" at the Science Day, Vijaya National School, Matale, 17th November 2006.

4. Invited talk on "Landslides in the Kandy district: causes, mechanisms, recognition and mitigation", Seminar organized by the Kandy District Secretary at the Kandy District Secretariat, Kandy, 05th December 2006.

5. Presentation on "Geo-hazards effecting Sri Lanka". Seminar on "Current Geo-Hazards and Remedial Measures", organized by the Geological Survey & Mines Bureau, Colombo, 8th December 2006.

OTHER CONTRIBUTIONS IN 2006:

a) WORKSHOPS CONDUCTED IN 2006:

1. Conducted a workshop on "Landslides in the Kotmale area" for Grama Sevakas and Villagers, organized by the Kotmale Divisional Secretariat, Kotmale, 16th November 2006.

b) TELEVISION PROGRAMMES ON NATURAL DISASTERS

1. Short TV programme on "Potential landslides along the Kandy-Nuwara Eliya road" in "Live at 8" News Bulletin at 8.00 pm., Swarnavahini TV, 5th November 2006.

2. Short TV programme on "Potential landslides in the hill country" in News Bulletin at 8.00 pm., Pupavahini Government TV, 20th November 2006.

3. Short TV programme on "Sub-surface water channels in marble in the Uduwela area" in News First, News Bulletin at 7.00 pm., Sirasa TV, 25th November 2006.

4. Short TV programme on "Sub-surface water channels in the Uduwela area", in the programme "Good Evening (Suba Sandyavak)", Swarnavahini TV, 30th November, 2006.

5. TV programme on "Sub-surface water channels in the Uduwela area", Derana TV, December 2006.

RADIO PROGRAMMES ON NATURAL DISASTERS

1. A 30 minute-radio programme on "Landslides and Slope Instabilities", "Kandurata Sevaya" – Government Regional Radio Channel, 12 July 2006.

2. A 30 minute-radio programme on "Cracks developed in houses in Matale and Kotmale", "Kandurata Sevaya" – Government Regional Radio Channel, 19 July 2006.

3. Short radio programme on "Potential landslides in the hill country" in the News Bulletin at 12.45 pm, Government Radio Channels, 14th November 2006.

NEWS PAPER ARTICLES ON NATURAL DISASTERS:

1. "The crack in the Kotmale dam is dangerous", "Lakbima" National Newspaper, 10th July 2006.

2. "A journey to an underground channel at the Hantana range" (in Sinhalese), "Lanka" National Newspaper, 23th July 2006.

3. "The highland reservoirs that show risks" (in Sinhalese), "Lakbima" National Newspaper, 29th July 2006.

4. "Why houses in the Matale and Kotmale regions are cracked?", "Lakbima" National Newspaper, 16th August 2006.

5. "An underground water channel is found in an estate in Hantana" (in Sinhalese), "Lankadeepa" National Newspaper, 29th November 2006.

In addition to these, several news items on natural disasters appeared in "Lakbima", "Lanka", "Lankadeepa" and "The Sunday Times" newspapers.

FELLOWSHIPS AND AWARDS:

1. **Kehelpannala K.V.W.**
   DAAD Re-invitation Fellowship (October-November 2005)*.

2. **Kehelpannala K.V.W.**
   Invited Visiting Professor, University of Shizuoka, Japan (January-March 2006).

**** Not included in the Annual Research Report 2005.***

SCIENCE DISSEMINATION

Tilakaratne C.T.K. and Sellam S.

Research colloquia, public lectures, research meetings and the science popularization programme for schools were conducted as in the previous years in keeping with the IFS commitment to fundamental science.

(A) Research meetings, research colloquia, special lectures, 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. Special lectures were arranged to expose researchers in the IFS and other institutions, to visitors who come to IFS. In addition, public lectures were organised to promote the public understanding of science.

(B) Awareness and educational programmes for students

(i) School Science Programme: (SSP)

The School Science Program (SSP) is one of the most important annually conducted programs for the dissemination of science among the younger generation. The theme for 2006 is on importance of fundamental studies.

(iv) Visits: Lab visits were organised for

Postgraduate students
Undergraduate students
Students from other institutions
School children and teachers

Special lecture on IFS and its activities were prepared in advance to enable these students to understand the IFS activities better.

(C) Preparation of Scientific reports/bulletins:

Annual Research Report 2005 was compiled. Mid year report and quarterly research reports were prepared.

On request, Statistical and Scientific Reports about IFS were prepared for other institutions (National Science Foundation, National Library etc.).

Pragñā- ***IFS Science Bulletin:*** Three volumes of the Bulletin were published this year. These were distributed to schools , research institutes, universities and scientists.

(D) Science and Technology Promotion

- **Electronic English-Tamil Science glossary** -(*Vinghana Padangal* "விஞ்ஞான பதங்கள்) with an intelligent search engine was developed and published in Compact disk form jointly with Prof. A. Nanayakkara. This contains 45,000 words in the fields of Biology, Chemistry, Computer Science, Physics, and Mathematics.

- **Sinhala Science Web"විදු ම‍ං ගෙත"**:
  Tilakaratne C.T.K. and **Nanayakkara A.** Designed/developed a Sinhala Science WEB site (**www.sbwcatkan.org**) which is being developed for sharing latest scientific knowledge in Sinhala (THIS WEB SITE CONTAINS OVER 150 WEB PAGES AND THIS IS THE FIRST WEB SITE IN SRI LANKA OF THIS NATURE).

  This web includes information on

  1. Latest cure for terminal illnesses which may otherwise not be available to Sinhala speaking readers.

  2. Electronic (on-line) scientific glossaries in English-Sinhala for the subjects such as Chemistry, Physics, Mathematics, Zoology and Botany.

  4. Information on interesting and timely scientific events and News items (in Sinhala) on recent significant Scientific discoveries and inventions.

- Free version of the English-Sinhala electronic Science glossary (*Vidu Hela Vadan*- "විදු හෙළ වදන්") & English-Tamil Science electronic glossary (*Vinghana Padangal- "*விஞ்ஞான பதங்கள்") -with an intelligent search was distributed among the School science programme participants.

(E) Auditorium was rented out for outsiders on seven occasions.

RESEARCH MEETINGS

01.02.2006 **Plants and Heavy Metals**
Ms. K.M.L. Kulasekera, Research Assistant

15.02.2006 **Community composition of benthic macro invertebrates of Heen Ganga tributaries in the Knuckles region**
Ms. W.M.D. Weerasinghe, Research Assistant, IFS

29.03.2006 **Theoretical investigation on band positions of some conducting polymers**
Ms. S.B.M.S. Senevirathne, Research Assistant, IFS

19.04.2006 **Interactions between Fungi and Bacteria for Biofilm formation and its implications**
Mr. W.M.M.S. Bandara, Research Assistant, IFS

03.05.2006 **Chemistry and Biological activity studies of some Sri Lankan seaweeds**
Mr. M. Haroon, Lecturer/Chemistry, South Eastern University of Sri Lanka, Oluvil and Postgraduate student, IFS

17.05.2006 **Dye-sensitized photoelectrochemical solar cell based on SnO_2/MgO composite**
Mr. P.K.D.D.P. Pitigala, Research Assistant, IFS

07.06.2006 **Biotechnological potential of Biofilms in drug discovery**
Ms. J.S. Zavahir, Research Assistant, IFS

09.06.2006 **Chromopore linked polymers as fundamental units for solar energy conversion**
Ms. M.K.I. Senevirathne, Research Assistant, IFS

19.07.2006 **Photovoltaic Effects of Dye deposited Metal Electrodes in Electrolytic media**
Mr. E.V.A. Premalal, Research Assistant, IFS

02.08.2006 **Tracing of a pre-Cambrian Plate boundary: An example from Sri Lanka**
Mr. L.V. Ranaweera, Research Assistant, IFS

06.09.2006 **Somatic Embryogenesis and artificial seed production in gigant Bamboo (Dandrocalamus giganteus)**
Ms. K.M.M.N.Maddegoda , Research Assistant, IFS

20.09.2006 **Chemistry and Biological Activity Studies of Endophytic Micro organisms**
Ms. R. Premaratne, Research Assistant, IFS

08.11.2006 **Development of electrodes for Li-ion rechargeable batteries**
Mr. Pushpaka Samarasingha, Research Assistant IFS

15.11.2006 **Photo responses of Copolymers Based on Derivatives of Thiophone Units**
Mr. J.M.R.C. Fernando, Research Assistant, IFS

22.11.2006 **Effect of organo-chalcogen donor molecule; BEDT-TTF, on the efficiency enhancement of the Polymer sensitized solar cell**
Ms. N de Silva, Research Assistant, IFS

29.11.2006 **Plant regeneration from rice callus *in vitro***
Ms. T.P. Wijesekara, Research Assistant, IFS

28.12.2006 **Development of Beneficial Microbial Biofilms for improved Plant Growth**
Ms. M.L.M.A.W. Weerasekara, Research Assistant, IFS

RESEARCH COLLOQUIA

08.02.2006 **Diagnosis of Tuberculosis by DNA Amplification**
Dr. D.N. Magana-Arachchi, Research Fellow, IFS

08.03.2006 **Development of cathode materials for the molten carbonate fuel cell (MCFC)**
Dr.A. Wijayasinghe, Research Fellow, IFS

PUBLIC LECTURES

18.01.2006 **A science - web site in Sinhala**
Dr. C.T.K. Tilakaratne, Coordinator, Science Dissemination Unit, IFS

15.03.2006 **Remote Sensing and its Application**
Mr. A.M.S.B. Adikari, Environmental and Forest Conservation, Mahaweli Authority of Sri Lanka, Polgolla

05.04.2006 **Coconut in the diet and the risk of cardiovascular diseases**
Dr. U.P. de S. Waidyanatha, Former Chairman, Coconut Research Institute, Lunuwila

06.04.2006 **Conservation of Primates**
Dr. Sindhu Radakrishnan, Indian Institute of Science

27.09.2006 **Nuclear Proliferation and Sri Lanka**
Lieutenant Colonel C.J.S. Weerakoon, Sri Lanka Army, Colombo

25.10.2006 **What is happening in the Matale and Kotmale area**
Dr. K.V.W. Kehelpannala, Senior Research Fellow, IFS

SPECIAL LECTURES

23.06.2006 **Robotic Exploration of the Solar System and Beyond**
Dr. Sarath Gunapala, Jet-Propulsion Laboratory, USA

11.09.2006 **The Problem of Mass**
Prof. L.C.R. Wijewardhana, Professor of Physics, University of Cincinnati and Visiting Professor, IFS

WORKSHOPS AND SEMINARS

25.01.2006 Young Researchers' Forum organised by PGIS, Peradeniya in collaboration with IFS at IFS.

17.02.2006 Training Programme for Science Teachers from Kegalle zone.

14.07.2006 **Instrumentation Workshop** organized by Prof. R. Weerasooriya for final year students of Faculty of Agriculture, Rajarata University of Sri Lanka.

25.08.2006
26.08.2006 Training Workshop on Skills for Science Communication to the Public organized by the NSF Special Committee on Popularization of Science in collaboration with the IFS.

11.10.2006 Short Course on Theory and Practice of FTIR Spectroscopy conducted by Prof. K. Tennakone, IFS and Dr. Atula Bandara, University of Peradeniya.

EDUCATIONAL VISIT

26.01.2006 Undergraduate students from Department of Botany, University of Peradeniya.

27.01.2006 Undergraduate students from Department of Botany, Open University of Sri Lanka.

04.04.2006 Students from Rippon Balika Maha Vidyalaya, Galle.

23.07.2006)
24.07.2006) Students from Sabaragamuwa University of Sri Lanka.

03.10.2006 Undergraduate students from Faculty of Engineering, University of Moratuwa.

22.12.2006 Undergraduate students from Faculty of Science, University of Peradeniya.

SPECIAL PROGRAMME FOR SCHOOL CHILDREN

03.02.2006 Demonstration Experiment Program at 10.00 a.m. for Grade 10 and 11 students from Kandy/Sivananda Tamil School.

SCHOOL SCIENCE PROGRAMME
11-13 TH DECEMBER, 2006

11th December

Why we should pursue fundamental Studies?
Prof. K. Tennakone

The Warming Planet
Prof. C. Santiapillai

12th December

What is the world made of? What holds it together?
Prof. A. Nanayakkara

Molecular Biology - The biology of a cell at the molecul level
Dr. D.N. Maganaarachchi

13th December

Primate Behavior, Ecology and Conservation
Dr. W.P.J. Dittus

Orbital Towers and Space Elevators
Prof. W. Stuiver

RESEARCH ASSISTANTS 2006

The period mentioned within brackets shows their stay at IFS

Research Assistants (Grade I)

Bandara W.M.M.S.	*(17.03.2005-todate)*
Jayaweera P.V.V	*(03.04.2000-todate)*
Piyasena K.G.N.P.	*(01.06.2002-todate)*
Premaratne S.R.	*(01.09.2005-todate)*
Rathnayake R.R.	*(15.01.2001-todate)*
Wijesekara K.B.	*(16.06.2003-todate)*
Wijesekera T.P.	*(01.05.2004-todate)*
Zavahir J.S.	*(01.09.2005-todate)*

Research Assistants (Grade II)

Amarasinghe N.R.	*(17.11.2003-todate)*
Ariyaratne R.A.Y.K.	*(15.03.2006-todate)*
Ariyasinghe Y.P.Y.P.	*(01.11.2006-todate)*
Balasuriya B.M.G.K	*(03.11.2003-todate)*
Bandaranayake K.M.P.	*(17.04.2000-todate)*
Banneheka B.M.N.M.S.	*(08.05.2006-todate)*
Chaturani G.D.G.	*(03.04.2006-todate)*
de Silva N.	*(15.07.2002-todate)*
Fernando W.I.T.	*(15.07.2002-28.03.2006)*
Gnanakkan D.T.	*(01.02.2005-29.01.2006))*
Gunawardene D.C.	*(01.03.2006-todate)*
Jayarathna I.P.L.	*(01.12.2006-todate)*
Kumara I.G.C.K.	*(03.07.2006-todate)*
Maddegoda K.M.M.N.	*(03.01.2005-todate)*
Pitigala P.K.D.D.P.	*(01.07.2002-30.06.2006)*
Premalal E.V.A.	*(20.05.2004-todate)*
Priyanwada N.H.N.	*(03.07.2006-todate)*
Ranaweera L.V.	*(03.11.2003-todate)*
Samarasinghe P.B.	*(01.12.2005-todate)*
Seneviratne M.K.I.	*(01.09.2003-todate)*
Senevirathne S.B.M.S.	*(15.12.2003-todate)*
Senevirathna H.R.W.U.	*(20.12.2004-todate)*
Vitharana M.C.	*(03.01.2005-28.01.2006)*
Wanigatunga R.P.	*(03.04.2006-todate)*
Weerasinghe W.M.D.	*(01.01.2004-todate)*
Weerasinghe H.A.S.	*(15.03.2006-todate)*
Weerasekara M.L.M.A.W.	*(01.09.2005-todate)*
Yasomanee J.P.	*(01.12.2005-todate)*
Zahmeeth S.S.	*(01.06.2006-todate)*

Project Leaders are responsible for authenticity of reports they have submitted.