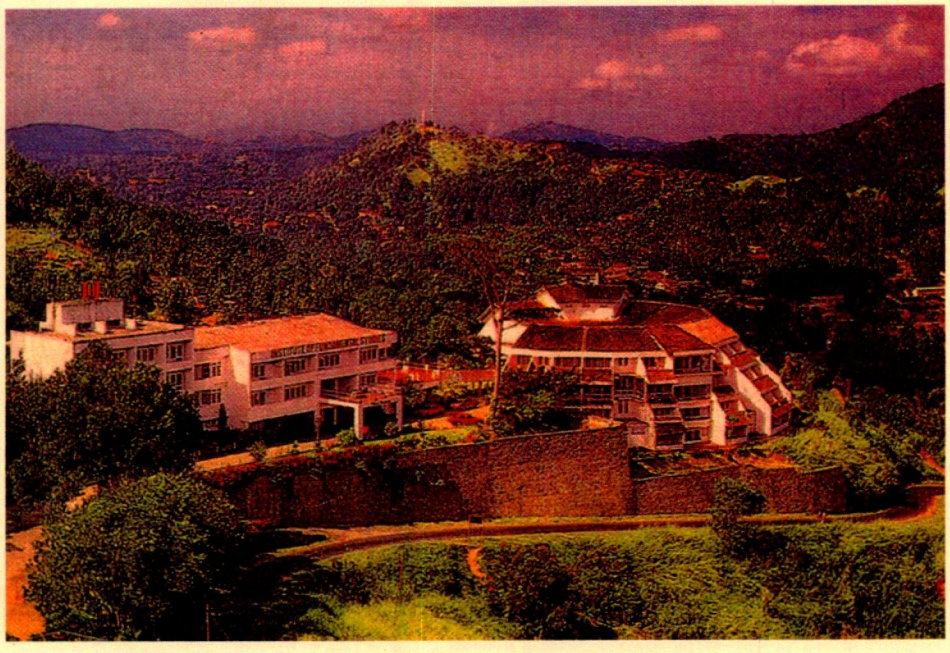
ANNUAL RESEARCH REPORT 2000



Institute of Fundamental Studies
Hantana Road, Kandy
Sri Lanka

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ANNUAL RESEARCH REPORT
2000

CONTENTS

PUBLICATIONS IN REFEREED JOURNALS 2000

(° Journals listed in the Science Citation Index 1999, Please refer page 05 for the Journal Impact Factor)

1. Athukoralage P.S., **Herath H.M.T.B.**, Deraniyagala S.A., Wijesundera R.L.C., and **Weerasinghe P.A.** Antifungal activity studies of *Gordonia dassanayakei*, ***Fitoterapia°*** (in press).

2. Ayers A.E., Klapötke T.M., and **Dias H.V.R.** "Azido Derivatives of Germanium(II) and Tin(II): Syntheses and Characterization of [(Mes)2DAP]GeN3, [(Mes)2DAP]SnN3, and the Corresponding Chloro Analogues Featuring Heterocyclic 6-π-Electron Ring Systems". ***Inorganic Chemistry°*, 39** (in press).

3. **Bandara J.** and **Tennakone K.** Interparticle charge Transfer in Dye-Sensitized Films Comprising of Two Kinds of Semiconductor Crystallites. ***Journal of Colloids and Interfacial Science°*** (in press).

4. ***Dias H.V.R.** and Jin W. Low Valent Gallium, Indium, and Tin Compounds that Contain a Highly Fluorinated Tris(pyrazolyl)borate Ligand: Syntheses and Characterization of [HB(3,5-$(CF_3)_2$Pz) 3]Ga, [HB(3,5-$(CF_3)_2$Pz)3]In, and [HB(3,5-$(CF_3)_2$Pz) 3]Sn(CF_3SO_3). ***Inorganic Chemistry°*, 39**, 815-819 (2000).

5. ***Dias H.V.R.**, Polach S.A., and Wang Z. Coinage Metal Complexes of 3,5-bis(trifluoromethyl) pyrazolate Ligand: Synthesis and Characterization of {[3,5-$(CF_3)_2$Pz]Cu}3 and {[3,5-($(CF_3)_2$Pz]Ag}3. ***Journal of Fluorine Chemistry°*, 103**, 163-169 (2000).

6. ***Fernando G.W.**, Watson R.E., Weinert M., Kocharian A., Ratnaweera A., and Tennakone K. Magnetic Moment of Iron in Metallic Environments. ***Physical Review B°*,61**,375 (2000).

7. **Fernando G.W.**, Sevilla E.H., and Cooper B.R. Theoretical Study of Relativistic Effects in the Electronic Structure of Plutonium. ***Physical Review B°*, 61**,12562 (2000).

8. ***Herath H.M.T.B.**, Athukoralage P.S., and Jamie J.F. Two new oleanane triterpenoids from *Gordonia ceylanica* and their conversions to taraxarane triterpenoids. ***Phytochemistry°*, 54**(8), 823-827 (2000).

9. ***** **Herath H.M.T.B.** and Padmasiri W.W. Demethyldactyloidin and other constituents in *Myristica ceylanica*. ***Natural Product Letters°*, 14**(2), 141-146 (1999).

10. **Herath H.M.T.B.** and Athukoralage P.S. Triterpenoids of *Gordonia dassanayakei*. ***Natural Product Sciences*, 6**, 102-105 (2000).

11. **Herath H.M.T.B.** and Susila de Silva. New constituents from *Gliricidia sepium*. ***Fitoterapia°*, 71**(6), 722-724 (2000).

12. *Hoffman D.K., **Gunaratne G.H.**, Zhiang D.S., and Kouri D.J. Fourier Filtering of Images. ***Chaos°***, **10**, 240-247 (2000).

13. ***Jayasinghe U.L.B.**, Nadeem M., Atta-ur-Rahman, and Choudhary M.I. 11-Hydroxyepipachysamine-E, A New steroidal alkaloid from *Sarcococca brevifolia*. ***Natural Product Letters°***, **14**, 293-298, (2000).

14. **Jayasinghe U.L.B.**, Kumarihamy B.M.M., Nadeem M., Choudhary M.I., Attta-ur-Rahman, and Weerasuriya A. *iso*-N-formyl-5-en-chonemorphine, A Steroidal alkaloid from *Sarcococca zeylanica*. ***Natural Product Letters°*** (in press).

15. **Jayasinghe U.L.B.**, Vithana H.S.K., Wannigama G.P., and Fujimoto Y. 24-Methylenecycloartenone from *Bhesa nitidissima*. ***Fitoterapia°*** (in press).

16. **Kehelpannala K.V.W.** and Ratnayake R.M.J.W.K. Polyphase migmatization of layered basic rocks in the Wanni Complex of Sri Lanka. ***Gondwana Research°*** (in press).

17. **Kehelpannala K.V.W.** Scapolite-bearing pyroxenites from the high-grade gneiss terrain of Sri Lanka. ***Gondwana Research°*** (in press).

18. Kroener A., Collins A.S., Henger E., Willner A.P., Muhongo S., and **Kehelpannala K.V.W.** The East African Orogen: New Zircon and Nd ages and implications for Rodinia and Gondwana Supercontinent formation and dispersal. ***Gondwana Research°*** (in press).

19. Kumara G.R.R.A., Konno A., **Senadeera G.K.R.**, Jayaweera P.V.V., de Silva D.B.R.A., and **Tennakone K.** Dye-sensitized solar cell with the hole collector p-CuSCN deposited from a solution in n-propel sulphide. ***Solar Energy Materials and Solar Cells°*** (in press).

20. Kumara G.R.R.A., Konno A., and **Tennakone K.** Photoelectrochemical Cells made from SnO_2/ZnO films Sensitized with Eosin Dyes. ***Chemistry Letters°*** (in press).

21. Kumara G.R.R.A., **Tennakone K.**, Perera V.P.S., Konno A., Kaneko S., and Okuya M. Suppression of recombinations in a dye-sensitized photoelectrochemical cell made from a film of tin (iv) oxide crystallite coated with a thin layer of aluminium oxide. ***Journal of Physics D°*** (in press).

22. Miransky V.A., Shovkovy I.A., and **Wijewardhana L.C.R.** Bethe-Salpeter equation for diquarks in color flavor locked phase of cold dense QCD. ***Physical Review D°*** (in press).

23. *Moellers C., Nehlin L., Glimelius K., and **Iqbal M.C.M.** Influence of *in vitro* culture conditions on biosynthesis of glucosinolates in microspore-drived embryos of *Brassica napus*. ***Physiologia Plantarum°***, **107**, 441-449 (1999).

24. ***Ramasamy M.S.**, Srikrishnaraj K.A., Hadjrini N., Perera S., and Ramasamy R. Physiological aspects of multiple blood feeding in the malaria vector *Anophelese tessellatus*. ***Journal of Insect Physiology°***, **46**,1051-10059 (2000).

25. ***Seneviratne G.**, Van Holm L.H.J., and Ekanayake E.M.H.G.S. Effect of peat and coir-dust-based rhizobial inoculants on the nodulation, plant growth and yield of Soybean (*Glycine max* [L.] Merril) cv PB 1. ***Tropical Agricultural Research and Extension***, 2, 133-135 (1999).

26. ***Seneviratne G.** Litter quality and nitrogen release in tropical agriculture: a synthesis. ***Biology and Fertility of Soils°***, 31, 60-64 (2000).

27. **Seneviratne G.** Litter nitrogen release in tropical agroecosystems. ***Current Science°***, 79, 1054 (2000).

28. **Seneviratne G.**, Van Holm L.H.J., and Ekanayake E.M.H.G.S. Agronomic benefits of rhizobial inoculant use over nitrogen fertilizer application in tropical soybean. ***Field Crops Research°***, 68, 199-203 (2000).

29. **Seneviratne G.** and Ekanayake E.M.H.G.S. *Sesbania rostrata:* a simple method of producing the green manure to achieve N synchrony in lowland rice. ***International Rice Research Notes***, 26 (in press).

30. ***Silva E.I.L.** and Davies R.W. The Effects of Simulated Irrigation Induced Changes in Salinity on Metabolism of Lotic Biota. ***Hydrobiologia°***, 416, 193-202 (2000).

31. **Silva E.I.L.** and Gamlath G.A.R.K. Catchment Characteristics and Water Quality of three FISHSTRAT Reservoirs (Victoria, Minneriya and Udawalawe) in Sri Lanka. ***Sri Lanka Journal of Aquatic Science***, 5, 55 - 73 (2000).

32. ***Silva E.I.L.** and Manuweera L. Surface and Rain Water Quality in Sri Lanka - A Risk of Acidification. ***The Science of the Total Environment°*** (in press).

33. **Silva E.I.L.** and Schiemer F. Hydraulic Changes of three FISHSTRAT Reservoirs (Minneriya, Udawalawe and Victoria) in Sri Lanka. ***Sri Lanka Journal of Aquatic Science***, 5, 75 - 86 (2000).

34. **Silva E.I.L.**, Shimizu A., and Matsunami A. Salt Pollution in a Japanese Stream and its Effects on Water Chemistry and Epilithic Algal Chlorophyll -*a*. ***Hydrobiologia°*** (in press).

35. Smith K.K., **Dharmaratne H.R.W.**, Feltenstine W.M., Broom S.L., Roach J.T., Nanayakkara N.P.D., Khan I. A., and Sufka J. Anxiolytic Effects of Kava extracts and Kavalactones in the chick social separation -stress paradigm. ***Psychopharmacology°*** (in press).

36. Surendran S.N., Abhayawardana T.A., de Silva B.G.D.N.K., Ramasamy R., and **Ramasamy M.S.** *Anopheles culicifacies* Y chromosome dimorphism indicates sibling species (B and E) with different vector potential in Sri Lanka. ***Medical and Veterinary Entomology°***, 14, 437-440 (2000).

37. **Tennakone K.** and **Bandara J.** Photocatalytic Activity of dye-sensitized tin(IV) oxide particles attached zinc oxide particles: Long distance electron transfer via ballistic transport of electrons across nanocrystallites. ***Applied Catalysis A (General)°*** (in press).

38. **Tennakone K., Senadeera G.K.R.**, de Silva D.B.R.A., and Kottegoda I.R.M. Highly stable dye-sensitized solid-state solar cell with the semiconductor $4CuBr.3S(C_4H_9)_2$ as the hole collector. ***Applied Physics Letters°***, **77**, 2367 (2000).

39. ***Weerasinghe P.A.**, Wijesekara M.L.M.C., and Van Holm L.H.J. Use of isozymes to differentiate growth categories of *Pericopsis mooniana* trees. ***Journal of Biologia Plantarum°***, **42**, 541-547 (1999).

40. ***Weerasinghe P.A.**, Van Holm L.H.J., Kumari D.L.C., and Serasinghe P.S.J.W. Effect of foliar application of chelated micronutrients on tea (*Camellia sinensis*) yield. ***Tropical Agricultural Research and Extension*** (in press).

41. **Weerasooriya R.** and Dharmasena B. Pyrite-assisted degradation of TCE. ***Chemosphere°*** (in press).

42. ***Weerasooriya R.** and Tobschall H.J. On the mechanistic modeling of chromate adsorption onto goethite. ***Colloids and Surfaces°***, **162**, 167-175 (2000).

43. **Weerasooriya R.**, Dharmasena B., and Aluthpatabendi D. Copper-gibbsite interactions: an application of 1-pK surface complexation model. ***Colloids and Surfaces°*** (in press).

****Reported as "in press" in the annual Research Report 1999.***

IMPACT FACTORS OF JOURNALS IN WHICH THE ARTICLES ARE PUBLISHED

Journal	Impact factor
Applied Catalysis A (General)	1.557
Applied Physics Letters	4.184
Biology and Fertility of Soils	1.270
Chaos	2.006
Chemistry Letters	1.536
Chemosphere	1.255
Colloids and Surfaces	0.944
Current Science	0.562
Field Crops Research	1.062
Fitoterapia	+
Gondwana Research	0.415
Hydrobiologia	0.703
Inorganic Chemistry	2.843
International Rice Research Notes	-
Journal of Biologia Plantarum	0.414
Journal of Colloids and Interfacial Science	1.614
Journal of Fluorine Chemistry	0.701
Journal of Insect Physiology	1.251
Journal of Physics D	1.188
Medical and Veterinary Entomology	1.268
Natural Product Letters	0.732
Natural Product Sciences	-
Physical Review B	3.008
Physical Review D	3.695
Physiologia Plantarum	2.460
Phytochemistry	1.106
Psychopharmacology	2.918
Science of the Total Environment	1.126
Solar Energy Materials and Solar Cells	0.587
Sri Lanka Journal of Aquatic Science	-
The Science of the Total Environment	1.126
Tropical Agricultural Research and Extension	-

\+ Listed in the Science Citation Index, Impact Factor not computed (impact factors are computed to an accuracy of three decimal places)

\- Not listed in the Science Citation Index

PROJECT: **APPLIED MATHEMATICS**
DEVELOPMENT OF DIAGNOSTICS FOR OSTEOPOROSIS

COMMENCEMENT: 1999

INVESTIGATORS:

Gunaratne G.H., Visiting Research Professor (1997-to date)
Tennakone K., Research Professor (1987-to date)

PROGRESS ACHIEVED:

Background: Osteoporosis is a major socio-economic problem in an aging population. Unfortunately, therapeutic agents which can prevent and even reverse osteoporosis often induce adverse side effects. Thus, non-invasive diagnostic tools to determine the need for therapeutic intervention are essential for optimal management of osteoporosis. Bone Mineral Density (BMD) is the principal such investigative tool. Ultrasound transmission through bone and geometrical characteristics of the trabecular architecture (TA) are being studied as additional diagnostics.

We propose an approach to develop new and effective diagnostic tools for osteoporosis which combines mathematical modeling, mechanical studies of osteoporotic bone, and a finite element analysis of digitized images of TAs. The mathematical model, whose form is suggested by images of trabecular architectures, is a disordered cubic network of fragile springs. "Osteoporosis" is imposed by random removal of springs, while "therapeutic regeneration" is modeled by strengthening springs that experience large strain (as suggested by Wolff's law). Numerical studies of the system show analogs of several known mechanical properties of bone including, (1) an initially linear stress vs. strain curve that becomes nonlinear beyond the yield point, (2) an exponential decay of the ultimate stress with decreasing BMD, and 3) a dramatic increase of bone strength (disproportionate to the improvement of BMD) following therapeutic intervention. We expect a comprehensive analysis of the model to elucidate the principal differences between healthy and osteoporotic bone. Candidates for diagnostic tools will be introduced based on their ability to quantify these differences.

Progress: Numerical studies show a fundamental difference between stress propagation in "healthy" and "weak" networks. Elastic elements experiencing large stresses lie on a dense subset in the former and along a few coherent pathways in the latter. This variability can be quantified using the ratio Γ of responses of the network to static and periodic strain. For a wide range of control parameters, Γ bears the same bi-linear relationship to the ultimate stress of the network. Thus nonlinear response can be considered a candidate a diagnostic tool.

PROJECT OUTOUT 2000:

Development of the model, and identifying the measure Γ as a possible surrogate for bone strength. We are expecting to begin a collaboration to study bones samples from rats subjected to induced loss of bone mass. We will check if the results from the model can be extended to these bones.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Hoffman D. K., Gunaratne G. H., Zhang D. S., and Kouri D. J. A Method to Fourier Filter Textured Images. ***Chaos***, **10**, 240-247 (2000).

* *Reported as "in press" in the Annual Research Report 1999.*

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2000:

1. Gunaratne G. H., Bassler K. E., Mohanty K. K., and Wimalawansa S. J. Effects of Trabecular Micro-Architecture on the Breaking Strength in Osteoporosis: Mathematical modeling. *Proceedings of the ASMBR*, **22**, SA081, 2000.

2. Gunaratne G. H. Development of Non-Invasive Diagnostics for Osteoporosis: A Model Based Approach, University of Houston, October 2000.

3. Gunaratne G. H. Development of Non-Invasive Diagnostics for Osteoporosis: A Model Based Approach, University of Texas at Austin, November 2000.

PROJECT: **COMPUTATIONAL AND THEORETICAL PHYSICS, QUANTUM CHAOS**

COMMENCEMENT: March 2000

INVESTIGATORS:

Bandara V., Pre-University Student (2000)
Nanayakkara A., Senior Research Fellow (2000-to date)
Udalagama C., Research Assistant (2000)

PROJECT OUTPUT 2000:

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 Quantum Action Variable theory for multidimensional systems which bridges 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.

We have investigated both 1-D and 2-D systems classical mechanically and quantum mechanically. Also we examined new quantization conditions which can be used in multidimensional environment. A new quantization condition was developed for 1-D systems. Also a powerful asymptotic energy expansion method was developed for 1-D systems which is suitable for wide range of potentials. Results have been submitted to appropriate journals. Investigation of new quantization conditions for multidimensional systems and the extension of this new asymptotic energy expansion method for 2-D systems are in progress.

PROJECT: **PARTICLE PHYSICS AND QUANTUM FIELD THEORY**
PHYSICS OF HIGH DENSITY QUARK MATTER

COMMENCEMENT: 1997

INVESTIGATORS:

Wijewardhana L.C.R., Visiting Research Professor (1997-to date)

PROJECT OUTPUT 2000:

Quark matter at high density is a colour superconductor. It has been the subject of many studies for the last few years. This recent increased activity was initiated by the observation that the colour superconducting order parameter could be much larger than previously thought.

Because of asymptotic freedom, QCD becomes a weakly interacting theory at high densities. This allows one to obtain some rigorous results for dense quark matter in the asymptotic limit. Of course, from the viewpoint of phenomenology, it is desirable to have a theory valid at intermediate densities that could be produced in heavy ion collisions or could exist in nature (for example, inside neutron or quark stars). This dilemma is partially resolved by studying predictions of the theory at high densities and, then, extending their validity as far as possible to the region of interest. Notice that all the heavy quark flavors could be safely omitted from the analysis when probing the quark matter at realistic intermediate densities. As a result, one arrives at a model of dense QCD with either two ("up" and "down") or three ("up", "down" and "strange") flavors.

In the past year, we have analyzed the properties diquarks states with the quantum numbers of the Nambu-Goldstone (NG) bosons, in cold dense QCD with two and three flavors. Part of this research was carried out during a visit to the IFS.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. Miransky V.A., Shovkovy I.A., Wijewardhana L.C.R. Bethe-Salpeter equation for diquarks in color flavor locked phase of cold dense QCD. ***Physical Review D*** (in press).

PROJECT: CONDENSED MATTER THEORY

COMMENCEMENT: 1999

INVESTIGATORS:

Fernando G.W., Visiting Research Professor (1997-to date)
Tennakone K., Research Professor (1987-to date)

PROJECT OUTPUT 2000:

We are currently examining the fundamental aspects of first principles many body theory, including density functional theory. Work carried out with (current and former) students M. Rasamny and M. Valiev at University of Connecticut and UC San Diego, respectively. During the summer 2000, we had an undergraduate student from Cornell working on transport properties of magnetic heterojunctions. We also have an on-going project related to developing systematic interatomic potentials and studying diffusion of actinides in metallic systems. This is in collaboration with Prof. B. R. Cooper at West Virginia University and Dr. Elena Sevilla at University of Connecticut (UConn). We have a joint collaboration on catalytic systems with the IMS (Institute of Materials Science - UConn) and PCI (Precision Combustion Inc. in New Haven, CT) on a Critical Technologies Initiative. A post-doctoral fellow, Marwan Rasamny and a graduate student have been working on this project. Another project that is currently underway is a study of magnetism and structural properties of simple and complex oxides. This work is closely related to an experimental program on these materials under Profs. J. I. Budnick, D. Pease, Boris Sinkovic and Barry Wells in the Physics Department - UConn, and carried out in collaboration with Drs. R. E. Watson and M. Weinert at Brookhaven National Lab.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Fernando G.W., Watson R.E., Weinert M., Kocharian A., Ratnaweera A., and Tennakone K. Magnetic Moment of Iron in Metallic Environments. ***Physical Review B,*** **61**,375 (2000).

2. Fernando G. W., Sevilla E. H., and Cooper B. R. Theoretical Study of Relativistic Effects in the Electronic Structure of Plutonium. ***Physical Review B,*** **61**,12562 (2000).

* *Reported as "in press" in the Annual Research Report 1999.*

PROJECT: CONDENSED MATTER PHYSICS

COMMENCEMENT: 1987

INVESTIGATORS:

Aponsu G.M.L.P., Research Assistant (1996-1997)
Bandaranayake K.M.P., Research Assistant (2000-to date)
de Silva D.B.R.A., Research Assistant (1999-2000)
de Silva L.A.A., Research Assistant (1999)
Jayaweera P.V.V., Research Assistant (2000-to date)
Kottegoda I.R.M., Research Assistant (1996-to date)
Kumara G.R.R.A., Research Assistant (1995-1999)
Kumarasinghe A.R., Research Assistant (1992-1996)
Perera V.P.S., Research Assistant (1996-1999)
Senadeera G.K.R., Research Fellow (1999-to date)
Sirimanne P.M., Research Assistant (1992-1996)
Tennakone K., Research Professor (1987-to date)
Wijayantha K.G.U., Research Student Fellow (1994-1997)

PROGRESS ACHIEVED:

The project was launched in 1987 to initiate research in the area of Condensed Matter Physics at the Institute of Fundamental Studies. Theme of research at the beginning was High Temperature Superconductivity and Semiconductor Physics. Preparation and characterization of thin films of semiconductor materials, identification of new semiconducting materials, physical phenomena in semiconductor nanostructures and physics of photovoltaic solar energy conversion are the current areas of research. The major achievements of the project are finding that led development of devices based on dye-sensitized nanocrystalline composite films and identification of new semiconductor materials suitable for construction of dye-sensitized solid state solar cells. Theoretical understanding of the electron transport mechanisms in nanocrystalline semiconductor films is also an important contribution. The project has contributed significantly to the literature on the above subjects and the papers published are widely cited. This project overlaps with the projects on Photochemistry and Solid State Chemistry.

PROJECT OUTPUT 2000:

Stability and the efficiencies of dye-sensitized solid-state cells were improved and new types of hole collectors were tested. SnO_2/ZnO cell was further optimized and experiments conducted to understand its mode of operation. A major highlight of the work done in the year 2000 is the discovery of dye-sensitized SnO_2/MgO systems, which could elucidate the mechanism of charge separation, suggesting ways devising more efficient systems.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. Bandara J. and Tennakone K. Interparticle charge Transfer in Dye-Sensitized Films Comprising of Two Kinds of Semiconductor Crystallites. ***Journal of Colloids and Interfacial Science*** (in press).

2. Kumara G.R.R.A., Konno A., and Tennakone K. Photoelectrochemical Cells made from SnO_2/ZnO films Sensitized with Eosin Dyes. ***Chemistry Letters*** (in press).

3. Kumara G.R.R.A., Konno A., Senadeera G.K.R, Jayaweera P.V.V., de Silva D.B.R.A., and Tennakone K. Dye-sensitized solar cell with the hole collector p-CuSCN deposited from a solution in n-propyl sulphide. ***Solar Energy Materials and Solar Cells*** (in press).

4. Kumara G.R.R.A., Tennakone K., Perera V.P.S., Konno A., Kaneko S., and Okuya M. Suppression of recombinations in a dye-sensitized photoelectrochemical cell made from a film of tin (iv) oxide crystallite coated with a thin layer of aluminium oxide. ***Journal of Physics D*** (in press).

5. Tennakone K. and Bandara J. Photocatalytic Activity of dye-sensitized tin(IV) oxide particles attached zinc oxide particles: Long distance electron transfer via ballistic transport of electrons across nanocrystallites. ***Applied Catalysis A-General*** (in press).

6. Tennakone K., Senadeera G.K.R., de Silva D.B.R.A., and Kottegoda I.R.M. Highly stable dye-sensitized solid-state solar cell with the semiconductor $4CuBr.3S(C_4H_9)_2$ as the hole collector. ***Applied Physics Letters***, 77, 2367 (2000).

PATENTS:

1. Tennakone K., Senadeera G.K.R., and de Silva D.B.R.A. 2000. *Patent No. 11982*, The Registry of Patents and Trade Marks, Sri Lanaka.

ABSTRACTS / CONFERENCE PROCEEDINGS:

1. Tennakone K. Dye-sensitized Solar Cells: Their problems and possible strategies for improvement Plenary Lecture. **(Abstract)** *Proceedings of the Thirteenth International Conference on Photochemical Conversion and storage of Solar Energy*, Colorado, USA, 27 (2000).

PROJECT: PHOTOCHEMISTRY

COMMENCEMENT: 1999

INVESTIGATORS:

Bandara J., Research Fellow (1999-to date)
Bandaranayake P., Research Assistant (2000-to date)
Tennakone K., Research Professor (1987-to date)

PROGRESS ACHIEVED:

(1) The mechanisms of charge separation, transport and recombinations involved in Dye-sensitized (DS) Photoelectrochemical cells (PECs) based on nanocrystalline semiconductor films have attracted much attention. One of the most important factors that control the high light-to-energy conversion efficiencies is the kinetics of recombination process, ie. Nanocrystalline SnO_2 based dye-sensitized photo-electrochemical solar cells have very low open-circuit voltages 325-375 mV and efficiencies ~1% due to rapid charge recombination. In order to minimize the charge recombination, a new bilayer SnO_2/MgO nanoporous electrode was fabricated in which case the thin layer of insulating MgO acts as an energy barrier for recombination, enhancing the overall cell performance. Ie. the SnO_2 crystallites with a thin film of MgO, the voltage and the efficiency are increased to 650-700 mV, ~6.5% respectively. This process can be applied successfully for several other thin nonporous oxide films as well as photocatalytic application, which are under investigation.

(2) It has been reported that the catalytic activity of SnO_2/ZnO originates from ballistic injection of energetic electrons generated in sensitization of SnO_2, to the conduction band of ZnO enabling wide charge separation. Further experiments were investigated to confirm the existence of high-energy electron in sensitization of composite SnO_2/ZnO by use of generated $OH^{\bullet}$ (H_2O_2) radicals.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. Bandara J. and Tennakone K. Interparticle Charge Transfer in Dye-Sensitized Films Comprising of Two Kinds of Semiconductor Crystallites. ***Journal of colloids and Interfacial Science*** (in press).

2. Tennakone K. and Bandara J. Photocatalytic activity of dye-sensitized Tin(IV) oxide nanocrystalline particles attached to zinc oxide particles: Long distance electron transfer *via* ballistic transport of electrons across nanocrystallites. ***Applied Catalysis A: General*** (in press).

PROJECT : **SOLID STATE CHEMISTRY**

COMMENCEMENT : 1999

INVESTIGATORS :

Senadeera G.K.R., Research Fellow (1999-to date)
Tennakone K., Research Professor (1987-to date)

PROGRESS ACHIEVED:

1. Investigations were carried out to assess the feasibility of solid polymer electrolyte as an alternative material for photo-electrochemical cells by preparing various polymer electrolytes and testing their performances with some dye sensitized n-type semiconductors.

2. New methods for fabricating dye sensitized solid-state cells based on copper halides and copper thiocyanates were discovered.

3. Significant enhancement of photo-current/voltage was observed with several n-type semiconductors in the presence of Al_2O_3.

PROJECT OUTPUT 2000:

Physico-chemical properties of 4CuBr. 3S $(C_4H_9)_2$ semiconductor: We have identified 4CuBr. 3S R_2 (R=C_4H_9, C_3H_7 i.e complexes of Cu (I) bromides with n-butyl and n-propyl sulfides) as p-type semiconductors suitable for positive charge collection in photocells. Measurements of A.C impedance, polarization, thermoelectric, and capacitance of these complexes were measured. As a possible application of these materials photocells were fabricated with dye coated thin films of TiO_2 and current voltage characteristics were determined.

p-CuSCN deposition from a solution in n-alkylsulphides (i.e., methyl sulphides, ethyl sulphides , propyl sulphides and butyl sulphides): A new method for deposition of CuSCN on dye coated TiO_2 films was discovered. IR spectroscopy, A.C. impedance and gravimetric measurements were conducted to elucidate the film structure. Photovoltage/current and quantum efficiency measurements were performed on the cells fabricated with dye coated thin films of TiO_2 with the above complex as the hole collector.

Enhancement of the energy and quantum conversion efficiencies of a photoelectrochemical cell sensitized with a combination of cationic and anionic dyes: 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 was successfully introduced into a photoelectrochemical cell by ionic linkage of Bromopyrogallol Red anions surface complexed to TiO_2 with the Acridine Orange cations.

PROJECT: PHOTOCHEMISTRY

COMMENCEMENT: 1999

INVESTIGATORS:

Bandara J., Research Fellow (1999-to date)
Bandaranayake P., Research Assistant (2000-to date)
Tennakone K., Research Professor (1987-to date)

PROGRESS ACHIEVED:

(1) The mechanisms of charge separation, transport and recombinations involved in Dye-sensitized (DS) Photoelectrochemical cells (PECs) based on nanocrystalline semiconductor films have attracted much attention. One of the most important factors that control the high light-to-energy conversion efficiencies is the kinetics of recombination process, ie. Nanocrystalline SnO_2 based dye-sensitized photo-electrochemical solar cells have very low open-circuit voltages 325-375 mV and efficiencies ~1% due to rapid charge recombination. In order to minimize the charge recombination, a new bilayer SnO_2/MgO nanoporous electrode was fabricated in which case the thin layer of insulating MgO acts as an energy barrier for recombination, enhancing the overall cell performance. Ie. the SnO_2 crystallites with a thin film of MgO, the voltage and the efficiency are increased to 650-700 mV, ~6.5% respectively. This process can be applied successfully for several other thin nonporous oxide films as well as photocatalytic application, which are under investigation.

(2) It has been reported that the catalytic activity of SnO_2/ZnO originates from ballistic injection of energetic electrons generated in sensitization of SnO_2, to the conduction band of ZnO enabling wide charge separation. Further experiments were investigated to confirm the existence of high-energy electron in sensitization of composite SnO_2/ZnO by use of generated $OH^{\bullet}$ (H_2O_2) radicals.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. Bandara J. and Tennakone K. Interparticle Charge Transfer in Dye-Sensitized Films Comprising of Two Kinds of Semiconductor Crystallites. ***Journal of colloids and Interfacial Science*** (in press).

2. Tennakone K. and Bandara J. Photocatalytic activity of dye-sensitized Tin(IV) oxide nanocrystalline particles attached to zinc oxide particles: Long distance electron transfer *via* ballistic transport of electrons across nanocrystallites. ***Applied Catalysis A: General*** (in press).

PROJECT : **SOLID STATE CHEMISTRY**

COMMENCEMENT : 1999

INVESTIGATORS :

Senadeera G.K.R., Research Fellow (1999-to date)
Tennakone K., Research Professor (1987-to date)

PROGRESS ACHIEVED:

1. Investigations were carried out to assess the feasibility of solid polymer electrolyte as an alternative material for photo-electrochemical cells by preparing various polymer electrolytes and testing their performances with some dye sensitized n-type semiconductors.
2. New methods for fabricating dye sensitized solid-state cells based on copper halides and copper thiocyanates were discovered.
3. Significant enhancement of photo-current/voltage was observed with several n-type semiconductors in the presence of Al_2O_3.

PROJECT OUTPUT 2000:

Physico-chemical properties of 4CuBr. 3S $(C_4H_9)_2$ semiconductor: We have identified 4CuBr. 3S R_2 (R=C_4H_9, C_3H_7 i.e complexes of Cu (I) bromides with n-butyl and n-propyl sulfides) as p-type semiconductors suitable for positive charge collection in photocells. Measurements of A.C impedance, polarization, thermoelectric, and capacitance of these complexes were measured. As a possible application of these materials photocells were fabricated with dye coated thin films of TiO_2 and current voltage characteristics were determined.

p-CuSCN deposition from a solution in n-alkylsulphides (i.e., methyl sulphides, ethyl sulphides , propyl sulphides and butyl sulphides): A new method for deposition of CuSCN on dye coated TiO_2 films was discovered. IR spectroscopy, A.C. impedance and gravimetric measurements were conducted to elucidate the film structure. Photovoltage/current and quantum efficiency measurements were performed on the cells fabricated with dye coated thin films of TiO_2 with the above complex as the hole collector.

Enhancement of the energy and quantum conversion efficiencies of a photoelectrochemical cell sensitized with a combination of cationic and anionic dyes: 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 was successfully introduced into a photoelectrochemical cell by ionic linkage of Bromopyrogallol Red anions surface complexed to TiO_2 with the Acridine Orange cations.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. Tennakone K., Senadeera G.K.R., de Silva D.B.R.A., and Kottegoda I.R.M. Highly stable dye-sensitized solid-state solar cell with the semiconductor $4CuBr.3S(C_4H_9)_2$ as the hole collector. ***Applied Physics Letters (American Institute of Physics)***, 77, 5, 2367 (2000).

2. Kumara G.R.R.A., Konno A., Senadeera G.K.R., Jayaweera P.V.V., de Silva D.B.R.A., and Tennakone K. Dye-sensitized solar cell with the hole collector p-CuSCN deposited from a solution in n-propel sulphide. ***Solar Energy Materials and Solar Cells*** (in press).

PATENTS:

1. Tennakone K., Senadeera G.K.R., and de Silva D.B.R.A. 2000. *Patent No. 11982*, The Registry of Patents and Trade Marks, Sri Lanaka.

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2000:

1. Senadeera G.K.R., Tennakone K., and Perera V.P.S. Fabrication of solid-state dye-sensitized TiO_2 Photovoltaic cells with CuCNS (full paper). *Proceedings of the 5th workshop on low cost electronic materials, solar cells and renewable energy sources*, 81-85 (2000).

PROJECT: METAL COORDINATION CHEMISTRY

COMMENCEMENT: 1999

INVESTIGATORS:

Dias H. V. R., Visiting Research Professor (1999-to date)
Diyabalanage H. V. K., Research Assistant (1997-2000)
Herath H. M. T. B., Senior Research Fellow (1992-to date)
Tennakoon K., Research Professor (1987-to date)

PROJECT OUTPUT 2000:

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. Thus the development of new ligands with useful steric/electronic properties are of particular interest. Current efforts are focussed on the design, synthesis and applications of nitrogen and oxygen based ligands such as tris(pyrazolyl)borates, tropolone derivatives, and aminotroponimines. We are using these new ligands to prepare metal catalysts for oxygen activation, isolate reaction intermediates, develop transition metal containing drugs, and to control photochemical processes of metal coordination compounds.

We have been able to isolate and characterize several key intermediates of metal mediated processes. These include models for intermediate in silver salt metathesis, silver catalyzed oxidation of ethylene, Wolff rearrangement process, and nitrene transfer reactions. The unique features of the highly fluorinated tris(pyrazolyl)borates are particularly important to the stability of these silver complexes. With the aid of aminotroponiminates, the azido derivatives featuring germanium(II) and tin(II) have been synthesized. Virtually nothing is known about such species as they tend to decompose easily with the elimination of nitrogen. The unusual stability of aminotroponiminato germanium and tin adducts may be attributed to the unique electronic effects of the nitrogen based system. The aminotroponiminate has a planar, heterobicyclic, 10-π electron ligand backbone.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Dias H.V.R., Polach S.A., and Wang Z. Coinage Metal Complexes of 3,5-bis(trifluoromethyl)pyrazolate Ligand: Synthesis and Characterization of {[3,5-$(CF_3)_2Pz$]Cu}$_3$ and {[3,5-$(CF_3)_2Pz$]Ag}$_3$. ***Journal of Fluorine Chemistry***, **103**, 163-169 (2000).

2. *Dias H.V.R. and Jin W. Low Valent Gallium, Indium, and Tin Compounds That Contain a Highly Fluorinated Tris(pyrazolyl)borate Ligand: Syntheses and Characterization of [HB(3,5-$(CF_3)_2Pz)_3$]Ga, [HB(3,5-$(CF_3)_2Pz)_3$]In, and [HB(3,5-$(CF_3)_2Pz)_3$]Sn(CF_3SO_3). ***Inorganic Chemistry***, **39**, 815-819 (2000).

3. Ayers A.E., Klapötke T.M., and Dias H.V.R. Azido Derivatives of Germanium(II) and Tin(II): Syntheses and Characterization of [(Mes)$_2$DAP]GeN$_3$, [(Mes)$_2$DAP]SnN$_3$, and the Corresponding Chloro Analogues Featuring Heterocyclic 6-π-Electron Ring Systems. ***Inorganic Chemistry*** (in press).

** Reported as "in press" in the Annual Research Report 1999.*

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2000:

1. Lovely C.J., Mahmud H., Badarinarayana V., and Dias H.V.R. Approaches to Pyrroloquinoline Natural Products. *Natural Products, Gordon Research Conference*, Plymouth, NH, July 2000

2. Dias H.V.R. and Polach S.A. "The Isolation of Reaction Intermediates Using Scorpionate Ligands" *American Chemical Society, Southwest Regional Meeting*, New Orleans, Louisiana, 2000.

PROJECT: **NATURAL PRODUCTS CHEMISTRY**

I. CHEMISTRY, ANTI VIRAL/HIV ACTIVITY AND ANTIMICROBIAL ACTIVITY STUDIES OF SRI LANKAN PLANTS

COMMENCEMENT: 1994

INVESTIGATORS:

Dharmaratne H.R.W., Senior Research Fellow (1993 -to date)
Marasinghe G.P.K., Research Assistant (1995 - 2000)
Tennakoon S.B., Research Assistant (2000 -to date)
Wickramasinghe C.S., Research Assistant (1995 - 2000)

PROGRESS ACHIEVED:

Cordatolide **A** and cordatolide **B** isolated from *Calophyllum cordato-oblongum* were found to be anti HIV 1 RT active. Soulattrolide which has been isolated from *C. mooni* showed a remarkable anti HIV-1 RT activity, which is higher than the reported anti HIV-1 activity by other research groups. Cordatolide **B**-OMe, oblongulide, Cordato-oblongic acid, cordato-oblongic acid methylester, isocordato-oblongic acid methylester, inophyllum **A**, thwaitesixanthone, calothwaitesixanthone and calozeyloxanthone isolated from different *Calophyllum* species of Sri Lanka were tested for inhibitory activity against the HIV-1 and its virally-encoded reverse transcriptase (RT). These compounds were found to be inactive in both the HIV-1 RT and whole virus systems. In contrast, cordatolide **A** and **B** demonstrated IC50 values of 19.3 and 11.7 μM, respectively, against HIV-1 replication in a novel green fluorescent protein (GFP)-based reporter cell assay (HOG.R5) [bio assays were carried out in the USA]. Structure activity relationship of coumarins were studied using above results.

Further investigation on *Calophyllum cordato-oblongum* extracts afforded three pyranocoumarin derivatives cordatolide **A**-OMe, cordatolide **B**-OMe and cordatolide **C**-OMe. Methylation of cordatolode **B** and the attempted methylation of cordatolode **A** under acidic conditions gave the methyl ether of cordatolide **B** and 11,12-anhydrocordatolide. Methyl ether of cordatolide **A**, methyl ether of cordatolide **B** and methyl ether of cordatolide **C** are new compounds. 11,12-anhydrocordatolide is a new synthetic compound. A reaction Mechanism was proposed via a carbonium ion, for the formation of methyl ether of cordatolide **B** and 11,12-anhydrocordatolide in above methylation reactions. A new chromen acid, iso-cordato-oblongic acid was isolated from the hexane extract of the stem bark of *C. cordato-oblongum* and its structure was established.

Chemical investigation of the buds of *C. moonii, C. bracteatum* and *C. thwaitesii*, afforded pyranocuoumarins and other compounds. However, this is the first report of a coumarin from *C. thwaitesii*. The presence of pyranocoumarins in buds of above four species including *C. cordato-oblongum*, indicated a possible role of these coumarins in the defence mechanism of *Calophyllum* species.

Extracts from various plant parts of four *Calophyllum* species were tested for Pepsin inhibitory activity and two plants showed activity. Chemical investigation of some of the above plants afforded xanthones, chromen acids and triterpenoids. Three of the isolated xanthones were found to be new prenylated compounds, and some of the secondary metabolites were reported first time from these plants. Seven prenylated xanthones and two chromen acids isolated from *Calophyllum thwaitesii and C. mooni,* were subjected to antimicrobial activity studies using Minimum Inhibitory Concentration method (MIC), with a special reference to Methicillin Resistant *Staphylococcus aureus* (MRSA). Our results showed that calozeyloxanthone isolated from *C. mooni* was highly active against MRSA.

Calozeyloxanthone was found to be active against Vancomycin Resistant Enterococci (VRE) and Vancomycin Sensitive Enterococci (VSE) with MIC values of 6.25 μg/ml and 12.5 μg/ml respectively. A marked synergism between calozeyloxanthone and vancomycin hydrochloride (VCM) against VRE was also observed (bio assays on VRE were carried out in Japan).

Thwaitesixanthone, calothwaitesixanthone, trapezifolixanthone, calabaxanthone and calozeyloxanthone were subjected to anti cancer screening assays using human cell lines from malignant melanoma, epidermoid carcinoma (oral), ductal carcinoma (breast) and ovary carcinoma. Cell line from a kidney of African green monkey was used as the normal cell line. In the above assays, calozeyloxanthone showed moderate activity for entire cell lines except epidermoid carcinoma, while trapizifolixanthone and calabaxanthones showed activity against only malignant melanoma. (bio assays were carried out in the USA).

A considerable amount (1.14%) of an anti-inflammatory active lupeol and few unidentified compounds were isolated from the hexane extract of *Zanthoxylum rhesta.*

Following postgraduate degrees have been completed.

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).

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

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

Following awards have been received by our Research Assistants for some of the above work.

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

11. *Kandiah Memorial Award (11) 1997* for the best piece of research carried out by a postgraduate student in Sri Lanka 1997 - Wanigasekera W. M. A. P.

111. *Kandiah Memorial Award (11) 1999* for the best piece of research carried out by a postgraduate student in Sri Lanka 1999 - Wijesinghe W. M. N. M.

PROJECT OUTPUT 2000:

Calozeyloxanthone was found to be active against Vancomycin Resistant Enterococci (VRE) and Vancomycin Sensitive Enterococci (VSE) with MIC values of 6.25 μg/ml and 12.5 μg/ml respectively. A marked synergism between calozeyloxanthone and vancomycin hydrochloride (VCM) against VRE was also observed [bio assays were carried out in Japan].

Cordatolide **B**-OMe, oblongulide, Cordato-oblongic acid, cordato-oblongic acid methylester, isocordato-oblongic acid methylester, inophyllum **A**, thwaitesixanthone, calothwaitesixanthone and calozeyloxanthone isolated from different *Calophyllum* species of Sri Lanka were tested for inhibitory activity against the HIV-1 and its virally-encoded reverse transcriptase (RT). These compounds were found to be inactive in both the HIV-1 RT and whole virus systems. In contrast, cordatolide **A** and **B** demonstrated IC50 values of 19.3 and 11.7 μM, respectively, against HIV-1 replication in a novel green fluorescent protein (GFP)-based reporter cell assay (HOG.R5) [bio assays were carried out in the USA]. Structure activity relationship of coumarins were studied using above results.

Thwaitesixanthone, calothwaitesixanthone, trapezifolixanthone, calabaxanthone and calozeyloxanthone were subjected to anti cancer screening assays using human cell lines from malignant melanoma, epidermoid carcinoma (oral), ductal carcinoma (breast) and ovary carcinoma. Cell line from a kidney of African green monkey was used as the normal cell line. In the above assays, calozeyloxanthone showed moderate activity with IC 50 > 10.0 for entire cell lines except epidermoid carcinoma, while trapizifolixanthone and calabaxanthones showed activity against only malignant melanoma with IC 50 > 10. According to the above results, calozeyloxanthone, trapezifolixanthone and calabaxanthone show some anti cancer activity. Therefore, it is worthwhile to check the anticancer activity of all the xanthones from Sri Lankan plants, while chemically modifying already active xanthones to enhance their activity [bio assays were carried out in the USA]. Further investigation on the anti cancer activity of Sri Lankan plants are in progress.

Chemical investigation of *Garcenia mangostana* is in progress, and anti microbial activity studies of compounds from *Garcenia mangostana* and other *Calophyllum* species have been carried out.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1) Smith K.K., Dharmaratne H.R.W., Feltenstine W.M., Broom S.L., Roach J.T., Nanayakkara N.P.D., Khan I.A., and Sufka J. Anxiolytic Effects of Kava extracts and Kavalactones in the chick social separation-stress paradigm. ***Psychopharmacology*** (in press).

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2000:

1. Dharmaratne H.R.W., Wickramasinghe S.C., and Tennakoon S.B. Anticancer Activity of Xanthones from *Calophyllum* species. *Proceedings of the Sri Lanka Association for the Advancement of Science*, **56,** 2000.

2. Dharmaratne H.R.W., Nanayakkara N.P.D., and Khan I.A. Isolation and ^{13}C NMR Spectroscopic Studies of Kavalactones. The Cochran Centre Symposium, University of Mississippi, USA. **51,** 2000.

3. Smith K.K., Dharmaratne H.R.W., Feltenstine W.M., Broom S.L., Roach J.T., Nanayakkara N.P.D., Khan I.A., and Sufka J. Anxiolytic Effects of Kava extracts and Kavalactones in the chick social separation-stress paradigm. The Cochran Center Symposium, University of Mississippi, USA. **52,** 2000.

POSTGRADUATE DEGREES COMPLETED IN 2000:

Marasinghe G.P.K. – *Chemistry and antiviral/anti-HIV activity of family Clusiaceae.* M. Phil. degree- Awarded by University of Peradeniya.

PROJECT: **NATURAL PRODUCTS CHEMISTRY**

II. SEARCH FOR BIOACTIVE COMPOUNDS FROM SRI LANKAN PLANTS AS POTENTIAL RESOURCES FOR TREATMENT AND CONTROL OF DISEASES

COMMENCEMENT: 1992

INVESTIGATORS:

Dasanayake Bandara A.G., Research Assistant (1996 -1999)
Jayasinghe U.L.B., Senior Research Fellow (1992 - to date)
Jayasooriya C.P., Research Assistant (2000 - to date)
Kumarihamy B.M.M., Research Assistant (1997 - 2001)
Marikkar J.M.M.N., Research Assistant (1996 -1997)

PROGRESS ACHIEVED:

Pometia eximia **(Sapindaceae):** Preliminary investigation of the methanol extract of the stem of the plant showed strong molluscicidal activity against *Biomphalaria glabrata* snails and larvicidal activity against *Aedes albopictus* larvae. Chromatographic separation of the methanol extract gave hederagenin and nine saponins containing hederagenin as aglycone. Five saponins showed strong molluscicidal activity against *Biomphalaria glabrata* snails and one of them showed strong insecticidal activity against brown rice plant hopper *Nilaparvata lugens.*

Filicium decipiens **(Sapindaceae):** Preliminary investigation of the stem/leaves of the plant showed antibacterial and antifungal activity. Chemical investigation of these extracts furnished a new norneohopene ester of caffeic acid, three flavonol glycosides and sitosterol-D-glucoside.

Sarcococca brevifolia **(Buxaceae):** Chemical investigation of the aerial part of the plant furnished four new steroidal alkaloids. Two of them showed strong antibacterial activity.

Uncaria elliptica **(Rubiaceae):** We have revised the previous structure assignments of uncaric acid, diketouncaric acid and diacetouncaric acid which were reported from the same plant. A quinovic acid glycoside has been reported for the first time from this plant. Re-investigation of the alkaloid fraction of the plant gave ajmalicine, farmosanine, isomitraphylline and mitraphylline.

Terminalia catappa **(Combretaceae):** Various extracts of the plant showed preliminary antiviral activity against pepsin A inhibition assay and molluscicidal activity against *Biomphalaria glabrata*_snails. Chemical investigation of this plant gave six compounds including two glycosides. All these compounds are new to the plant.

Anogeissus latifolia **(Combretaceae):** Several compounds have been reported from this plant.

PROJECT OUTPUT 2000:

Diploclisia glaucescens (Menispermaceae): Five ecdysteroids have been isolated from stem of the plant using HPLC (High Performance Liquid Chromatography). Structure elucidation of these isolates is in progress. Further the chemical investigation of methanol extract of the leaves of *D. glaucescens* furnished an unusual ecdysone; 1β-hydroxy-3-deoxy-20-hydroxyecdysone and 20-hydroxyecdysone. Structures were established on detailed analysis of spectral data. This unusual ecdysone showed 40% potency of 20-hydroxyecdysone in the Spiracle index assay against the 4th instar larvae of the silkworm *Bombyx mori*. In addition to that two triterpenoidal saponins with three sugar moieties have been isolated from the leaves of the same plant. Further we have identified some antifungal active extracts of the plants which belongs to the family Rubiaceae and Meliaceae. Isolation of active principles is in progress.

PUBLICATIONS IN THE REFEREED JOURNALS IN 2000:

1. *Jayasinghe U.L.B., Nadeem M., Atta-ur-Rahman, and Choudhary M.I. 11-hydroxyepipachysamine-*E*, A new steroidal alkaloid from *Sarcococca brevifolia*. ***Natural Product Letters***, **14**, 293 - 298 (2000).

2. Jayasinghe U.L.B., Kumarihamy B.M.M., Nadeem M, Choudhary M.I., Attta-ur-Rahman, and Weerasuriya A. *iso*-N-formyl-5-en-chonemorphine, A Steroidal alkaloid from *Sarcococca zeylanica*. ***Natural Product Letters*** (in press).

3. Jayasinghe U.L.B., Vithana H.S.K., Wannigama G.P., and Fujimoto Y. 24-Methylenecycloartenone from *Bhesa nitidissima*. ***Fitoterapia*** (in press).

* *Reported as "in press" in the Annual Research Report 1999*

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2000:

1. Jayasinghe U.L.B., Kumarihamy B.M.M., Vasquez E.A., and Kraus W. Nematicidal activity of some Sri Lankan plants. *Proceedings of the Sri Lanka Association for the Advancement of Science*, Peradeniya, **238** (2000).

2. Jayasinghe U.L.B., Kumarihamy B.M.M., and Kraus W. Antifungal and antibacterial steroidal alkaloids from *Sarcococca zeylanica*. *Proceedings of the Sri Lanka Association for the Advancement of Science*, Peradeniya, **239** (2000).

3. Jayasinghe U.L.B., Kumarihamy B.M.M., Waiblinger J., and Kraus W. Antifeedant activity of some Sri Lankan plants. *Proceedings of the Sri Lanka Association for the Advancement of Science*, Peradeniya, **240**(2000).

BOOKS AND MONOGRAPHS:

1. Jayasinghe U.L.B., Wannigama G.P., and Fujimoto Y. Chemistry and Bioactivity of Saponins of some Sri Lankan Plants, Saponins in Food, Feedstuffs and Medicinal Plants (ed. Oleszek W. and Marston A.) Kluwer Academic Publishers, Netherlands 113 - 119 (2000).

PROJECT: **NATURAL PRODUCTS CHEMISTRY**

III. (A) PHYTOCHEMICAL AND BIOLOGICAL INVESTIGATIONS OF SRI LANKAN *MYRISTICACEAE* AND *GORDONIA* SPECIES

(B) BIOCHEMICAL PEST CONTROL EFFECT AND CHEMICAL INVESTIGATION OF *GLIRICIDIA SEPIUM*

COMMENCEMENT: 1992

INVESTIGATORS:

Herath H.M.T.B., Senior Research Fellow (1992-to date)
Samarakoon A.H.M.G.D.S., Research Assistant (1999-to date)

PROGRESS ACHIEVED:

Phytochemical and biological investigations of Sri Lankan *Myristica* species: Hexane and dichloromethane extracts from the stem bark of *Myristica dactyloides* afforded eight aryl alkanones and five lignans. One aryl alkanone and four of the lignans were found to be new natural products. Bio assays showed neither anti-HIV nor antifungal activity, but the dichloromethane extract showed considerable insecticidal activity. The above compounds were identified using spectral data with most of the NMR spectral data being provided by our foreign collaboraters. Chemical investigation of the hexane extract from the root bark of *Myristica ceylanica* gave eight pure compounds. Four of them were found to be aryl alkanones and another one was identified as a lignan. The structural elucidation of the other three unidentified compounds and further studies on the same extract are in progress.

Phytochemical and biological investigations of Sri Lankan *Gordonia* species: Hexane and diclorometane extracts of *Gordonia ceylanica* (Theaceae) gave thirteen pure compounds. Three of them were identified as new triterpenoids, and another three as oleanane triterpenoids, which are new to the species. Structures of the above compounds were established by IR, ^{1}H NMR, ^{13}C NMR and MS spectral data and the known compounds were further confirmed by comparison of the spectral data with the previously reported compounds.

Bio-Chemical Pest Control effect and Chemical Investigations of *Gliricidia sepium*: The hot hexane and dichloromethane extracts of the fresh stem of *Gliricidia sepium* gave twelve pure compounds. Using spectroscopic data the structures of eight of these compounds have been established as: (1.) 7,2'-dihydroxy-3',4'-dimethoxyisoflovan, (2.) 7,4', dihydroxy-3'-methoxyisoflavan, (3.) Isovestitol, (4) Formononetin, (5) Afromosin, (6) Sitosterol, (7) Stigmasterol, and (8.) bis(2-ethylhexyl) phthalate. Compound (1) is a completely new natural product where as the other seven compounds are new to *G. sepium*. Structural elucidations of the remaining four compounds and further chemical investigations are in progress.

Biological Studies of Extracts and the fractions of *G. sepium* against *Glyptotermes dilatatus:* Preliminary olfactometer studies showed that the attraction of the termite *G. dilatatus,* towards the heartwood and the stem bark of *G.sepium* and their organic extracts is significantly higher than even some of the highly susceptible tea clones. Feeding experiments with different parts of the raw plant materials and their organic extracts indicated that the raw heartwood is highly toxic and the hexane and dichloromethane extracts are also significantly toxic to *Glyptotermes dilatatus.*

PROJECT OUTPUT 2000:

Chemical investigation of the hot hexane extract of the stem bark of *Gordonia ceylanica* afforded two new oleanane triterpenoids, 3β-acetoxy-11α, 13β-dihydroxyolean-12-one and 3β, 11α-diacetoxy-13β-hydroxyolean-12-one. The attempted acid hydrolysis of these two compounds resulted the dehydration and subsequent methyl group migration to afford the taraxarane triterpenoids 3β, 11α-dihydroxytaraxer-14-en-12-one and 3β-hydroxy-11α-aacetoxytaraxer-14-en-12-one, respectively.

The 3-4% methylene chloride in hexane fraction of the hot hexane extract of the stem bark of *Gordonia dassanayakei* obtained by medium pressure column chormatography inhibited the growth of some plant pathogenic fungi (*Curvularia sp, Colletotrichum gloeosporioides, Rhizoctonia solani, Corynespora cassiicola and Fusaarium sp)* which cause disease in crops of economic importance to Sri Lanka. The compound responsible for the antifungal activity in the above fractions fraction was isolated and identified as 3-formyl-2,4-dihydroxy-6methylbenzoic acid-3'-hydroxy-4'-(methoxycarbonyl)-2',5' -dimethylphenyl ester. Further the ED_{50} values for these plant pathogenic fungi are reported.

Chemical investigation of the hot hexane extract of the stem bark of *Gordonia dassanayakei* afforded a new oleanane triterpenoid, 11α ,13β-dihydroxyolean-3-12-dione and two other oleanane triterpenoids, 3β-acetoxy-11α ,13 βdihydroxyolean-12-one and 3 β,11α diacetoxy-13β-hydroxyolean-12-one and a hopane 6α,22-diol, which are new to the plant.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Herath H.M.T.B. and Padmasiri W.W. Demethyldactyloidin and other constituents in *Myristica ceylanica. **Natural Product Letters,*** 14(2), 141-146 (1999).

2. *Herath H.M.T.B., Athukoralage P.S., and Jamie J.F. Two new oleanane triterpenoids from *Gordonia ceylanica* and their conversions to taraxarane triterpenoids. ***Phytochemistry,*** **54**(8), 823-827 (2000).

3. Herath H.M.T.B. and Athukoralage P.S. Triterpenoids of *Gordonia dassanayakei.* ***Natural Product Sciences,*** **6**, 102-105 (2000).

4. Herath H.M.T.B. and de Silva S. New constituents from *Gliricidia sepium.* ***Fitoterapia,*** **71**(6), 722-724 (2000).

5. Athukoralage P.S., Herath H.M.T.B., Deraniyagala S.A., Wijesundara R.L.C., and Weerasinghe P.A. Antifungal activity studies of *Gordonia dassanayakei*. ***Fitoterapia*** (in press).

* *Reported as "in press" in the Annual Research Report 1999*

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2000:

1. Athukoralage P.S., Herath H.M.T.B., Deraniyagala S.A., and Wijesundera R.L.C. Antifungal constituents of *Gordonia dassanayakei*. **(Abstracts)**. *Proceedings of the Sri Lanka association for the Advancement of Science, Part I,* **56**, 255 (2000).

PROJECT: **BIOCHEMISTRY**

COMMENCEMENT: 1997

INVESTIGATORS:

Dharmaratne H.R.W., Senior Research Fellow (1993-to date)
Athauda S.B.P., Visiting Scientist (1997-todate)
Rajapakse R.G.S.C., Research Assistant (1998 - 2000)

PROJECT OUTPUT 2000:

Isolation and Characterisation of thermally stable enzyme from juice of *Nepenthes distillatoria:* Two acid proteinases(a major and a minor)were purified from the juice of *Nepenthes distillatoria* by successive chromatographies on columns of DEAE-cellulose-52, Sephacryl S-200, pepstatin sepharose and Mono Q (FPLC) to achieve homogeneity as analysed by SDS-PAGE. Two proteinases were eluted at different ionic strength from two anion exchangers (DEAE-52 and Mono Q). This result suggests that charge of the two proteinases differ at neutral pH. Molecular weight of the two proteinases was estimated to be 58,000 and 40,000, for the major and minor acid proteinases, respectively by gel filtration and SDS-PAGE. NH_2-terminal amino acid sequence of purified proteinases was determined by using automated gas phase sequencer.

Major :IGPSGVETTVYAGDGEYLMNLSIG

Minor : QRVQVETPYAYA

These results suggest that two proteinases identified from Nepenthes juice are different enzyme but not isoenzymes. Glycosylation of the two protein was analysed by SDS-PAGE followed by periodic acid-Schiff's base staining and only major proteinase band was stained. This suggests that major acid proteinase is a glycoprotein.

Stability of the major proteinase was reported last year and that of minor proteinases were investigated at pH (3.0-8.0). Percentage remaining activities of minor acid proteinase in pH 3.0 incubated for 7 days and 30 days at 4 ^{0}C were 99% and 97%; at 25 ^{0}C were 99% and 93%; at 37 ^{0}C were 96% and 85%; at 50 ^{0}C were 73% and 44%; respectively. The percentage remaining activities of minor proteinase incubated at 4 ^{0}C for 7 days and 30 days in buffer at pH 4.0 were 98% and 90%; at pH 5.0 were 96% and 88%; at pH 6.0 were 87% and 85%; at pH 7.0 were 84% and 76% and at pH 10.0 were 83% and 60% , respectively.

The percentage activities of the remaining minor proteinase incubated at 37 ^{0}C for 7 and 30 days in buffer at pH 3.0 were 99% and 85%, at pH 5.0 were 45% and 0 respectively. These results suggest that *Nepenthes* minor acid proteinase is rather stable in pH 3.0-7.0 at 4 ^{0}C and in pH 3.0 at 37 ^{0}C and relatively less stable compare to that of major acid proteinase.

Proteinases activities of both enzymes at acidic pH were inhibited completely by 0.1mM pepstatin and incubating with DAN and Cu^{2+} for 4 h. These results indicate that both proteinases belong to the family of aspartic proteinase.

Cleavage specificity of the major proteinase at pH 3.0 was investigated by using the B chain of oxidized insulin as the substrate. Several peptide bonds, especially Phe-Phe, Glu-Ala, Leu-Cys, Leu-Tyr and Tyr-Leu bonds, were simultaneously cleaved to marked extents by the proteinase. The extents of the cleavage of these bonds were estimated to be 80%, 55%, 50%, 38% and 35%, respectively. It was similar to, but not identical with those of human pepsin and cathepsin D. Especially, the rapid hydrolysis of Leu-Cys seems to be characteristic of the major enzyme, since this bond is known to be insensitive to pepsin and most of other aspartic proteinases.

Amino acid sequencing and cDNA cloning of two proteinases are in progress to elucidate primary structure of the two enzymes.

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2000:

Rajapakshe R.G.S.C., Athauda Senarath B.P., Dharmaratne H.R.W., and Takahashi Kenji. Stability of acid proteinases of *Nepenthes distillatoria* at different pH. *Annual research sessions,* Faculty of Science, University of Peradeniya, **20,** (2000).

Athauda Senarath B.P., Inoue Hideshi, and Takahashi Kenji. A minor acid proteinase from juice of *Nepenthes distillatoria. 8th International Conference on Aspartic proteinases,* Funchal, Madeira, Portugal P, **6-19,** (2000)

PROJECT: MOLECULAR IMMUNOLOGY OF MALARIA

COMMENCEMENT: 1990

INVESTIGATORS:

Hadjirin N., Research Assistant (1999 –to date)
Moorthy S.A.V., Reserch Assistant (1998 –to date)
Ramasamy M.S., Research Professor (1990-to date)
Suresh Y.K., Research Assistant (1999 –to date)

PROJECT OUTPUT 2000:

Studies on developing a transmission blocking vaccine for malaria: A cDNA library of *Anopheles* in lambda zap vector was screened with a rabbit antiserum raised against *Anopheles tessellatus* midgut glycoproteins. This antiserum has been demonstrated by us to block malaria parasite transmission to mosquitoes. Eight positive clones that were believed to be unique were identified through restriction enzyme fragment mapping and recombinant protein expression. The Bluescript plasmid from these clones were excised using standard procedures and then DNA sequences at the ends using M17 forward and reverse primers. The results showed that seven of the eight clones coded for a myosin heavy chain. The eight clone coded for a homologue of a *Drosophila* TRP gamma chain gene of a cation membrane channel. Therefore being a gene for a putative membrane protein, the complete sequence of this clone is being determined at the European Molecular Biology Laboratory in Heidelberg in collaboration with Dr. George Dimopoulos. It is expected that the complete sequence of the gene will be obtained through identifying the corresponding genomic clone in a library available at Heidelberg and sequencing it.

Studies on experimental blood stage malaria vaccines: Experiments were continued on the ability of the putative malaria vaccine candidate antigen MSA2 [merozoite surface antigen 2] of *Plasmodium falciparum*. Mucosal immunisation of rabbits with MSA2 was attempted in collaboration with Dr. K Leenhouts and Professor R. Ramasamy from the Netherlands. Dr. Leenhouts visited the laboratory in this connection. Significant systemic antibody responses were generated through both oral and nasal immunisations. Oral immunisation was more effective than nasal immunisation. These collaborative studies are being continued in different strains of mice of varying H2 haplotypes. ICR [outbred], C57 [H2b], Balb/c [H2d] and C3H [H2k] mice obtained from the Medical Research Institute, Colombo are being investigated. Specialised reagents, materials and expertise are being provided by the Netherlands group for this purpose.

POSTGADUATE DEGREES AWARDED:

Yasawardena S.G.- Immunisation with genetically engineered immunogens from merozoite surface antigens of *Plasmodium falciparum* and the effects of antibodies on red cell invasion . Ph.D. Degree- Awarded by University of Colombo.

PROJECT: MOLECULAR ENTOMOLOGY

COMMENCEMENT: 1990

INVESTIGATORS:

Hadjirin N., Research Assistant (1999 –to date)
Moorthy S.A.V., Reserch Assistant (1998 –to date)
Ramasamy M.S., Research Professor (1990-to date)
Surendran S.N., Assistant Lecturer, University of Jaffna (1999 –to date)
Suresh Y.K., Research Assistant (1999 –to date)

PROJECT OUTPUT 2000:

Multiple blood feeding in a malaria vector: The malaria vector *Anopheles tessellatus* is able to take several blood meals in a gonotrophic cycle. The fecundity is largely dependant on the first blood meal and is not generally increased by subsequent blood meals during a gonotrophic cycle. Larval rearing densities influenced adult body size. There is an inverse relationship between wing length and larval rearing densities. Smaller mosquitoes produced from larvae reared at higher densities had reduced body reserves of protein, lipid and carbohydrates. At emergence, ovarian development in *An. tessellatus* is in the previtellogenic stage and remained at this stage until the intake of a blood meal. The number of ovarian follicles is related to wing length and irrespective of adult body size, *An. tessellatus* developed oocytes to maturity with a single blood meal. This is attributed to the availability of metabolic reserves above the threshold level required for further development of oocytes. Mosquitoes that took more than one blood meal had largely digested their previous blood meal and had ongoing vitellogenesis. Blood meals subsequent to the first one, apparently therefore contribute mainly to increasing metabolic reserves. The stimulus for a second and third blood meal in *An. tessellatus* appears to be the completion of digestion of the previous blood meal. There was no evidence that multiple blood meals taken in the first gonotrophic cycle significantly

Presence of *anopheles culicifacies* sibling species in Sri lanka: In Sri Lanka malaria is *transmitted* mainly by *An. culicifacies* Giles *sensu lata*. In India this nominal taxon comprises sibling species A,B,C,D and E, distinguished by their chromosome morphology. Species B , identified by its polytene chromosome sequence is not such an efficient vector of malaria as other members of the *An. culicifacies* complex in India. All specimens of *An. culicifacies s.l.* examined in Sri Lanka possess polytenes previously interpreted as species B, despite their important vector status. Recently, species E was reported from Rameshwaram Island, between Sri Lanka and the Indian mainland where both species B and E are sympatric. Species B and E share a polytene sequence but differ by the mitotic Y-chromosome, being acrocentric in species B and submetacentric in species E, the latter being implicated as a vector of vivax malaria. We have surveyed Y-chromosomes of male progeny from *An. culicifacies* females collected from cattle bait in diverse malarious districts of Sri Lanka – Badulla, Monaragala. Puttalam and Trincomalee. Karyotypes of readable quality was obtained from 42/83 families examined, with overall proportions of 24% acrocentric and 76% submetacentric Y-

chromosome carriers both types being sympatric in at least ¾ sites sampled. By analogy with the situation in Rameshwarm Island we interpret these observations to demonstrate the widespread presence of two members of the *An. culicifacies* complex in Sri Lanka, their karyotypes being compatible with species B and E, the latter being predominant. This is the first report of the presence of species complex of *An. culicifacies* and of species E in Sri Lanka.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Ramasamy M.S., Srikrishnaraj K.A., Hadjirin N., Perera S., and Ramasamy R. Physiological aspects of multiple blood feeding in the malaria vector *Anopheles tessellatus*. ***Journal of Insect Physiology***, **46,** 1051-1059 (2000).

2. Surendran S.N., Abhayawardana T.A., de Silva B.G.N.K., Ramasamy R., and Ramasamy M.S. *Anopheles culicificies* Y-chromosome dimorphism indicates sibling species (B and E) with different malaria vector potential in Sri Lanka. ***Medical and Veterinary Entomology***, **14,** 437-440 (2000).

* *Reported as "in press" in the Annual Research Report 1999.*

PROJECT: PLANT BIOTECHNOLOGY

COMMENCEMENT: 1988

INVESTIGATORS:

Iddagoda N., Research Fellow (1989-1997)
Iqbal M.C.M., Visiting Scientist (1988-1989, 1994)
Karunaratne S.M., Visiting Research Fellow (1988-1991)
Kovoor A., Senior Research Fellow (1988-1991)
Kumari W.M.G.C., Research Student Fellow (1995-1997)
Meemaduma V., Research Assistant (1999-to date)
Nilmini Deepika P.K.D., Research Assistant (1993-1995)
Rajapakse M.C., Junior Research Fellow (1988-1992)
Ramanayake S.M.S.D., Research Fellow (1988-to date)
Tennakoon T.M.A., Research Assistant (1997-2000)
Wanniarachchi V.A.V.R., Research Assistant (1996-1999)
Weerawardene E., Research Assistant (2000-to date)
Wickramasinghe W.M.T.D., Research Assistant (1995-1996)
Yakandawala K., Research Student Fellow (1994-1996)

PROGRESS ACHIEVED:

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

Bamboo: 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 buds of a 6 – year old and a 50 – 70 year old field grown clumps responded to axillary shoot proliferation and root induction. Plantlets were produced from both. There are no reports on the achievement of micropropagated plants from mature field grown clumps of bamboo that are as old as the one we studied. In vitro flowering was also induced in axillary shoots of the older clump and in those raised from a juvenile clump. The morphological features of the flowers (in vitro and in vivo) and factors that may have contributed to in vitro flowering were studied.

Mitochondria were isolated from bamboo tissues to develop a protocol for studying the mitochondrial DNA of different lines of *D. giganteus* (in vitro and in nature). We have also commenced finger printing lines of this species using RAPDs.

The axillary buds of *B. vulgaris* proliferated but it was not possible to attain continuous and rapid proliferation. Some factors responsible for the recalcitrance in this species were identified.

Callus was induced from different explants of the two bamboo species. Those from *B. vulgaris* were lost due to accidental contamination and studies on this species were suspended. Callus induced from seeds of *D.giganteus* became embryogenic and a few plantlets were regenerated. Callus that was initiated from mature tree explants proliferated fast and it was possible to obtain globular embryogenic callus. Different types of calli, soft friable, hard globular and mucilaginous callus differentiated. It was possible to initiate suspension cultures from all these. Histological studies of callus transferred to a regeneration medium that is being developed showed that early stages of somatic embryogenesis and organogenesis occur in this medium. But many of the regenerating embryoids and shoot apices disorganized after sometime. The behaviour of cell suspensions was also studied. Early stages of embryoids were also observerd in cell suspensions. Further studies are ongoing.

In vitro cultures from a flowering clump have been initiated to study the possibility of inducing more flowers or shoots in vitro.

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 plants 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 2000:

Rhizogenesis in *D. giganteus* has been improved. Continuosly proliferating cultures of spikelets have been induced in the same species.

DNA was extracted from 130 individuals from a population of *D. giganteus*. DNA from ten other species of bamboo was also extracted. Some morphological features were recorded. Primers for identification of polymorphism in *D. giganteus* using RAPDs have been selected. Work is in progress to detect genetic diversity and relationships among these individuals. Three manuscripts have been submitted for publication.

COMMUNICATIONS:

1. Ramanayake S. M. S. D. 2000, The charm peculiarity and the usefulness of bamboo – Let's preserve it!, *Sunday Observer*, 30th July 2000, Lake House Publishers.

2. Ramanayake S. M. S. D. 2000, Transition to flowering in plants. *Pragna, IFS Science Bulletin*, Vol.XIII (2,3), June & September 2000.

PROJECT: **PLANT BIOTECHNOLOGY**
II. POLLEN BIOLOGY AND HAPLOIDS

COMMENCEMENT: 1997

INVESTIGATORS:

Iqbal M.C.M., Research Fellow (1997-to date)
Wijesekara K.B., Research Assistant (1998-to date)

PROGRESS ACHIEVED:

Androgenesis: Haploid induction from microspores (androgenesis).
Introduction: The pollen grains in the anthers of plants contain half the normal complement of chromosomes. They are destined to fertilize the egg cell (which also has half the normal complement of chromosomes), to produce a fertilized seed. Under certain conditions of culture it is possible to induce the immature pollen grains to undergo embryogenesis and produce a haploid or doubled haploid plant.

Objectives: To identify factors that induce androgenesis and study mutant embryos that are not expressed during normal development.

To achieve the above we attempted androgenesis with coconut *Cocos nucifera* and tea *Camellia sinensis*. However, androgenesis was not possible with these perennials. Only callus was produced from *C. sinensis*. Subsequently different species from the Solanaceae family were screened for their ability to induce androgenesis. Of the species screened, *Solanum pseudocapsicum* underwent embryogenesis but was not consistent. *Datura metel* consistently produced embryos after the basic media and culture conditions were established. Experimental manipulations to enhance and identify factor(s) involved in androgenesis are being studied, chief amongst these are the temperature regimes before incubation of the anthers.

Antifungal activity in plant extracts: (in collaboration with the Natural products group).
Extracts of common weeds are assayed for activity against fungi. One weed species was highly active against the fungi *Rhizoctonia* and *Sclerotinia*. The crude extract is being fractionated to determine the identity of the active compound.

PROJECT OUTPUT 2000:

Androgenesis: Haploid induction from microspores (androgenesis).
Haploid embryogenesis was induced in *Datura metel*. A preincubation experimental manipulation of the temperature was responsible for significantly higher embryogenesis. Embryo mutants were identified following haploid induction some of which have not being reported.

Antifungal activity in plant extracts: The extract from one of the many weeds screened for antifungal activity completely inhibited the growth of two fungi. These fungi, however, grew again when transferred to media without the extract showing that the active compound(s) is fungistatic. A similar extract from the seeds of another plant was fungicidal.

One manuscript has been accepted (Fruits in *Brugmansia* x *candida* Pers) by the Ceylon Journal of Science and another submitted to the Pakistan Journal of Biological Sciences.

Research for undergraduate degrees completed: (i) Antifungal activity of extracts from some common weed species [H.I.D.D. Hettiarachchi]. (ii) Screening local rice genotypes (*Oryza sativa* ssp.*indica*) for callus induction and plant regeneration [L.A.S. Rupika].

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Moellers C., Nehlin L., Glimelius K., and Iqbal M.C.M. Influence of *in vitro* culture conditions on biosynthesis of glucosinolates in microspore-derived embryos of *Brassica napus* . ***Physiologia Plantarum,*** **107**, 442-446 (1999).

   * *Reported as "in press" in the Annual Research Report 1999.*

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2000:

1. Iqbal M.C.M. and Wijesekera K.B. In vitro propagation of *Gordonia dassanayakei* **(Abstracts).** *Proceedings of the Sri Lanka association for the Advancement of Science, Part I,* **56**, 99 (2000).

2. Iqbal M.C.M. and Wijesekera K.B. Abnormalities in microspore derived embryos of *Datura metel.* **(Abstracts).** *Proceedings of the Sri Lanka association for the Advancement of Science, Part I,* **56**, 100 (2000).

3. Meiyalaghan S., Iqbal M.C.M. and Wijesekera K.B. Antifungal activity of water extracts of some common weed species **(Abstracts).** *Proceedings of the Sri Lanka association for the Advancement of Science, Part I,* **56**, 53 (2000).

PROJECT: **BIOLOGICAL NITROGEN FIXATION**

COMMENCEMENT: 1986

INVESTIGATORS:

Ekanayake S., Research Assistant (1994-1998)
Karagaswewa M., Research Assistant (1991-1996)
Kulasooriya S.A., Visiting Scientist, IFS (1986-1996)
Liyanarachchi L.A.W., Research Assistant (1997-1998)
Pahalawatta V., Research Assistant (1999)
Premaratne R.R., Research Assistant (1993-1997)
Rizvi E.M.J.M., Research Assistant (1991-1997)
Seneviratne G., Research Fellow (1994-to date)
Sepalika J.A.H., Research Assistant (1998-to date)
Somaratne S., Lecturer, Open University of Sri Lanka (1999-to date)
Van Holm L., Team Leader (1991-1997)
Van Nieuwenhove C., Research Associate (1991-1997)
Vlassak K., Project Coordinator (1991-1997)
Wedisinghe S., Research Assistant (1996-1997)
Weerasinghe A., Research Fellow (1994- 2000)

PROGRESS ACHIEVED:

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. These studies were concluded after testing a liquid formulation of them at Maha Illuppallama. This was done in collaboration with the Department of agriculture. A 26% of seed yield increase of soybean was achieved with the liquid formulation, as compared to uninoculated control. It is concluded that these microbial fertilizers can 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 for nitrogen fixing leguminous tree, *Albizia* was tested on tea estates and an 84% plant growth increase was obtained in comparison to the non-inoculated control.

b) A novel *ex situ* method of green manuring for lowland rice was tested in farmers' fields. This involves high density planting of green manure crops (eg. *Sesbania rostrata)* in small areas of marginal paddy lands. The method considerably reduces labour and irrigation costs and needs a lesser amount of water making it suitable for the dry zone.

c) Thirteen leaf isozymes were evaluated using 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.

d) 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.

e) Micropropagation of "Nadun" (*Pericopsis mooniana)* was studied in a project funded by NORAD. Satisfactory results were obtained for the problem of browning, by reducing pH in the culture medium. In addition, dipping leaf explant in 300 mg/l of cefotaxime increased the regeneration up to 50%. Callus induction was maximized in a medium supplemented with 2 mg/l of 2.4-D and 0.5 mg/l of BAP.

NUMBER OF PUBLICATIONS IN REFEREED JOURNALS: 05

PROJECT OUTPUT 2000:

1. Polyphenols are known as disinfectants and act as bactericides. Soil polyphenols therefore inhibit 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), with urea and SDS as denaturing agents. A study on the interaction between phenolic compounds and rhizobia was conducted and the results have now been written-up and sent for publication. Effect of phenolic compounds on the production of nitrogenous enzyme in rhizobia is also being studied.

2. A research project was started to study soil organic matter decomposition 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. Data are now being analyzed.

3. Our project discovered that soil surface mulch application with plant litter mitigates soil N_2O emission. This was published and established now. Current studies are focused on the litter quality and temperature effects on this mitigation.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Seneviratne G., Van Holm L.H.J., and Ekanayake E.M.H.G.S. Effect of peat and coir-dust-based rhizobial inoculants on the nodulation, plant growth and yield of Soybean (*Glycine max* [L.] Merril) cv PB 1. ***Tropical Agricultural Research and Extension,*** **2**, 133-135 (1999).

2. *Seneviratne G. Litter quality and nitrogen release in tropical agriculture: a synthesis. ***Biology and Fertility of Soils,*** **31**, 60-64 (2000).

3. *Seneviratne G. Litter nitrogen release in tropical agroecosystems. ***Current Science,*** **79**, 1054 (2000).

4. Seneviratne G., Van Holm L.H.J., and Ekanayake E.M.H.G.S. Agronomic benefits of rhizobial inoculant use over nitrogen fertilizer application in tropical soybean. ***Field Crops Research,*** **68**, 199-203 (2000).

5. Seneviratne G., and Ekanayake E.M.H.G.S. *Sesbania rostrata:* a simple method of producing the green manure to achieve N synchrony in lowland rice. ***International Rice Research Notes,*** 26 (in press).

6. * Weerasinghe P.A., Wijesekara M.L.M.C., and Van Holm L.H.J. Use of isozymes to differentiate growth categories of *Pericopsis mooniana* trees. ***Journal of Biologia Plantarum,*** **42**, 541-547 (1999).

7. *Weerasinghe P.A., Van Holm L.H.J., Kumari D.L.C., and Serasinghe P.S.J.W. Effect of foliar application of chelated micronutrients on tea (*Camellia sinensis*) yield. ***Tropical Agricultural Research and Extension*** (in press).

* *Reported as "in press" in the Annual Research Report 1999.*

PROJECT: **SYNTHETIC ORGANIC CHEMISTRY**

COMMENCEMENT: 1998

INVESTIGATORS:

Diyabalanage H.V.K., Research Assistant (1997-2000)
Herath H.M.T.B., Senior Research Fellow (1992-to date)
Liyanagamage V., Research Assistant (1999-2000)

PROGRESS ACHIEVED:

Synthesis of 1,3,5-trioxyganeted-9-acridone derivatives: Following four compounds have been synthesized under this project.(I) 1,3,5-trihydroxy-2,4-bis(3-methyl-1-butene-3-ol)-9-acridone, (II) 1,3,5-trihydroxy-2-(3-methyl-1-butene-3-ol)-9-acridone or 1,3,5- trihydroxy-4-(3-methyl-1-butene-3-ol)-9-acridone, (III) 1,3,5-trihydroxy-2,4-bis(3-methyl-2-butene)-9-acridone (IV) 1,3,5-trihydroxy-2-(3-methyl-2-butene)-9-acridone or 1,3,5-trihydroxy-4-(3-methyl-2-butene)-9-acridone.

Synthesis of 1,3,8-trioxyganeted-9-acridone derivatives: Under this programme the parent molecule 1,3,8-trihydroxy-9-acridone was successfully synthesized by conversion of 6-chloro-2-nitrocynobenzene to 6-hydroxyanthrnillic acid in three steps and react with phloroglucinol. Dramatization is in progress.

Preparation of Organometallic complexes: (Collaborative project with Prof. Rasika Dias, University of Texas). Two metal complexes of 1,3-dihydroxy-9-acridone were prepared with Cu and Mn as metal atoms.

PROJECT OUTPUT 2000:

Attempts were made to synthesize the naturally occurring and new prenyl analogous of 1,3-dioxygenated acridone derivatives of 1,3-dihydroxy-9-acridone, 1,3,5-trihydroxy-9-acridone, 1,3-dihydroxy-5-methxy-5-methxy-9-acridone and 3,5-dimethoxy-1-hydroxy-9-acridone via Palladium catalyzed Heck condensation and several other methods.

Reaction of 3,5-dimethoxy-1-hydroxy-9-acridone with 4-bromo-2-methyl-2-butene in the presence of K_2CO_3 in dry acetone gave 3,5-dimethoxy-1-hydroxy-10-(3'-methylbut-2'enyl)-9-acridone as a single product. The treatment of 1,3-dihydroxy-9-acridone with 3-methylcrotanaldehyde in anhydrous acetone with K_2CO_3 at 4°C gave n-methylnoracronycine as the major product after separation by column and preparative thin layer chromatographic techniques(PTLC).

Attempt for the PTLC and the column chromatographic separation of the iodinated products of 1,3,5-trihydroxy-9-acridone and 1,3-dihydroxy-9-acridone was unsuccessful due to deiodination of compounds during the process.

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2000:

1. Diyabalanage H.V.K., Liyanagamage V.P.K., and Herath H.M.T.B. Prenylation of 1,3- dioxygenated-9-acridone analogous. **(Abstracts)**. *Proceedings of the Sri Lanka association for the Advancement of Science, Part I*, **56**, 241 (2000).

PROJECT: ECOLOGY AND ENVIRONMENTAL BIOLOGY

COMMENCEMENT: 1989

INVESTIGATORS:

Ariyananda T., Research Assistant (1994-1995)
de Silva N. R. N., Research Assistant- FISHSTRAT (1998-1999)
Ekanayake R., Research Assistant (1999-2000)
Ekanayake M.P.B., Research Assistant (1999- to date)
Gamlath R., Research Student Fellow (1996-1999)
Research Assistant- FISHSTRAT (1999 - 2000)
Manuweera L., Research Assistant (1993-1995)
Nathaneal S., Research Assistant (1989-1995)
Samaradiwakara S., Research Student Fellow (1996- 1999)
Silva E.I.L., Senior Research Fellow (1989-1998)
Associate Research Professor (1999-to date)
Withana D., Junior Research Assistant (1989-1992)

PROGRESS ACHIEVED:

The project initiated as Ecology and Conservation in 1989 was renamed as Ecosystem Analysis and Impact Assessment. in 1992. The name of the project was changed again in 1996 as Ecology and Environmental Biology with a view to restructure the research activities towards basic ecological studies in aquatic ecosystem. 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 reference to aquatic ecology and limnology. The studies carried out since 1989 were oriented in 1996 towards basic ecological studies on aquatic ecosystems with a special emphasis on limnology and stream ecology.

A systematic study was carried out on limnology and 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 of Mahaweli Reservoirs. In addition, the environmental impact of Kandalama Hotel Complex on the tank's ecosystem was studied during pre-construction, construction and operational phases. A study was also carried out to determine the rainwater quality and buffer intensities of surface water in Sri Lanka. Further, commercially important freshwater fish species were analyzed for bio-accumulation of trace elements while several pelagic blood fish were analyzed for the levels of histamine. A study was also launched to determine the impact of operational activities of shrimp farms in the northwestern province on brackish water ecosystems. In 1995, an intensive study was carried out to determine the levels of organic and inorganic pollution along the course of the Meda-Ela in Kandy.

Towards the end of 1996, an intensive and systematic limnological study was started in the Kandy Lake with a view to answer several questions on limnology of hypereutropic, tropical urban water body. This study was intensified from May 1999 with the emergence of a

Microcystis, a cyanobacteria bloom in the 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 structure and functioning of a tropical stream draining an intensively exploited watershed. Some of the results from these studies were analyzed using existing mathematical models and attempts were also made to derive new mathematical models to explain the behavior of aquatic ecosystem (both lotic and lentic) in the tropics. A new limological study was commenced in August 1998 to compare the primary productivity and nutrient dynamics of three morphologically and functionally different reservoirs viz., Victoria, Minneriya and Udawalawe. This is 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 in man-made water bodies, which is currently being considered as an important aspects of land-ocean nutrient fluxes. The results that are ecologically significant and scientifically important were published in refereed journals and monographs and in the proceedings of local, regional and international meetings.

NUMBER OF PUBLICATIONS IN REFEREED JOURNALS : 26

PROJECT OUTPUT 2000:

A major emphasis was paid on field studies, laboratory analysis and preliminary data compilation of FISHSTRAT project during the year 2000. Two descriptive papers were published in a local journal on FISHSTRAT reservoirs as agreed at the first workshop on limnology held in Bangkok. A multi-authored paper on photosynthetic-primary productivity of Sri Lankan irrigation tanks was submitted to an international journal. In addition, three papers were presented on limnology and land-ocean nutrient fluxes at international meetings. Further, seven presentations on different aspects of aquatic ecology (e.g. Water Chemistry, Algae, Kandy Lake, Seasonal Tanks, Brackish Water Ecology, Inland Fisheries and Aquaculture, and Aquatic Bio-diversity) were delivered on invitation at universities, schools, government organization etc. The Ph.D. thesis submitted by S. Nathanael entitled "Some Aspects of Biology and Fisheries of Cichlids in the Victoria Reservoir" to the University of Peradeniya was accepted subjected to revisions.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Silva E.I.L. and Davies R.W. The Effects of Simulated Irrigation Induced Changes in Salinity on Metabolism of Lotic Biota. ***Hydrobiologia,*** **416,** 193-202 (2000).

2. *Silva E.I.L. and Manuweera L. Surface and Rain Water Quality in Sri Lanka - A Risk of Acidification. ***The Science of the Total Environment*** (in press).

3. Silva E.I.L. and Gamlath G.A.R.K. Catchment Characteristics and Water Quality of Three FISHSTRAT Reservoirs (Victoria, Minneriya and Udawalawe) in Sri Lanka. ***Sri Lanka Journal of Aquatic Science,*** **5**, 55 - 73 (2000).

5. E.I.L. Silva and F. Schiemer. Hydraulic Changes of three Reservoirs (Minneriya, Udawalawe and Victoria) in Sri Lanka. ***Sri Lanka Journal of Aquatic Science***, **5**, 75 - 86 (2000).

6. E.I.L. Silva, A. Shimizu and H. Matsunami. Salt pollution in a Japanese stream and its on water chemistry and epilithic algal chlorophyll-*a*. ***Hydrobiologia***, , **437**, 139-148 (2000).

* *Reported as "in press" in the Annual Research Report 1999.*

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2000:

1. Schiemer F., Amarasinghe U.S., Frouzova J., Sricharoendhaam B., and Silva E.I.L. Ecosystem structure and dynamics - a management basis for Asian reservoirs and Lakes **(Abstract).** *International Workshop on Reservoir and Culture Based Fisheries* - Biology and management, Bangkok , Thailand, 45 (2000).

2. Silva E.I.L. and Schiemer F. Human Factor : Fourth Dimension of Limnology in the Tropics **(Abstract).** *International Workshop on Reservoir and Culture Based Fisheries* - Biology and management February, Bangkok , Thailand, 44 (2000).

3. Silva E.I.L. Some evidence for retention of silica in manmade water bodies in Sri Lanka **(Abstract).** *International Workshop on Land Ocean Nutrient Fluxes - the Silica Cycle,* Nha Trang, Vietnam, 16 (2000).

4. Schiemer F., Amarasinghe U.S., Frouzova J., Sricharoendhaam B., and Silva E.I.L. Ecosystem structure and dynamics - a management basis for Asian reservoirs and Lakes. In : S.S. De Silva (ed)., *Proceedings of International Workshop on Reservoir and Culture-Based Fisheries*: Biology and Management ACIAR (in press).

5. Silva E.I.L. and Schiemer F. Human Factor : Fourth Dimension of Limnology in the Tropics. In : S.S. De Silva (ed)., *Proceedings of International Workshop on Reservoir and Culture-Based Fisheries*: Biology and Management, ACIAR (in press).

6. Silva E.I.L. Some evidence for retention of silica in manmade water bodies in Sri Lanka. In : V. Ittekott and N. Tac An (eds), Land-Ocean Nutrient Fluxes : the Silica Cycle. *Proceedings of International Workshop on Lamd Ocean Nutrient Fluxes - the Silica Cycle.* Nha Trang, Vietnam (in press).

7. Silva E.I.L. Ecosystem processes and dynamics - a management base for brackish water resources in Sri Lanka (Key note presentation) at the *National Workshop on "Esturine Biology"*, Eastern University, Batticaloa, 2000.

PROJECT: **CHEMICAL MODELING OF AQUATIC SYSTEMS**

COMMENCEMENT: 1992

INVESTIGATORS:

Aluthpatabendi D., Lab Assistant (1992- to date)
Dharmasena B., Volunteer Pre-University Student (1998- 1999)
Dissanayake C.B., Research Professor (1992-1996)
Liyanagedara M.L, Research Assistant (1992-1996)
Namarathna S.Y., Research Fellow (1992-1996)
Rupasinghe S., Volunteer Pre-University Student (1999- to date)
Wijeyathunga A, Pre-University Student (1999-2000)
Weerasooriya R., Associate Research Professor (1992-to date)
Wickramarathna U., Research Assistant (1997-1998)

PROGRESS ACHIEVED:

1. In order to account for the finite size of ions, the newly developed charge distribution multi-site surface complexation model (CD-MUSIC) was used to quantify chromate-binding data on goethite.

2. Chemical characterization of the kaolinite water interfacial processes was completed. The proton, bromide, chloride, iodide and fluoride ion binding on kaolinite based on surface complexation theory was also completed.

3. Chemical kinetics modeling for the complexation of copper – organic polymer system is developed. Kinetic modeling of ferric-fluoride systems under acidic conditions was completed.

4. A direct method for the quantification of copper-fulvate complexation was developed.

5. Surface complexation modeling of Cd(II) adsorption on model minerals at differing experimental conditions was completed.

6. Determination of near-surface solid composition of the goethite copper systems to elucidate Cu-intra-particle diffusion from surface precipitation on external surfaces was completed. X-ray photon spectroscopy was used to accomplish these results.

7. Essential conceptual frameworks of water purification methodologies for fluoride, nitrate and organic-Cl were developed (Project objectives were revived to meet current IFS theme of basic research).

8. A precise mechanistic model was developed to understand the formation of N-nitrosamines (Project objectives were revived to meet current IFS theme of basic research).

NUMBER OF PUBLICATIONS IN REFEREED JOURNALS: 29

PROJECT OUTPUT 2000:

Pyrite- TCE system: New reaction system in pyrite mediated environment was identified. Chemical kinetics of TCE degradation by pyrite was investigated at different experimental conditions. The TCE was transformed into C_2H_2, 1.1-dichloroethene (DCE) and C_2H_4 by a slow process (240 hrs are required to convert TCE by 80%). Thereafter the degradation rate showed a monotonous increase with the pH. A simple kinetic model was proposed to quantify the TCE degradation by pyrite.

This project was funded by the International Foundation for Science, Sweden.

Copper –gibbsite interactions: During the past year, we have attempted to account for the finite size of ions into surface complextion theory. In this context, copper and proton adsorption on gibbsite were determined by differing experimental conditions. The pH_{zpc} of gibbsite was 8.7. As determined by Basic Stern layer model, the optimized binding constants of electrolyte ions were $K_{Na} = -0.31$ and $K_{NO3} = 7.94$. These parameters were coupled with the charge distribution multi-site ion complexation (CD-MUSIC) model in quantifying copper adsorption by following reaction stoichiometry.

$(>AlOH^{-1/2})_2 + Cu^{++} = (>AlOH^{-1/2})_2^l Cu^m]$ log K = 7.15 where $l+m = 2$.

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. *Weerasooriya R. and Tobschall H.J. On the mechanistic modeling of chromate adsorption onto goethite. ***Colloids and Surfaces,*** **162,** 167-175 (2000).

2. Weerasooriya R. and Dharmasena B. Pyrite-assisted degradation of TCE. ***Chemosphere*** (in press).

3. Weerasooriya R., Dharmasena B., and Aluthpatabendi D. Copper-gibbsite interactions: an application of 1-pK surface complexation model. ***Colloids and Surfaces*** (in press).

* *Reported as "in press" in the Annual Research Report 1999.*

PROJECT: STRUCTURAL GEOLOGY

COMMENCEMENT: 1995

INVESTIGATORS:

Kehelpannala, K.V.W. , Research Fellow (1994 - 1999)
Senior Research Fellow (1999 –to date)
Ratnayake, N.P., Research Assistant (1997)
Ratnayake, R.M.J.W.K., Research Assistant (1998 -to date)

PROGRESS ACHIEVED:

The genetic relationship between the structure and some mineralizers (e.g. pegmatites and veins) in the high-grade basement of Sri Lanka was established. The study revealed that the maximum principal palaeostress (σ_1) and the least principal palaeostress (σ_3) during the second strongest deformation (D_5) were nearly E-W and N-S, respectively. By applying this, at least six types of mineralizers were identified in the areas NW of Matale. The anatomy of some mica-bearing veins and pegmatite was also studied. This study led us to identify geometrical features, which are indicative of tensile stress refraction at interfaces between lithologies with contrasting viscosities. Ductile deformation of granulites of Sri Lanka was studied and the deformational history of the Sri Lankan Gondwana fragment was reconstructed from microstructures, mesoscopic structures and from large-scale structures observed in the high-grade gneisses.

The nature of post-metamorphic metasomatism of orthogneisses of diverse bulk compositions through fluxing of K-bearing fluids along deep to mid crustal shear zones was studied in detail. The mechanisms and the process of large-scale K-metasomatism of granulite facies rocks through shear-controlled fluid fluxing were elucidated. The change in bulk compositions of orthogneisses during post-metamorphic metasomatism was studied in order to characterize their chemical changes. Some mineral reactions involved in the transformation of orthogneisses to metasomatic rocks were studied. It was established that the main mechanism of metasomatic transformation is characterized by the formation of metasomatic microcline feldspar and myrmekites with diverse geometry in the presence of externally derived K^+ ions in aqueous fluids. The role of shear zones in controlling fluid-driven metasomatism of high-grade orthogneisses was also investigated. A nomenclature for metasomatic rocks exposed around Ambagaspitiya was proposed. This work will be continued.

Preliminary studies on the origin of compositional layering in high-grade gneisses were commenced, and criteria for distinguishing the gneissic layering produced by metamorphic differentiation from that produced through the intrusion of magmatic materials were established. This work will be continued.

The earth tremor occurred near Kandy on 23.11.98 was investigated. This investigation showed that the tremor might have had a magnitude of about 3-3.5 (Richter scale) and that it was not caused by the Victoria reservoir. The recurrent occurrence of small earthquakes in Sri Lanka may be due to a nearly NNW-SSE compression acting on Sri Lanka, which leads to slow build

up of elastic energy along some of the brittle faults in the crust of the island. It was also shown that this type of earth tremors might occur in Sri Lanka in the future as long as the above compression is active. Further research is needed to understand the exact mechanism of neotectonics and the occurrence of earth tremors in countries like Sri Lanka, which have been hitherto considered as aseismic.

Ductile shear zones seem to play a major role in transporting fluids in the earth's crust. However, the mechanism of migration of the fluids along these apparently non-porous structures has not yet been properly elucidated. A detailed study of ductile shear zones in the Kurunegala district and at Digana was undertaken in order to elucidate the role of these structures in the origin of some late-stage, fluid-controlled crustal processes. In addition, the influence of the stress on the formation of in-situ charnockite and retrogression was also established. It was shown that the nucleation and subsequent growth of in-situ charnockite and retrogression of orthogneisses along ductile shear zones and foliation planes, forming irregular patches, are very similar and can be explained by the model presented by Kehelpannala (1998) and Kehelpannala and Ratnayake (1999). In addition, the criteria for distinguishing relict charnockite from in-situ charnockite were established. This work will be continued.

Geology and structure of large vein graphite mineralizations, especially those in the Kurunegala and Kegalle districts, were studied, and their relationship to the graphite deposits was established.

Migmatites with a wide range of chemical compositions occurring in the major doubly plunging synforms in central Sri Lanka were studied. Our field and laboratory studies on these migmatites indicate that they are characterized by multi-stage development of leucosomes with varying modal compositions and that they have a polyphase origin. Our study clearly demonstrates that migmatites may be classified or differentiated on the basis of their genetic relationships. This work will be continued.

PROJECT OUTPUT IN 2000:

1. Study on migmatization of basic metamorphic rocks was continued, and different generations of leucosomes in these rocks were identified. The study on the influence of deformation on the development leucosomes in layered basic rocks was continued, and chemical analysis of layer and vein leucosomes was carried out. It was established that the layer leucosomes in the migmatites studied have a magmatic origin, and most of the vein leucosomes are controlled by ductile deformation of the host rocks. (This work is being continued).

2. Magmatic events in Sri Lanka relevant to Rodinia suppercontinent formation and dispersal were studied. (This work is being carried out in collaboration with Prof. A. Kröner, University of Mainz, Germany).

3. Study of the origin of scapolite-bearing pyroxenites was started. This study shows that pyroxenites with euhedral megacrysts of scapolite and sphene in the lower crustal rocks of Sri Lanka have a magmatic origin. (This work is being continued).

4. Study of stable carbon isotope of graphite disseminated in granulite facies rocks of Sri Lanka and vein graphite was started, and some graphite samples sent to Japan have already been analysed at the Shizuoka University, Japan. The carbon isotopic data suggest that graphite disseminated in orthogneisses at Digana have been precipitated from externally derived C-H-O solutions. (This work is being carried out in collaboration with Prof. H. Wada, University of Shizuoka, Japan).

PUBLICATIONS IN REFEREED JOURNALS IN 2000:

1. Kehelpannala K.V.W. and Ratnayake R.M.J.W.K. Polyphase migmatization of layered basic rocks in the Wanni Complex of Sri Lanka. ***Gondwana Research*** (in press).

2. Kehelpannala K.V.W. Scapolite-bearing pyroxenites from the high-grade gneiss terrain of Sri Lanka. ***Gondwana Research*** (in press).

3. Kröner A, Collins A.S., Hegner E., Willner A.P., Muhongo S., and Kehelpannala K.V.W. The East African Orogen: New zircon and Nd ages and implications for Rodinia and Gondwana supercontinent formation and dispersal. ***Gondwana Research*** (in press).

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2000:

1. Kröner A., Collins A.S., Willner A.P., Henger E., Muhongo S. and Kehelpannala W. The role of East Africa, Madagascar and Sri Lanka in Neoproterozoic orogenesis and supercontinent formation **(Extended Abstract).** Joint Symposium, German and Austrian Geological Societies, Vienna, February 2000.

SCIENCE DISSEMINATION

Work Output for 2000:

The scope for the 1999 Science Dissemination Unit, as in 1998, focussed on the basic sciences in keeping with the IFS commitment to Fundamental Science. Research Colloquia, Public Lectures and Research Meetings and the Science Popularization Programme for school children were conducted as in the previous years.

(A) Workshops, Research colloquia, public lectures, symposia conferences:

Workshops: Workshop on Computer Interfacing was organised for the IFS members in the view to upgrade the interfacing of instruments at IFS. Mini Workshop on Restoration of Eutrophic Lakes and Reservoirs was organised.

Research meetings: Nineteen such meetings were conducted and the research students presented their work in this event. This gives them the opportunity to discuss their research problems with the expertise and to get more ideas to solve such difficulties.

Research colloquia: Scientists with special knowledge were invited to talk to their colleagues at research Colloquia. Ten such colloquia were conducted. Special lectures were intended to provide a quick forum for the eminent scientists visiting the institute and the country.

Public lectures: This promotes the public understanding of science. Eight public lectures were held.

(B) Awareness and educational programmes for schools

School Science Programme(SSP): This is meant for students who have excelled at the G.C.E.(O/L) examination. This activity is designed to promote thinking, imagination, curiosity, wonder and excitement at new ideas discovered. The focus of the SSP is on scientific creativity. The initial stimuli were lectures, given by scientists specialised in their fields of study. Each topic was accompanied by a set of Course Notes.

In bringing together students of varied ethnic, religious and economic backgrounds this programme encourages them to understand and respect differences between themselves as individuals. Although IFS had to limit this year's programme for Central Province students, the selection procedure ensured that students from underprivileged schools were well represented. This time due to the financial situation we had to restrict the SSP for one programme including 150 students.

Workshop : A workshop was held at Dehiattakandiya Educational Zone to develop the knowledge and skills in science among Grade 11 students. This was very successful and we are planning to have this type of programmes at zonal level especially in less privileged areas.

Lab visits : Lab visits were organised for under graduate students and for School children. Special lecture on IFS and its activities was prepared for them to make things easier to

understand. In addition a booklet about the present research projects at IFS was compiled and distributed among the students.

Astronomy programme: This was organized for A/L students of Kingswood College. In addition Dr. A. Nanayakkara delivered two lectures in the same field at Kandy Schools.

(C) Publication of reports, papers, proceedings

Annual research report for year 1999 was prepared and compiled.

Pragñā- IFS Science Bulletin: Now the bulletin is printed in colour. 700 copies of each issue were distributed to schools (With A/L classes), Research Institutes, universities and scientists. Two volumes out of four of the Bulletins were published.

A booklet about the present research projects at IFS was compiled and distributed among the students who visited IFS.

(D) Activities with other institutions related to research and training

We organised a special lab visit including lectures about Chromatography for the M. Sc. students from Postgraduate Institute of Science. In addition to that, special lab visits including lectures and demonstration were organized for the undergraduate students from University of Sabaragamuwa, University of Kelaniya and Institute of Chemistry.

IFS EVENTS 2000

RESEARCH MEETINGS, RESEARCH COLLOQUIA AND PUBLIC LECTURES

RESEARCH MEETINGS

09.02.2000 **IN-VITRO STUDIES FOR INDUCTION OF FLOWERING AND SOMATIC EMBRYOGENESIS IN *DENDROCALAMUS GIGANTEUS***
Mr.T.M.A.Tennakoon, Research Assistant, IFS

16.02.2000 **QUANTITATIVE ASSESSMENT OF ARSENIC SPECIES BINDING ON GIBBSITE – PROGRESS REPORT**
Mr.Indika Arachchige , Faculty of Science, University of Kelaniya

01.03.2000 **NEW COUMARINS FROM CALOPHYLLUM SPECIES AND THEIR SYNTHESIS AND BIOACTIVITY**
Ms. G.P.K. Marasinghe, Research Assistant, IFS

15.03.2000 **PLANTS FROM POLLEN OF *DATURA METEL* (KALU-ATTANA)**
Mr. K.B. Wijesekera, Research Assistant, IFS

22.03.2000 **DIPTERAN TOXIC PROTEINS FROM SRI LANKAN STRAINS OF *BACILLUS THURINGIENSIS***
Ms. K.Y. Suresh, Research Assistant, IFS

10.04.2000 **CHEMISTRY AND BIO-ACTIVITY OF SOME SRI LANKAN RUBIACEAE AND BUXACEAE**
Ms. B.M.M. Kumarihamy, Research Assistant, IFS

19.04.2000 **OXAZOLINE, A STABLE INTERMEDIATE IN ORGANIC SYNTHESIS**
Ms. V.P.K. Liyanagamage, Research Assistant, IFS

24.05.2000 **THERMALLY STABLE ACID PROTEINASES FROM *NEPENTHES DISTILLATORIA* (BANDURA)**
Mr. R.G.S.C. Rajapakse, Research Assistant, IFS

07.06.2000 **SYNTHESIS OF SOME ACRIDONE–COUMARIN DIMERS (ACRIMARINES)**
Ms.H.V.K. Diyabalanage, Research Assistant, IFS

21.06.2000 **INHIBITORY EFFECTS OF ENVIRONMENTAL FACTORS ON SOIL RHIZOBIA**
Ms. H.S. Jayasinghearachchi, Research Assistant, IFS

02.08.2000 **CHEMISTRY AND ANTIMICROBIAL ACTIVITY STUDIES OF *CALOPHYLLUM* SPECIES**
Ms. S.C. Wickremasinghe, Research Assistant, IFS

23.08. 2000 **THE USE OF RANDOM AMPLIFIED POLYMORPHIC DNA (RAPDs) IN THE STUDY OF GENETIC DIVERSITY IN A POPULATION OF BAMBOO**
Ms.V.N. Meemaduma, Research Assistant, IFS

06.09.2000 **MIGMATIZATION OF HIGH-GRADE ROCKS, AROUND KANDY**
Mr. R.M.W.J.K. Ratnayake, Research Assistant, IFS

04.10.2000 **KANDY LAKE: IS IT RECOVERING?**
Mr. M.P.B. Ekanayake, Research Assistant, IFS

18.10.2000 **FACTORS CONTROLLING SOIL ORGANIC MATTER DECOMPOSITION IN DIFFERENT LAND-USE PATTERNS**
Mr. S.Somaratne, Open University of Sri Lanka, Nawala

01.11.2000 **STRUCTURAL VARIATIONS IN Y-CHROMOSOME COMPATIBLE WITH THE PRESENCE OF SIBLING SPECIES B AND E IN THE *ANOPHELES CULICIFACIES* (DIPTERA: CULICIDAE) SPECIES COMPLEX IN SRI LANKA**
Mr. S.N. Surendran, University of Jaffna

10.11.2000 **QUANTITATIVE ASSESSMENT OF COPPER SPECIES IN A NATURAL HETEROGENOUS AQUATIC ENVIRONMENT**
Mr. M.B. Herath, University of Peradeniya

15.11.2000 **IMMUNO SCREENING OF *ANOPHELES GAMBIAE* CDNA LIBRARY**
Ms. S.A.V. Moorthy, Research Assistant, IFS

RESEARCH COLLOQUIA

12.01.2000 **STABLE ISOTOPIC VIEW ON THE ORIGIN OF GRAPHITE AND ISOTOPIC EXCHANGE REACTIONS IN METAMORPHOSED MARBLES**
Prof. Hideki Wada, Department of Biology and Geosciences, Shizuoka University, Japan

08.03.2000 **RECENT DEVELOPMENTS IN PLANT SYSTEMATICS WITH SPECIAL REFERENCE TO MOLECULAR DATA**
Dr. D.M.D. Dissanayake, Senior Lecturer, Department of Botany, University of Peradeniya

22.06.2000 **NATURAL PRODUCTS, LEAD COMPOUNDS, DRUGS AND PRODRUGS**
Dr. H.M.T.B. Herath, Senior Research Fellow, IFS

12.07.2000 **TRANSITION TO FLOWERING IN PLANTS**
Ms. S.M.S.D. Ramanayake, Research Fellow, IFS

08.11.2000 **SILICA BEHIND THE DAMS**
Prof. E.I.L. Silva, Associate Research Professor, IFS

SPECIAL LECTURES

06.03.2000 **NEW APPROACH TO α-AMINO AND α-HYDROXY COMPOUNDS**
Dr. (Mrs.) Vajira P. Bulugahapitiya, Department of Chemistry, Faculty of Science, University of Ruhuna, Matara

12.09.2000 **THE RECOVERY OF SOIL FERTILITY THROUGH FOREST GARDENING ON DEGRADED TEA LANDS**
Mr. I. Siddique and Mr. S. Hockin, Department of Plant & Soil Science, University of Aberdeen, UK

27.10.2000 **REFLECTIONS ON SPACE - BASED SET1**
Prof. W. Stuiver, University of Hawai, USA

23.11.2000 **PERIODONTAL PATHOGEN SPECIFIC SERUM IGG DURING PREGNANCY CAN PREDICT LOW BIRTH WEIGHT**
Dr. Ananda P.Dassanayake, Associate Professor, University of Alabama at Birmingham, School of Dentistry, USA

PUBLIC LECTURES

29.03.2000 **APPLICATION OF DNA – MARKER TECHNIQUES FOR BREEDING AND CONSERVATION OF PLANTS**
Mr. J.M.D.T. Everard Jayamanne, Senior Plant Breeder, Genetics and Plant Breeding Division, Coconut Research Institute, Lunuwila

26.04.2000 **GOD MAKING IN SCIENCE, SOME THOUGHTS ON SCIENCE AND CULTURE**
Dr. Arjuna de Zoysa, Department of Mathematics and Philosophy of Engineering, The Open University of Sri Lanka, Nugegoda

31.05.2000 **WATER TREATMENT FOR DRINKING**
Dr. D.R.I.B. Werellagama, Department of Civil Engineering, University of Peradeniya

28.06.2000 **PLANTS FROM POLLEN**
Dr .M.C.M. Iqbal, Research Fellow, IFS

19.07.2000 **SOLAR CELLS THAT MIMIC PHOTOSYNTHESIS**
Prof. K.Tennakone, Director, IFS

26.07.2000 **QUANTUM CHAOLOGY! TRANSITION FROM CLASSICAL TO QUANTUM MECHANICS**
Dr. A. Nanayakkara, Senior Research Fellow, IFS

25.10.2000 **NEW DEVELOPMENTS IN PESTICIDES**
Dr. G.K. Manuweera, Registrar of Pesticides, Department of Agriculture, Peradeniya

22.11.2000 **ODIOUS SEEDS OF WAR - the parthenium weed**
Dr. A.H.M. Jayasuriya, Director, Plant Genetic Resources Center, Peradeniya

IFS Laboratory Tours

10.03.2000 Final year students from Institute of Chemistry,Ceylon.
21.03.2000 Students from Isipathana College, Colombo.
28.04.2000 Students from Sampath Kendraya, Avissawela.
29.04.2000 M.Sc. students from Postgraduate Institute of Science.
25.09.2000 Students from Sabaragamuwa University.
04.10.2000 Students from Good Shepherd Convent, Kotahena.
25.10.2000 Chemistry undergraduates from University of Kelaniya.

Astronomy Programme

24.10.2000 **Astronomy Programme** for students from Kingswood College, Kandy at 9.30 a.m. at the IFS.

WORKSHOPS

15th August	Mini Workshop on Restoration of Eutrophic Lakes and Reservoirs, organised by IFS.
09-10, 16-17 & 23-24 September	Workshop on Computer Interfacing, organised by IFS.

SPECIAL PROGRAMME FOR SCHOOL CHILDREN

23rd September — **Lecture on TIME TRAVEL at Mahamaya Girls' College, Kandy.**
Dr. A. Nanayakkara, *Senior Research Fellow, IFS*

30th September — **Workshop to develop the knowledge and skills in science among Grade 11 students in Dehiattakandiya Educational Zone.**

20th October — **Lecture on HUBBLE TELESCOPE** at St. Anthony's College, Katugastota.
Dr. A. Nanayakkara, Senior Research Fellow, IFS

15th-17th December — **School Science Programme**

15th December:

Physics and Chemistry of the Flame
Prof. K. Tennakone

Symmetry in Biology
Dr. M.C.M. Iqbal

Mysteries in Modern Science
Dr. A. Nanayakkara

Kandy Lake
Prof. E.I.L. Silva

16th December:

History and the Chemistry of Herbal Products in Medicine
Dr. H.M.T.B. Herath

Plant Biotechnology
Ms. S.M.S.D. Ramanayake

IFS Laboratory Tour

17th December :

Plate Tectonics
Dr. K.V. W. Kehelpannala

Earthquakes
Dr. K.V.W. Kehelpannala

RESEARCH STAFF 2000

Tennakone K.	Research Professor, Director
Ramasamy M.S.	Research Professor
Silva E.I.L	Associate Research Professor
Weerasooriya S.V.R.	Associate Research Professor
Kovoor A.	Honorary Visiting Research Professor
Ananthan Jeeva S.	Visiting Research Professor
de Silva A.P	Visiting Research Professor
Dias H.V.R.	Visiting Research Professor
Fernando G.W.	Visiting Research Professor
Gunaratne G.H.	Visiting Research Professor
Mendis Ashoka D	Visiting Research Professor
Sri Kantappa C.	Visiting Research Professor
Wijewardena L.C.R.	Visiting Research Professor
Dharmaratne H.R.W.	Senior Research Fellow
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Jayasinghe J.H.M.U.L.B.	Senior Research Fellow
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