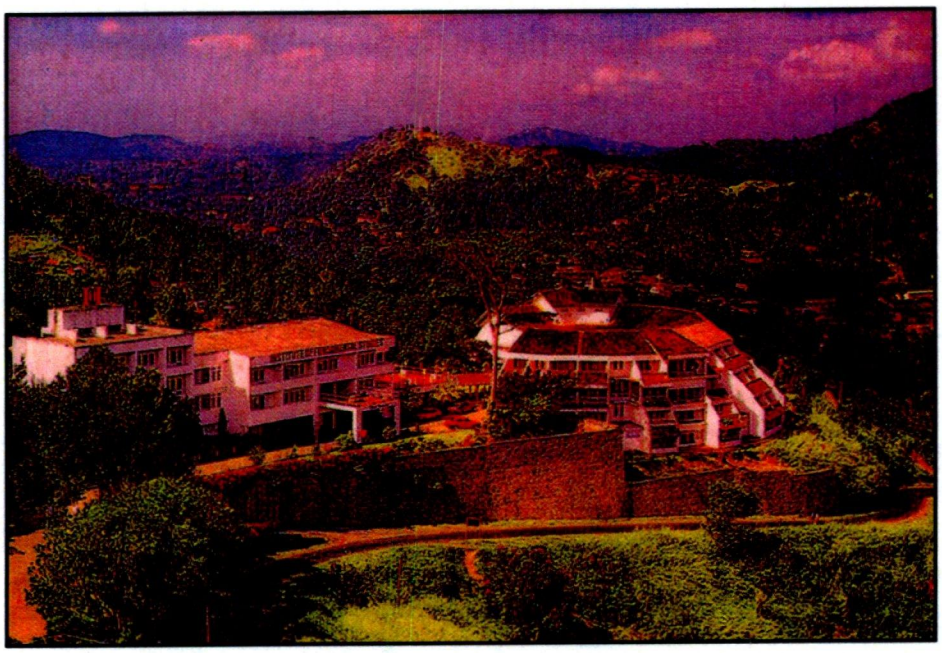
ANNUAL RESEARCH REPORT 2002



Institute of Fundamental Studies
Hantana Road
Kandy

INSTITUTE OF FUNDAMENTAL STUDIES

ANNUAL RESEARCH REPORT 2002

Compiled by

Science dissemination unit
Institute of Fundamental Studies
Hantana Road
Kandy.
Tel. No.: 08-232002
Fax No.:08-232131
e-mail : ifs@ifs.ac.lk

CONTENTS

PUBLICATIONS IN REFEREED JOURNALS 2002

1. Bamber R.N., Ariyananda T., and **Silva E.I.L.** The Male of Halmyrapseudes Srilankaensis (Bacescu, 1981) Comb. Nov. and an analysis of the Genus Halmyrapseudes Bacescu and Gutu, 1974 (Peracarida, Tanaidacea). ***Journal of Crustacean Biology*** [1,2], **22**(2): 287-297 (2002).

2. **Bandara J.**, **Tennakone K.**, and Jayatilaka P.P.B. Composite Tin and Zinc Oxide nanocrystalline particles for enhanced charge separation in sensitized degradation of Dyes. ***Chemosphere*** [1,2], **49**(4): 439-445 (2002).

3. **Bandaranayake P.K.M.**, **Jayaweera P.V.V.**, and **Tennakone K.** Dye sensitization of magnesium oxide coated cadmium sulfide. ***Solar Energy Materials and Solar Cells*** [1,2] (in press).

4. Binu-Lal S.S., **Kehelpannala K.V.W.**, Wada H., and Satish-Kumar M. Multistage graphite precipitation through protracted fluid flow in sheared metagranitoid, Digana, Sri-Lanka: Evidence from Stable Isotopes. ***Chemical Geology*** [1,2] (in press).

5. **Dharmaratne H.R.W.**, Nanayakkara N.P.D., and Khan I.A. (-)-3β, 4β-Epoxyvalerenic acid from *Valeriana officinalis.* ***Planta Medica*** [1,2], **68:** 661-662 (2002).

6. ***Dharmaratne H.R.W.**, Nanayakkara N.P.D., and Khan I.A. Kavalactones from *Piper methysticum* and their ^{13}C NMR Spectroscopic studies. ***Phytochemistry*** [1,2], **59:** 429-433 (2002).

7. ***Dharmaratne H.R.W.**, Tan G.T., Marasinghe G.P.K., and Pezzuto J.M. Inhibition of HIV-1 Reverse Transcriptase and HIV-1 Replication by *Calophyllum* Coumarins and Xanthones. ***Planta Medica*** [1,2], **68:** 86-87 (2002).

8. Espinoza-Ortiz J., Rajapaksa C.S., and **Gunaratne G.H.** Strength reduction in Electrical and Elastic networks. ***Physical Review B*** [1,2], **66**: 144203 (2002).

9. Ganzera M., **Dharmaratne H.R.W.**, Nanayakkara N.P.D., and Khan I.A. Determination of saponins and alkaloids in *Calophyllum thalictroides* (Blue Cohosh) by High Performance Liquid Chromatography and Evaporative Light Scattering Detection. ***Phytochemical Analysis***[1,2] (in press).

10. *Goldman D.I., Shattuck M., Swinney H.L., and **Gunaratne G.H.** Characterization of the Emergence of Order in an Oscillated Granular Layer. ***Physica A*** [1,2], **306:** 180-188 (2002).

11. **Gunaratne G.H.** Using Nonlinear Response to Estimate the Strength of Elastic Networks. ***Physical Review E*** [1,2], **67:** 061904 (2002).

12. ***Gunaratne G.H.**, Mohanty K.K., and Wimalawansa S.J.A Model of Bone and applications to Osteoporosis. ***Physica A*** [1,2], **315**: 244-250 (2001).

13. **Gunaratne G.H.,** Rajapakse C.S., Bassler K.E., Mohanty K.K., and Wimalawansa S. J. A Model for Bone Strength and Osteoporotic Fracture. ***Physical Review Letters*** [1,2], **88**: 068101 (2002).

14. **Iqbal M.C.M.** and Moellers C. Uptake and distribution of sinigrin in microspore derived embryos of *Brassica napus.* ***Journal of Plant Physiology***[1,2] (in press).

15. ***Iqbal M.C.M.** and **Wijeysekara K.B.** Cells of the connective tissue differentiate and migrate into pollen sacs. ***Naturwissenschaften*** [1,2], **89**(1): 39-42 (2002).

16. **Jayasinghe U.L.B.,** Hara N., and Fujimoto Y. Bidesmosidic saponins from the fruits of *Diploclisia glaucescens.* ***Phytochemistry*** [1,2] (in press).

17. **Jayasinghe U.L.B., Jayasooriya C.P.,** and Fujimoto Y. Oleanane glycosides from the leaves of *Diploclisia glaucescens.* ***Fitoterapia*** [2], **73:** 424-427 (2002).

18. **Jayasinghe U.L.B., Jayasooriya C.P.,** Ekanayake S.P., Bandara B.M.R., Merlini L., and Assante G. Antimicrobial activity of some Sri Lankan Rubiaceae and Meliaceae. ***Fitoterapia*** [2], **73:** 406-410 (2002).

19. ***Jayasinghe U.L.B., Jayasooriya C.P.,** Oyama K., and Fujimoto Y. 3-Deoxy-1β, 20-hydroxyecdysone from the leaves of *Diploclisia glaucescens.* ***Steroids*** [1,2], **67:** 555-558 (2002).

20. **Jayasinghe U.L.B., Kumarihamy B.M.M.,** Bandara A.G.D., Waiblinger J., and Karaus W. Antifeedant activity of some Sri Lankan plants. ***Natural Product Letters*** [2] (in press).

21. **Jayasinghe U.L.B., Kumarihamy B.M.M.,** Jayaratne K.H.R.N., Udishani N.W.M.G., Bandara B.M.R., Hara N., and Fujimoto Y. Antifungal constituents of *Bridelia retusa.* ***Phytochemistry*** [1,2](in press).

22. **Jayasinghe U.L.B., Kumarihamy B.M.M.,** Bandara A.G.D.,Vasquez E.A., and Kraus W. Nematicidal activity of some Sri Lankan Plants. ***Natural Product Letters*** [2] (in press).

23. Jayaweera P.M., Palayangoda S.S., **Tennakone K.,** and Gamage R.G.C.R. Cobalt (II)-bis-(1,10-phenanthroline)-triphenylmethane dye complexes and their photo-sensitization properties in nano-porous photovoltaic devices. ***Current Science*** [1,2], **3**(11): 1368-1372 (2002).

24. Konno A., Kumara G.R.R.A., Hata R., and **Tennakone K.** Effect of Imidazolium Salts on the Performance of Solid-state Dye-sensitized Photovolatic Cell Using Copper Iodide as a Hole Collector. ***Electrochemistry***[2], 432-434 (2002).

25. Kröner A., **Kehelpannala K.V.W.,** and Hegner H. Ca.750-1100 Ma magmatic events and Grenville-age deformation in Sri Lanka: relevance for Rodinia supercontinent formation and dispersal, and Gondwana amalgamation. ***Journal of Asian Earth Sciences***[2] (in press).

26. Kumara G.R.R.A., Kaneko S., Okuya M., and **Tennakone K.** Fabrication of Dye-sensitized Solar Cells Using Triethylamine Hydrothiocyanate as a CuI Crystal Growth Inhibitor. ***Langmuir, American Chemical Society*** [1,2] (in press).

27. Kumara G.R.R.A., Kaneko S., Okuya M., and **Tennakone K.** Nanocrystalline TiO_2 films for dye-sensitized solid-state solar cells. ***Key Engineering Materials: Journal of the Ceramic Society of Japan*** [1,2], **119:** 228-229 (2002).

28. *Kumara G.R.R.A., Konno A., Shiratsuchi K., and **Tennakone K.** Dye-sensitized solid-state solar cells: use of crystal growth inhibitors for deposition of the hole collector. ***Chemistry of Materials, American Chemical Society***[1,2], **14:** 954(2002).

29. Loinaz W., Okamura N., Takeuchi T., and **Wijewardhana L.C.R.** The Nutev anomaly, Neutrino mixing, and a heavy higgs. ***Physical Review D*** [1,2] (in press).

30. **Nanayakkara A.** Real eigenspectra in non-Hermitian multidimensional Hamiltonians. ***Physics Letters A*** [1,2], **304** (3-4): 67-72 (2002).

31. **Nanayakkara A.** and Bandara V. Approximate energy expressions for confining polynomial potentials. ***Sri Lankan Journal of Physics***, **3:** 7 (2002).

32. **Nanayakkara A.** and Abayaratne C. Identification of Semiclassical Chaos in 2D *PT*-symmetric Systems. ***Canadian Journal of Physics*** [1,2] (in press).

33. **Nanayakkara A.** and Abayaratne C. Phase space studies of complex Henon Heiles potentials. ***Sri Lankan Journal of Physics,*** **3:** 1 (2002).

34. **Nanayakkara A.** and Abayaratne C. Semiclassical Quantization of Complex Henon-Heiles Systems. ***Physics Letters A*** [1,2], **303** (4) : 243-248 (2002).

35. **Nanayakkara A.** and Bandara V. Asymptotic behavior of the eigen energies of anharmonic oscillators $V(x) = x^{2N} + bx^2$. ***Canadian Journal of Physics***[1,2], **80** (9): 959-968 (2002).

36. **Nanayakkara A.** and Dasanayake I. Analytic Semiclassical Energy Expansions of general Polynomial Potentials. ***Physics Letters A***[1,2], **294** (3-4): 158-162 (2002).

37. **Nanayakkara A.** and Ranatunga N. A new quantization method for evaluation of eigen energies. ***International Journal of Theoretical Physics***[1,2], **41** (7): 1355 (2002).

38. *Nathanael S. and **Silva E.I.L.** The role of Non-cichlid exotics in the fishery of the Victoria reservoir in Sri Lanka. ***Journal of Aquatic Science***, 7:15-22 (2002).

39. *Nathaneal S. and **Silva E.I.L.** Some aspects of the reproductive biology of three exotic cichlid species that colonize the Victoria Reservoir in Sri Lanka. ***Journal of Aquatic Science,*** **7:** 22-31(2002).

40. **Perera V.P.S., Senadeera R., Tennakone K.**, Ito S., Kitamura T., Wada Y., and Yanagida S. The Effect of MgO on the Enhancement of the Efficiency in Solid-State Dye Sensitized Photocells Fabricated with SnO_2 and CuI. ***Bulletin of the Chemical Society of Japan***[1,2] (in press).

41. **Ramanayake S.M.S.D.** and Wanniarachchi W.A.V.R. Embryogenic potential of callus derived from an adult giant bamboo (*Dendrocalamus giganteus* Wall. Ex Munro). ***Scientia Horticulturae***[1,2] (in press).

42. Rott E., **Silva E.I.L.,** Enriquez E., and Igthamjitr S. Phytoplankton community structure (species composition, diversity, chlorophyll, seasonal variations and key stone variables) in four reservoirs and a volcanic lake in Monsoon Asia. ***Hydrobiologia*** [1,2] (in press)

43. Sakagami Y., Kajimura K., Wijesinghe W.M.N.M., and **Dharmaratne H.R.W.** Antibacterial Activity of Calozeyloxanthone Isolated from *Calophyllum* species Against Vancomycin-Resistant Enterococci (VRE) and Synergism with Antibiotics. ***Planta Medica*** [1,2], **68:** 541 – 543 (2002).

44. ***Silva E.I.L.,** Amarasinghe U.S., De Silva S.S., Nissanka C., and Schiemer F. Photosynthetic primary productivity of eleven perennial irrigation reservoirs in Sri Lanka. ***Hydrobiologia*** [1,2], **485:** 19-33 (2002).

45. ***Senadeera G.K.R., Jayaweera P.V.V., Perera V.P.S.,** and **Tennakone K.** Solid state Dye sensitised photocell based on pentacene as hole collector. ***Solar Energy Materials and Solar Cells*** [1,2], **73:**103-108 (2002).

46. **Seneviratne G.** Litter controls on carbon sequestration. ***Current Science*** [1,2], **82:** 130-131 (2002).

47. **Seneviratne G.** Planting trees for C sequestration: A reality? ***Current Science***[1,2], **82:** 777 (2002).

48. **Tennakone K.** Dye-sensitized semiconductor nanostructures for solar energy conversion. ***Ceylon Journal of Science (Physical Science)***, **9:**1-8 (2002).

49. ***Tennakone K., Bandaranayake P.K.M., Jayaweera P.V.V.,** Konno A., and Kumara G.R.R.A. Dye sensitized composite semiconductor naonstructures. ***Physica E*** [1,2], **14:** 190-196 (2002).

50. **Tennakone K., Jayaweera P.V.V.,** and **Bandaranayake P.K.M.** Dye sensitized Photoelectrochemical and solid state solar cells. ***Journal of Photochemistry and Photobiology A*** [1,2] (in press).

51. Vijverberg J., Amarasinghe P.B., Chittapalapong T., Pagulayan R.C., Ariyaratne M.G., Pamanian E.R., **Silva E.I.L.**, and Nagelkerke L.A.J. Structure of microcrustacean zooplankton communities in five Southeast Asian water bodies. ***Hydrobiologia*** [1,2] (in press).

52. ***Weerasooriya R., Aluthpatabendi D.**, and Tobschall H.J. Charge distribution multi-site complexation modeling of Pb(II) adsorption on gibbsite. ***Colloids and Surfaces A: Physicochemical and Engineering Aspects*** [1,2], **189**:131-144 (2001).

53. **Weerasooriya R.**, Tobschall H.J., **Wijesekara H.K.D.K.**, and Pathiratne K.A.S. On the mechanistic modeling of As (III) adsorption on gibbsite. ***Chemosphere*** [1,2] (in press).

54. ***Weerasooriya R., Wijesekara D.**, and Bandara A. Surface complexation modeling of cadmium adsorption on gibbsite, ***Colloids and Surfaces A:Physicochemical and Engineering Aspects*** [1,2], **207**:13-24 (2002).

55. Weinert M., Watson R. E. and **Fernando G. W.** Density Functional Theory and Atomic Multiplet Levels. ***Physical Review A***[1,2], **66:** 032508 (2002).

56. **Wijesekara K.B.** and **Iqbal M.C.M.** Cytological aspects of pollen embryogenesis in anther culture of *Datura metel L.* ***Ceylon Journal of Science (Biological Sciences),*** **30:** 89-98 (2002).

❖ *Names of the **IFS staff members** are in bold letters*

Reported as "in press" in the Annual Research Report 2001
[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index (expanded) in 2002***

IMPACT FACTORS OF JOURNALS IN WHICH, THE ARTICLES ARE PUBLISHED

(Impact factors are computed to an accuracy of three decimal places, X: Impact Factor not computed for the year 2001)

JOURNAL	IMPACT FACTOR
Bulletin of the Chemical Society of Japan	1.376
Canadian Journal of Physics	0.623
Ceylon Journal of Science (Biological Sciences)	x
Ceylon Journal of Science (Physical Science)	x
Chemical Geology	2.532
Chemistry of Materials, American Chemical Society	3.690
Chemosphere	1.181
Colloids and Surfaces A	1.098
Current Science	0.600
Electrochemistry	0.606
Fitoterapia	0.486
Hydrobiologia	0.639
International Journal of Theoretical Physics	0.520
Journal of Aquatic Science	x
Journal of Asian Earth Science	0.971
Journal of Crustacean Biology	0.823
Journal of Photochemistry and Photobiology A	1.038
Journal of Plant Physiology	1.018
Key Engineering Materials: Journal of the Ceramic Society of Japan	0.541
Langmuir, American Chemical Society	2.963
Natural Product Letters	0.555
Naturwissenschaften	1.624
Physica A	1.295
Physica E	1.009
Physical Review A	2.810
Physical Review B	3.070
Physical Review D	4.363
Physical Review E	2.235
Physical Review Letters	6.668
Physics Letters A	1.220
Phytochemical Analysis	0.973
Phytochemistry	1.296
Planta Medica	2.085
Scientia Horticulturae	0.510
Solar Energy Materials and Solar Cells	1.306
Sri Lankan Journal of Physics	x
Steroids	2.088

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

COMMENCEMENT: 1999

INVESTIGATORS (2002):

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

PROGRESS ACHIEVED *(Since inception):*

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. Hence, non-invasive diagnostic tools to determine the need for therapeutic intervention are essential for optimal management of osteoporosis. Diagnostics currently in use, such as the bone mineral density (BMD), cannot be used to identify patients who require therapy with sufficient accuracy. Factors complicating the estimation of bone strength include anisotropy of the porous bone, thinning of struts forming the porous medium, and variations in bone quality. It is impossible to analyze such subtle details in clinical studies or in experiments on ex-vivo bone samples. Mathematical models have been used successfully to extract such details in many physical systems. A corresponding analysis of bone can provide a deeper insight on causes underlying loss of bone strength, and aid decisions on treatment options and the development of more accurate diagnostic tools.

We have recently introduced a model of porous bone which consists of a disordered network of fragile elastic springs. The advantage of using model systems is illustrated through a surprising observation on the nature of load transmission on a network. It is seen that, as a network loses trabeculae, it is only able use a systematically smaller fraction of the remaining segment for stress propagation. As a consequence of this inefficiency, bone strength decreases nonlinearly with BMD, and a new expression for it is derived on the basis of our model. It has been validated using previously published data. More sensitive and comprehensive tests of the expression using samples rat bones with varying levels of therapeutically induced bone loss are proposed.

Analysis of the model allowed us to propose a new explanation for the remarkable efficacy of certain therapies (e.g., bisphosphonates, salmon-calcitonin}) in reducing fracture incidence. It relies on the assumption that the efficiency of a treatment is based on its ability to regenerate bone mass preferentially in the most critical locations. In this view, less efficient therapies such as fluoride treatment do not induce bone growth to focus on the required locations. Results from numerical integration of our model confirms these suggestions; specifically, small variations in algorithms for mass deposition are seen to have dramatic effects on the enhancement of the ultimate strength of a network.

Studies of mathematical models can be used to estimate the relative contributions from distinct factors to loss of bone strength in a relatively short time frame. This

information can be used to deduce new diagnostics of bone strength. The most promising of these can then be subjected to studies on animal bones. We expect such a coordinated approach to provide new and reliable diagnostic tools for bone strength. By helping to determine the need and optimal time for therapy, they can reduce fractures in patients and improve the cost-effectiveness of medical therapy.

PROJECT OUTPUT 2002:

(1) 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 observation was used to introduce a new diagnostic to estimate the strength of a network. Studies of the model system shows that the measure (which depends on the linear response of the network to external strain) can accurately predict the breaking strength of the network. We are currently developing experiments (on rats) to test out the possibility of predicting bone strength.

(2) We have used fused random resistor networks to derive a relationship between the strength of a network as resistors are removed from it and the fraction of resistors present. This expression has also been confirmed in our model system of bone. Analysis of previously published data on strength of human bone is also seen to follow the same form.

(3) We are developing techniques to use digitized images of (the inner) porous bone (obtained using micro computed tomography) to evaluate mechanical properties of bone. These computations will be completed prior to the availability of experimental data (from rats).

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1.* *Title:* Characterization of the Emergence of Order in an Oscillated Granular Layer
Authors: Goldman D.I., Shattuck M., Swinney H.L., and **Gunaratne G.H.**
Journal: ***Physica A*, 306**: 180-188 (2002)[1,2]

2.* *Title:* A model of Bone and applications to Osteoporosis
Authors: **Gunaratne G.H.,** Mohanty K.K., and Wimalawansa S.J.
Journal: ***Physica A*, 315**: 244-250 (2001)[1,2]

3. *Title:* A Model for Bone Strength and Osteoporotic Fracture
Authors: **Gunaratne G.H.,** Rajapakse C.S., Bassler K.E., Mohanty K.K., and Wimalawansa S.J.
Journal: ***Physical Review Letters*, 88**: 068101 (2002)[1,2]

4. *Title:* Strength reduction in Electrical and Elastic networks
Authors: Espinoza-Ortiz J., Rajapaksa C.S., and **Gunaratne G.H.**
Journal: ***Physical Review B*, 66**: 144203 (2002)[1,2]

5. *Title:* Using Nonlinear Response to Estimate the Strength of Elastic Networks
Author: **Gunaratne G.H.**
Journal: ***Physical Review E*, 67:** 061904 (2002) [1,2]

* ***Reported as 'in press' in Annual Report 2001***
[1] ***Listed in the science citation index 2002***
[2] ***Listed in the science citation index-expanded 2002***

INVITED LECTURES/CONFERENCES ATTENDED IN 2002:

(1) **Gunaratne G.H.**
How Bones May Break
Workshop on Biomechanics, Notre Dame University.

(2) **Gunaratne G.H.**
Characterizations of Patterns
Workshop on Patterns, Colorado.

PROJECT: **COMPUTATIONAL MATHEMATICS AND PHYSICS**
QUANTUM CHAOS

COMMENCEMENT: 2000

INVESTIGATORS (2002):

Nanayakkara A., *Senior Research Fellow* **(Project Leader)**
Ranatunga N., *Research Assistant*

PROGRESS ACHIEVED (*Since inception*):

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. Major achievements of this project since its inception (till end of the year 2001) can be summarized as follows.

(1) A new powerful asymptotic energy expansion method was developed for 1-D systems. This method is based on power series expansion of the quantum action variable J in energy and can be applied to a wide range of potentials. Contour integrals involved in the method are much simpler than that in WKB methods. Since each term in the series can be evaluated analytically, the energy expressions produced by this method provide analytic insight into a given problem *(Results have been published).*

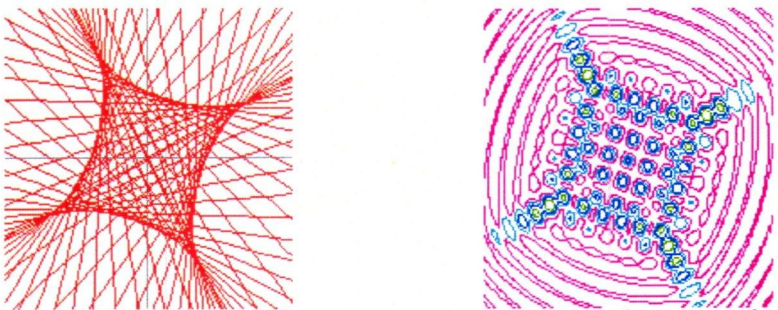
(2) A new quantization condition was developed for 1-D systems. This new method is a computational method which can be applied to large number of 1-D systems. One of the important findings about this method is its applicability to predict distributions of zeros of quantum mechanical wave functions semiclassically. The distribution of zeros of wave functions in multidimensions are believed to contain signature of chaos in the corresponding classical system *(Results have been published).*

PROJECT OUTPUT (2002):

During the year 2002 we mainly concentrated on multi-dimensional non Hermitian systems. The semiclassical concepts and methods which are normally used for studying semiclassical chaos in real phase-space were extended to complex phase-space for studying both PT-symmetric and η-pseudo Hermitian systems. Two major findings of this work are given below.

(1) It is found that most of the semiclassical methods which have been developed for quantizing multi-dimensional real Hermitian Hamiltonian systems can be successfully employed for complex non -Hermitian PT-symmetric systems with suitable extensions. *(This is done in collaboration with Dr. Chula Abayaratne, at the University of Sri Jayawardenapura. Results have been published).*

(2) A quantitative measure of the degree of classical chaotic behavior is pr ovided by Lyapunov exponents. If the Lyapunov exponent is positive, corresponding motion is identified as classically chaotic. Other wise, the motion is considered to be regular. On the other hand, it is well known that the quantum energy level statistics of systems show different statistical characteristics corresponding to whether the system is chaotic or regular in the classical limit. For systems which are regular in the classical limit, the energy levels correspond to Poisson statistics, while for systems which are chaotic in the classical limit, the statistics follow Gaussian ensemble statistics according to the system's symmetry. We found a new exactly solvable η-pseudo-Hermitian Hamiltonian system which has positive Lyapunov exponent but quantum energy level spacing distribution follows Poisson ensemble statistics rather than usual Gaussian ensemble statistics *(Results have been submitted for publication).*



The images above depict the classical and quantum versions of a type of symmetry breaking, which appears in the analysis of hydrogen in strong magnetic and weak perpendicular electric fields. The image on the left shows classical orbits returning to the neighborhood of the nucleus. Because of the electric field, most of the orbits fail to return directly to the nucleus, as they would if there were no electric field. The image on the right shows the quantum wavefunction associated with those trajectories. The breaking of symmetry manifests itself in a failure of the wavefronts to return to the nucleus as a perfect focus.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* Real eigenspectra in non-Hermitian multidimensional Hamiltonians
   Author: **Nanayakkara A.**
   Journal: ***Physics Letters A,*** **304**(3-4): 67-72 (2002) [1,2]

2. *Title:* Semiclassical quantization of complex Henon-Heiles systems
   Authors: **Nanayakkara A.** and Abayaratne C.
   Journal: ***Physics Letters A,*** **303**(4): 243-248 (2002) [1,2]

3. *Title:* A new quantization method for evaluation of eigen energies
   Authors: **Nanayakkara A.** and Ranatunga N.
   Journal: ***International Journal of Theoretical Physics,*** **41**(7): 1355 (2002) [1,2]

4. *Title:* Asymptotic behavior of the eigen energies of anharmonic oscillators $V(x) = x^{2N} + bx^2$
   Authors: **Nanayakkara A.** and Bandara V.
   Journal: ***Canadian Journal of Physics,*** **80**(9): 959-968 (2002) [1,2]

5. *Title:* Analytic Semiclassical Energy Expansions of general Polynomial Potentials
   Authors: **Nanayakkara A.** and Dasanayake I.
   Journal: ***Physics Letters A,*** **294**(3-4): 158-162 (2002) [1,2]

6. *Title:* Identification of Semiclassical Chaos in 2D *PT*-symmetric Systems
   Authors: **Nanayakkara A.** and Abayaratne C.
   Journal: ***Canadian Journal of Physics*** (in press) [1,2]

7. *Title:* Approximate energy expressions for confining polynomial potentials
   Authors: **Nanayakkara A.** and Bandara V.
   Journal: ***Sri Lankan Journal of Physics,*** **03:** 17 (2002)

8. *Title:* Phase space studies of complex Henon Heiles potentials
   Authors: **Nanayakkara A.** and Abayaratne C.
   Journal: ***Sri Lankan Journal of Physics,*** **03:** 1(2002)

[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

ABSTRACTS/ CONFERENCE PROCEEDINGS IN 2002:

1. **Nanayakkara A.**
   A new class of *PT* symmetric Hamiltonian systems,
   Proceedings of the technical sessions, 18th Technical Sessions of the Institute of Physics, SL 2002 (pg.89)

INVITED LECTURES/CONFERENCES ATTENDED IN 2002:

1. Delivered a lecture on Vishmitha Lokaya at Ranabima Royal College, Gettambe on 06th March, 2002.

2. Chief Guest of the Science Day at Holy Family Convent, Wennappuwa and delivered a keynote address on Mysteries in Modern Physics on 10th October, 2002.

3. Chief Guest of Astro Day 2002 at Vidyartha College, Kandy and delivered the keynote address on Astronomy on 11th November, 2002.

PROJECT: **PARTICLE PHYSICS AND QUANTUM FIELD THEORY**

COMMENCEMENT: 1997

INVESTIGATORS (2002):

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

PROGRESS ACHIEVED (*Since inception*):

During my visits to the I.F.S. I have worked on three research projects in Particle Physics and Quantum Field Theory. In 1997 and 1998 I collaborated with Anuradha Ratnaweera . We mapped out the behavior of gauge theories as a function of the number of quark flavors. Anuradha performed the required numerical computations using the computer facilities at the I.F.S. This led to a publication in Physical Review D.

During my next visits in 1998, 1999, and 2000 I worked on analyzing the properties of high density quark matter and published a paper on this. It was on the gap equation and color flavor locking in cold dense QCD with three massless flavors. We developed an effective potential method to formally analyze the stability of various phases that occur in such dense systems of hadronic matter.

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 2001, we analyzed the properties of diquark 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. We have published a paper in Physical Review D on this subject.

We also analyzed a model field theory , namely 2+1 QCD at large densities to map out its phase structure. We derived and solved the gap equation in the leading, hard-dense loop improved, one-gluon exchange approximation. The magnitude of the order parameter is proportional to a power of the coupling constant. For an asymptotically large chemical potential, a qualitatively new (with respect to the 3+1 dimensional case) phenomenon of non-decoupling of the fermion pairing dynamics from the infrared one was observed.

PROJECT OUTPUT 2002:

Curvature Invariants of Static Einstein Spaces

During my visit in 2002 I worked on two different projects. The first involved the analysis of certain geometric properties of black holes. Black holes are gravitating objects with a singularity at the centre where the gravity is infinite . This singularity is covered by a surface called the horizon . If one falls through this surface escape is impossible. In the first project I analyzed the properties of a certain coordinate invariant scalar quantity defined in terms of the derivatives of the curvature of space. This quantity changes sign as one crosses the horizon to enter the interior of the black hole. Therefore by measuring this scalar one could determine the approach of the horizon. The research project involved the detailed analytical study of the properties of this invariant function.

NUTEV Anomaly, Neutrino Mixing and the Higgs Boson

The second project was an attempt to understand the recent results of the Neutrino at the Tevatron(NEUTEV) experiment at Fermilab in Illinois U.S.A.. In this experiment neutrinos are scattered from nuclear targets. By observing what comes out, the effective couplings of neutrinos to matter could be derived. The parameter known as the weak mixing angle is determined from this data. The value measured here seems to disagree in a statistically significant way with what is measured at CERN accelerator in Switzerland using a different process at the energy of the neutral weak gauge boson called Z. There is also another experimental anomaly involving the Z particle. Its invisible decay width, as measured at CERN seems to disagree with the predictions of the standard theory of particle physics

We have tried to reconcile these observations by assuming that the standard neutrino mixes with a heavier neutrino, which does not feel the standard weak gauge forces. Such a mixing with a sterile neutrino would suppress the coupling of the standard neutrino to the Z particle.

The data also requires the Higgs particle, which is responsible for generating all the particle masses, to be much heavier than its currently expected mass value of about 130 GeV. We are also in the process of writing another paper to explain how such neutrino mixings could naturally arise in theoretical models.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* The Nutev anomaly, Neutrino mixing, and a heavy higgs
   Authors: Loinaz W., Okamura N., Takeuchi T., and **Wijewardhana L.C.R.**
   Journal: ***Physical Review D*** (in press) [1,2]

[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

INVITED LECTURES/CONFERENCES ATTENDED IN 2002:

1. Invited Plenary Lecture at The Workshop on Strongly Coupled Gauge Theories (SCGT2002) Nagoya Japan December 2002.

PROJECT: **CONDENSED MATTER THEORY**

COMMENCEMENT: 1999

INVESTIGATORS (2002):

Fernando G.W., *Visiting Research Professor* **(Project Leader)**

PROGRESS ACHIEVED (*Since inception*):

Over the past few years, we have been investigating fundamental aspects of first principles many body theory, including density functional theory. Some of this work was carried out with (former) students M. Rasamny and M. Valiev at the University of Connecticut and UC San Diego, respectively. During the summer 2000, we have had an undergraduate student from Cornell working on transport properties of magnetic heterojunctions. We have also been examining phase diagrams of various binary intermetallics from a theoretical point of view using first principles electronic structure theory with a former student of mine and colleagues at Brookhaven National Laboratory. Another one of our recent projects was related to developing systematic interatomic potentials and studying diffusion of actinides in metallic systems. This was in collaboration with Prof. B. R. Cooper at West Virginia University and Dr. Elena Sevilla at the University of Connecticut (UConn). During the years 2000 and 2001, we have had a collaboration on understanding catalytic systems with the IMS (Institute of Materials Science - UConn) and PCI (Precision Combustion Inc. in New Haven, CT). Over the past few years we have also worked on magnetic properties of selected transition metal compounds (oxides, nitrides etc.) in collaboration with several research groups from UConn (Profs. J. Budnick, D. Pease, B. Sinkovic), IFS (Prof. K. Tennakone and A. Ratnaweera), Brookhaven National Laboratory (Drs. R.E. Watson and M. Weinert) and JNC Bangalore (Dr. S. Narasimhan). Some of the above work is still in progress.

This year, in collaboration with Profs. G. Gunaratne and L. C. R. Wijewardhana, a research proposal was submitted to the National Science Foundation (USA) requesting support for our international collaborations with the IFS.

PROJECT OUTPUT 2002:

In order to directly evaluate the many electron effects in atoms, molecules and solids, we have begun an analytical calculation of the two electron Coulomb Green's function with Dr. A. Kussow. We have also continued our first principles based work on phase diagrams of various transition metal systems during this year. A project that was completed this year has to do with identifying various inadequacies of the local (spin) density approximation used in electronic structure calculations. We have examined the multiplet level structure of transition metal atoms and identified various trends and problems associated with methods used in such calculations. We are also developing theoretical techniques to study nanoscale systems such as thin multilayered films and

nanoparticles and are interested mainly in electronic and magnetic properties of such systems.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* Density Functional Theory and Atomic Multiplet Levels
   Authors: Weinert M., Watson R.E. and **Fernando G.W.**
   Journal: ***Physical Review A,*** **66:** 032508 (2002)[1,2]

[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

PROJECT: **CONDENSED MATTER PHYSICS**

COMMENCEMENT: 1987

INVESTIGATORS (2002):

Bandaranayake K.M.P., *Research Assistant*
Jayaweeera P.V.V., *Research Assistant*
Perera V.P.S., *Research Assistant*
Pitigala P.K.D.D.P., *Research Assistant*
Senadeera G.K.R., *Research Fellow*
Tennakone K., *Research Professor* **(Project Leader)**

PROGRESS ACHIEVED (*Since inception*):

The aim of the project initiated around mid nineteen eighties was to conduct research in major areas of condensed matter physics depending on the available facilities and personnel. In the first few years, a considerable effort was diverted to studies on high temperature superconductivity which was then a fashionable theme of research. Subsequently project moved in the direction of semiconductor physics overlapping with the projects on photochemistry and solid-state chemistry. The project continues to conduct research on semiconductor thin films, nanostructures and dye-sensitization covering both experimental and theoretical aspects. Dye-sensitized solid-state photovoltaic cells and nanostructured dye-sensitized photoelectrochemical cells based on composite materials are important innovations originating from the project. The work completed has given rise to nearly 140 publications international journals. The project has gained recognition has focus of activity in this field and papers published are frequently cited.

PROJECT OUTPUT 2002 :

In the year 2002 the project conducted investigation on electron transport and photovoltaic effects in nanostructured n-type semiconductor/ electrolyte and p-type semiconductor junctions. Photocurrent and photovoltage transients were measured and theoretical model was designed to understand the mechanism of recombinations. Experiments on dye-sensitized cadmium sulfide films conducted during this year confirmed the recombination mechanisms suggested earlier and based on experiments with nanocrystalline tin oxide films. Instruments were fabricated to record transient responses of photovoltaic devices and measure thickness of nanocrystalline thin film profiles. This project overlaps with the projects on Photochemistry and Solid-State Chemistry.

This project overlaps with the projects on Photochemistry and Solid State Chemistry.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1*. *Title:* Dye-sensitized composite semiconductor nanostructures
Authors: **Tennakone K., Bandaranayake K.M.P., Jayaweera P.V.V.,** Konno A., and Kumara G.R.R.A
Journal: ***Physica E*, 14**: 190-196 (2002) [1,2]

2.* *Title:* Dye-sensitized solid-state solar cells: use of crystal growth inhibitors for deposition of the hole collector
Authors: Kumara G.R.R.A., Konno A., Shiratsuchi K., and **Tennakone K.**
Journal: ***Chemistry of Materials, American Chemical Society,* 14:** 954(2002) [1,2]

3.* † *Title:* Solid-state dye-sensitized photocell based on Pentacene as a hole collector
Authors: **Senadeera G.K.R., Jayaweera P.V.V., Perera V.P.S** and **Tennakone K.**
Journal: ***Solar Energy Materials and Solar Cells*** , **73**:103-108 (2002) [1,2]

4. †† *Title:* Composite Tin and Zinc Oxide nanocrystalline particles for enhanced charge separation in sensitized degradation of dyes
Authors: **Bandara J., Tennakone K.,** and Jayatilaka P.P.B.
Journal: ***Chemosphere,* 49(4)**: 439-445 (2002) [1,2]

5. *Title:* Cobalt (II)-bis-(1,10-phenanthroline)-triphenylmethane dye complexes and their photo-sensitization properties in nano-porous photovoltaic devices
Authors: Jayaweera P.M., Palayangoda S.S., **Tennakone K.,** and Gamage R.G.C.R.
Journal: ***Current Science,* 83(11)**: 1368-1372 (2002) [1,2]

6. *Title:* Effect of Imidazolium Salts on the Performance of Solid-state Dye-sensitized Photovolatic Cell Using Copper Iodide as a Hole Collector
Authors: Konno A., Kumara G.R.R.A., Hata R., and **Tennakone K.**
Journal: ***Electrochemistry,*** 432-434 (2002)[2]

7. *Title:* Nanocrystalline TiO_2 films for dye-sensitized soild- state solar cells
Authors: Kumara G.R.R.A., Kaneko S., Okuya M., and **Tennakone K.**
Journal: ***Key Engineering Materials:Journal of the Ceramic Society of Japan,* 119:** 228-229 (2002) [1,2]

8. *Title:* Dye-sensitized semiconductor nanostructures for solar energy conversion
Author: **Tennakone K.**
Journal: ***Ceylon Journal of Science(Physical Science)*, 9** :1-8(2002)

9. *Title:* Dye-sensitized Photoelectrochemical and Solid-State Solar Cells
Authors: **Tennakone K., Jayaweera P.V.V.,** and **Bandaranayake P.K.M.**
Journal: ***Journal of Photochemistry and Photobiology A*** (in press) [1,2]

11.† *Title:* The Effect of MgO on the Enhancement of the Efficiency in Soild-State Dye-Sensitized Photocells Fabricated with SnO_2 and CuI.
Authors: **Perera V.P.S., Senadeera R., Tennakone K.,** Ito S., Kitamura T., Wada Y., and Yanagida S.
Journal: ***Bulletin of the Chemical Society of Japan*** (in press) [1,2]

12. *Title:* Fabrication of Dye-sensitized Solar Cells Using Triethylamine Hydrothiocyanate as a CuI Crystal Growth Inhibitor
Authors: Kumara G.R.A., Kaneko S., Okuya M., and **Tennakone K.**
Journal: ***Langmuir, American Chemical Society*** (in press) [1,2]

13. *Title:* Dye-sensitization of magnesium oxide coated cadmium sulfide
Authors: **Bandaranayake P.K.M., Jayaweera P.V.V.,** and **Tennakone K.**
Journal: ***Solar Energy Materials and Solar Cells (in press)*** [1,2]

† ***This also appears in the Publication List of Solid State Chemistry***
†† ***This also appears in the Publication List of Photochemistry***
[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

PATENTS:

1. **Tennakone K., Bandara J., Jayaweera P.V.V., Bandaranayake P.K.M.,** and **Institute of Fundamental Studies,** Dye-sensitized photoelectrochemical cell made from film of magnesium oxide coated tin (IV) oxide, *Patent No.12330, National Intellectual Property Office,2002.*

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2002:

1. Konno A., Kumara G.R.R.A. and **Tennakone K.**
Important properties of the CuI film Dye-Sensitized Solid-State Solar Cells, *14th International Conference on Photochemical Conversion and Storage of Solar Energy, Sapporo, Japan, August 4-9,2002*

2. **Perera V.P.S., Senadeera G.K.R., Tennakone K.,** Ito S., Wada Y. and Yanagida S.
Solid –state dye-sensitized photocells fabricated with nanocrystalline SnO_2 covered with a thin layer of MgO,
Centennial Meeting, Electrochemical Society, Philadelphia, USA, 11-17 May, 2002

3. Kumara G.R.R.A., **Tennakone K.**, Okuya M. and Kaneko S.
Solid-State Dye-Sensitized Solar Cells Made from Nanocrystalline Films of TiO_2 coated with MgO,
Centennial Meeting, Electrochemical Society, Philadelphia, USA, 11-17 May 2002

4. Konno A., Kumara G.R.R.A., and **Tennakone K.**
Improved Performance of Dye-Sensitized Solar Cells by Hybridization of Nano-Sized Metal Oxides,
Centennial Meeting Electrochemical Society, Philadelphia, USA, 11-17 May 2002

5. Konno A., Kumara G.R.R.A., and **Tennakone K.**
Stability Improvement of Dye-Sensitized Photovoltaic Cells by Adding Imidazolium Thiocyanate to Cuprous Iodide p-Type Semiconductor Layer,
Centennial Meeting, Electrochemical Society, Philadelphia, USA, 11-17 May 2002

6. **Perera V.P.S., Senadeera G.K.R.**, and **Tennakone K.**
The effect of aluminium on photocurrent increment in dye-sensitized photoelectrochemical cells based on nanocrystalline SnO_2 films,
Third Asian Photochemistry Conference, Mumbai, India, 6-11 January, 2002(p.45).

7. **Senadeera G.K.R.**, De Silva R.A.D.B., **Jayaweera P.V.V.**, and **Tennakone K.**
p-4CuBr.3S$(C_4H_9)_2$: Promising material as the hole collector in soild-state dye-sensitized photovoltaic cells with TiO_2,
Third Asian Photochemistry Conference, Mumbai, India, 6-11 January 2002(p.46).

INVITED LECTURES/CONFERENCES ATTENDED IN 2002:

1. **Tennakone K.**
Dye-sensitized Solar Cells: Their Mode of Operation and Prospects for Improvement
14th International Conference on Photochemical Conversion and Storage of Solar Energy, Sapporo, Japan , August 4-9, 2002.

2. **Tennakone K.**
Dye-sensitized semiconductor quantum dots,nanowires and nanobeads(invited lecture)
The "Cormorant Workshop on Nanomaterials for Photo Energy Conversion, Gifu University, Japan August 2-3, 2002.

3.**Tennakone K.**
Dye-sensitized semiconductor nanostructures for solar energy conversion
Keynote Address, Annual Sesions of the Post Graduate Institute of Science, University of Peradeniya.

POST-GRADUATE DEGREES COMPLETED IN 2002:

1.	Kottegoda I.R.M. Ph.D degree	- Sensitization of Mesoscopic and Structured Semiconductor Thin Films - Awarded by the University of Colombo, Sri Lanka

PROJECT: **PHOTOCHEMISTRY**

COMMENCEMENT: 1999

INVESTIGATORS (2002):

Bandara J., *Research Fellow* **(Project Leader)**
Bandaranayake P., *Research Assistant*
Tennakone K., *Research Professor*

PROGRESS ACHIEVED (*Since inception*):

The use of insulating oxide (MgO, CaO) coating on nanocrystalline oxides was successfully demonstrated as a mean of enhanced charge separation for the dye-sensitized (DS) photoelectrochemical cells (PECs) based on nanocrystalline semiconductor films. This process was well anticipated by several other researchers around the world and applied successfully for various thin nonporous oxide films as well as photocatalytic applications, which are under further investigation.

PROJECT OUTPUT 2002:

The interaction of water with oxide surfaces has received considerable attention because of its prominence in geochemistry, atmospheric chemistry and catalysis. However, the details of the interaction of water with oxides is still in debate due to limited abilities to study surface properties by common techniques. In this research project, we studied the interaction of water with oxide surface with the use of Sum Frequency Generation (SFG) spectroscopy, which has always been of great interest to researchers in surface science because it not only permits identification of surface molecular species but also provides information on surface structure.

Using quartz as a model surface, surface interaction of water was investigated. It was noticed that the interaction and orientation of water molecules are highly depended on the surface and solution pH value and hence the quartz dissolution kinetics. The clear evidence was established for the surface restructuring and the solution acidity. Two manuscripts are under preparation. This project overlaps with the projects on Condensed Matter Physics and Solid State Chemistry.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *††Title:* Composite Tin and Zinc oxide nanocrystalline particles for enhanced charge separation in sensitized degradation of Dyes
   Authors: **Bandara J., Tennakone K.**, and Jayatilaka P.P.B.
   Journal: ***Chemosphere,*** **49**(4): 439-445 (2002)[1,2]

††This also appears in the Publication List in Condensed Matter Physics
[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

PROJECT : SOLID STATE CHEMISTRY

COMMENCEMENT : 1999

INVESTIGATORS (2002):

Jayaweera P.V.V., *Research Assistant*
Perera V.P.S., *Research Assistant*
Pitigala P.K.D.D.P., *Research Assistant*
Senadeera G.K.R., *Research Fellow* **(Project Leader)**
Tennakone K., *Research Professor*

PROGRESS ACHIEVED (*Since inception*):

This Project was initiated in 1999 and investigations are being mainly concentrated on the synthesis, characterization and understanding of physico-chemical proprieties of some materials, such as solid polymer electrolytes, electronically conducting polymers and inorganic semiconductors (p-type) based on Cu, which have potential application in novel solid-state devices. In this context, materials synthesized either by chemically or electrochemically were characterized by (CV) cyclic voltametry, SEM, TEM, XPS, FTIR, AC impedance and photocurrent measurements. Some of the major achievements are the identification of complexes of Cu(I) bromide with sulfides and pentacene as promising materials suitable for positive charge collection in solid state dye sensitized photo cells.

In addition to above investigations, since the electrical properties of the films of semiconducting materials (specially used in the solar cells) strongly depend on the preparation methods yielding poor data reproducibility, we constructed a fully automated spray pyrolysis unit (equipment) for the film preparation. The preliminary experiments have been completed with very promising results.

PROJECT OUTPUT 2002:

(1) The photoelectric responses of electrodeposited C_{60} films on nanocrystalline TiO_2 with positive hole collecting CuSCN: Thin films of C_{60} were electrodeposited on TiO_2 electrodes. All solid-state photovoltaic devices were fabricated comprising of above C_{60} films with hole conducting inorganic semiconductor CuSCN, exhibiting high photocurrent responses compared to previously reported photovoltaic systems based on C_{60}.

(2) Chemical deposition of polypyrrole on surface modified TiO_2 and its application as sensitizer and hole conductor in solid state photocells with ionic liquids: Photophysical properties of thin films of Polypyrrole(PPY) covalently grafted on surface modified nanocrystalline TiO_2 substrates via siline compounds have been investigated.

(3) Deposition of polyaniline via molecular self-assembly on TiO_2 and its uses as a sensitizer in solid state solar cells: The chemical deposition of polyaniline on surface modified TiO_2 and its uses in photocells were investigated.

This project overlaps with the projects on Condensed Matter Physics and Photochemistry.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1.*† *Title:* Solid State Dye sensitized photocell based on Pentacene as a hole collector

Authors: **Senadeera G.K.R., Jayaweera P.V.V., Perera V.P.S.,** and **Tennakone K.**

Journal: ***Solar Energy Materials and Solar cells,*** **73:** 103-108 (2002)[1,2]

2.† *Title:* The Effect of MgO on the Enhancement of the Efficiency in Solid-State Dye Sensitized Photocells Fabricated with SnO_2 and CuI

Authors: **Perera V.P.S, Senadeera G.K.R., Tennakone K.,** Ito S., Kitamura T., Wada Y., and Yanagida S.

Journal: ***Bulletin of the chemical society of Japan (in press)***[1,2]

* ***Reported as 'in press' in Annual Report 2001***

† ***This also appears in the Publication List in Condensed Matter Physics***

[1] ***Listed in the science citation index in 2002***

[2] ***Listed in the science citation index-expanded in 2002***

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2002:

1. **Perera V.P.S., Senadeera G.K.R.,** and **Tennakone K.**
The effect of aluminium on photocurrent increment in dye sensitized photoelectrochemical cells based on nanocrystalline SnO_2 films,
Third Asian photochemistry conference (APC-2002) 6-11 January, Mumbai, India 2002(p.45).

2. **Senadeera G.K.R.,** De Silva D.B.R.A., **Jayaweera P.V.V.,** and **Tennakone K.**
p-4CuBr.3S$(C_4H_9)_2$: promising material as the hole collector in solid state dye sensitized photovoltaic cells with TiO_2,
Third Asian photochemistry conference (APC-2002) 6-11 January, Mumbai, India 2002 (p.46).

3. **Perera V.P.S., Senadeera G.K.R., Tennakone K.,** Ito S., Wada Y. and Yanagida S.
Solid state dye sensitized photocells fabricated with nanocrystalline SnO_2 covered with a thin layer of MgO,
14th international conference on photochemical conversion and storage of solar energy, August 4-9, Sapporo, Japan, 2002(W-1-P-57).

4. **Senadeera G.K.R.** and **Jayaweera P.V.V.**
   Effect of deposition current density on the properties of poly (3 methyl thiophene) and it's uses as sensitizer in photocells,
   Meeting abstracts, The electrochemical Society of Japan, Atsugi, Japan, September, 2002,2E 23, (P 139).

5. **Senadeera G.K.R.** and **Perera V.P.S.**
   The photo-electric response of electrodeposited C60 films on namocrystalline TiO2 with positive hole collecting CuSCN,
   18th Technical Session of Institute of Physics, Sri Lanka, March, 16, 2002(p.61).

6. **Senadeera G.K.R.** and **Perera V.P.S.**
   The effect of MgO on the enhancement of the efficiency in solid-state dye sensitized photocells fabricated with SnO2 and CuI
   18th Technical session of Institute of Physics, Sri Lanka, March, 16, 2002(p.79).

7. **Senadeera G.K.R.** and **Perera V.P.S.**
   Electrochemical synthesis and characterization of poly (3 methyl thiophene) and its evaluation as electrode material for photovoltaic device
   18th Technical Session of Institute of Physics, Sri Lanka, March,16, 2002(p.69).

PROJECT: **METAL COORDINATION CHEMISTRY**

COMMENCEMENT: 1999

INVESTIGATORS (2002):

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

PROJECT OUTPUT 2002 *(Since inception)*:

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 is of particular interest. Current efforts are focused on the design, synthesis and applications of nitrogen and oxygen based ligands such as tris(pyrazolyl)borates, pyrazolates, tropolone derivatives, and aminotroponimines. We are using these new ligands to prepare metal catalysts for oxo, nitrene, and carbene group transfer processes, 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 copper ethylene complexes using highly fluorinated tris(pyrazolyl)borate ligands. They are active as aziridination catalysts. The related tris(pyrazolyl)borato silver(I) complexes (e.g., $[HB(3,5\text{-}(CF_3)_2Pz)_3]AgC_2H_4$) are excellent catalyst for various carbene transfer reactions. We have also reported the synthesis of silver(I) and copper(I) pyrazolates $[(3,5\text{-}(CF_3)_2Pz)Cu]_3$ and $[(3,5\text{-}(CF_3)_2Pz)Ag]_3$ using $3,5\text{-}(CF_3)_2PzH$ and the corresponding metal oxide. They feature trimeric structures with close intramolecular Cu-Cu and Ag-Ag contacts. These coinage metal adducts exhibit rich luminescence properties.

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1. **Dias H.V.R.**
   Heterocyclic Ring Systems Featuring Group 14 Elements,
   Symposium: Organometallic Main Group Chemsitry-Fundamental and Applied Aspects; American Chemical Society, 58th Southwest regional meeting, Austin, Texas, Nov. 2002.

2. Lovely C. J., Browning R. G., Polach S. A., and **Dias H. V. R.**
   Carbene and nitrene transfer reactions catalyzed by fluorinated tris(pyrazolyl)borato copper(I) and silver(I) complexes,
   American Chemical Society, 58th Southwest regional meeting, Austin, Texas, Nov. 2002

PROJECT: **NATURAL PRODUCTS CHEMISTRY**

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

COMMENCEMENT: 1994

INVESTIGATORS (2002):

Dharmaratne H.R.W., *Associate Research Professor* **(Project Leader)**
Jayaweera D.S., *Laboratory Technician*
Napagoda M.T.,*Research Assistant*
Piyasena K.G N.P., *Research Assistant*
Wijeratne D.N.R., *Research Assistant*

PROGRESS ACHIEVED *(Since inception):*

The natural products programme at the IFS involves chemical and biological evaluation of medicinal and related plants in Sri Lanka. During the past eight years *Calophyllum* and *Garcinia* species from family Cluciaceae were investigated, and anti-HIV 1 RT, antibacterial, anti-MRSA, anti-VRE and anti fungal natural products were isolated and identified. Some of the above active compounds appear to hold promise as therapeutically important agents in the treatment of diseases and should be investigated further in appropriate in vivo models. Further, a number of new and known natural products were isolated from above plant species, and there structures were elucidated using spectroscopic and chemical conversions. Anti-HIV and anti-VRE experiments were conducted in the USA and Japan respectively.

Above findings paved the way to fifteen international publications, twenty two research communications and following postgraduate degrees.

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 antimicrobial activity of *Calophyllum moonii* M. Phil., University of Colombo (1999).

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

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

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

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

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

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

PROJECT OUTPUT 2002:

Extracts and pure compounds from different parts of *Calophyllum* and *Garcinia* species were subjected to anti fungal assays with a special reference to *Cladosporium, Aspergillus, Rhizoctonia* and *Corynespora* using agar plate assay and TLC bioassay. Methanol extract of the root stem of *C. thwaitesii* and hexane extract of the bark of *Garcinia mangostana* showed activity against *Cladosporium.* Activity guided fractionation of *Garcinia mangostana* extract indicated its' activity is due to the presence of γ–mangostin. Further anti-fungal studies on the MeOH extract of *C. thwaitesii,* and Chemistry and biological activity studies on the latex, fruits and the bark extracts of *Garcinia mangostana* and *C. cordato-oblongum* are in progress.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1*. *Title:* Kavalactones from *Piper methysticum*, and their ^{13}C NMR spectroscopic studies
Authors: **Dharmaratne H.R.W.**, Nanayakkara N.P.D., and Khan I.A.
Journal: ***Phytochemistry*, 59**:429-433 (2002) [1,2]

2*. *Title:* Inhibition of HIV-1 Reverse Transcriptase and HIV-1 Replication by *Calophyllum* Coumarins and Xanthones
Authors: **Dharmaratne H.R.W.**, Tan G.T., Marasinghe G.P.K., and Pezzuto J.M.
Journal: **Planta Medica, 68:** 86-87 (2002) [1,2]

3. *Title:* (-)-3β, 4β-Epoxyvalerenic acid from *Valeriana officinalis*
Authors: **Dharmaratne H.R.W.**, Nanayakkara N.P.D., and Khan I.A.
Journal: ***Planta Medica,* 68:** 661-662 (2002) [1,2]

4. *Title:* Antibacterial Activity of Calozeyloxanthone Isolated from *Calophyllum* species Against Vancomycin-Resistant Enterococci (VRE) and Synergism with Antibiotics
Authors: Sakagami Y., Kajimura K., Wijesinghe W.M.N.M., and **Dharmaratne H.R.W.**
Journal: ***Planta Medica,* 68:** 541 – 543 (2002) [1,2]

5. *Title:* Determination of saponins and alkaloids in *Calophyllum thalictroides* (Blue Cohosh) by High Performance Liquid Chromatography and Evaporative Light Scattering Detection.

Authors: Ganzera M., **Dharmaratne H.R.W.**, Nanayakkara N.P.D., and Khan I.A.

Journal: ***Phytochemical Analysis*** (in press)[1,2]

* ***Reported as "in press" in Annual Report 2001***

[1] ***Listed in the science citation index in 2002***

[2] ***Listed in the science citation index-expanded in 2002***

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 (2002):

Balasooriya B.A.I. S., *Research Assistant*
Jayasooriya C.P., *Research Assistant*
Jayasinghe U.L.B., *Senior Research Fellow* **(Project Leader)**
Kumarihamy B.M.M., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)* :

During the past ten years we have been doing research on the various parts of the following plants: *Pometia eximia* and *Filicium decipiens* (Sapindaceae), *Sarcococca brevifolia* (Buxaceae), *Uncaria elliptica* (Rubiaceae), *Terminalia catappa* (Combretaceae), *Diploclisia glaucescens* (Menispermaceae), *Bridelia retusa* and *Ageratum conyzoides* (Euphorbiaceae). This work led to the isolation and structure elucidation of hederagenin saponins, quinovic acid saponins, phytolaccagenic acid saponins, serjanic acid saponins, oleanolic acid saponins, norneohopane ester of caffeic acids, flavonoid glycosides, flavone C-glycosides, steroidal alkaloids, indole alkaloids, ecdysteroids, bisabolane sesquiterpenes and phenolic compounds etc. Some of these isolates showed strong antibacterial, antifungal, molluscicidal and insecticidal activity. Further, we have revised the previous structure assignments of uncaric acid, diketouncaric acid and diacetouncaric acid which were reported from *Uncaria elliptica* (Rubiaceae). In addition, we have identified a number of antifungal, antibacterial, nematicidal and antifeedant active extracts from some Sri Lankan plants. All these results led to 14 publications, 26 communications, chapter of a book and an M. Phil. Degree.

PROJECT OUTPUT 2002:

Chemical investigation of methanol extract of the fruits of *Diploclisia glaucescens* of the family Menispermaceae furnished a new ecdysteroid :

i) 2-deoxy-5β, 20-dihydroxyecdysone, together with
ii) 20-hydroxyecdysone, 3-deoxy-1β,20-dihydroxyecdysone, which have been previously reported from the stem and the leaves of the same plant.

In addition, saponins:
(1) 3-*O*-β-D-glucopyranosylecdsterone,
(2) 3-*O*-β-D-glucopyarnosyl-(1→2)-β-D-glucopyranosylserajanic acid 28-*O*-β-D-glucopyranosyl ester, and
(3) 3-*O*-β-D-xylopyranosyl-(1→2)-β-D-gluco pyranosyl-(1→2)-β-D-glucopyranosylserjanic acid 28-*O*-β-D-glucopyranosyl ester
have been isolated from the fruits of *D. glaucescens*. Saponin **3** was found to be a new natural product whereas saponins **1** and **2** are reported for the first time from the family Menispermaceae. Further, the structure elucidation of the alkaloids isolated from leaves of *Anamirta cocculus*, and *D. glaucescens* and the minor ecdysones isolated from the leaves of *D. glaucescens* are in progress.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

*1.	*Title:*	3-Deoxy-1β, 20-hydroxyecdysone from the leaves of *Diploclisia glaucescens*
	Authors:	**Jayasinghe U.L.B, Jayasooriya C.P.**, Oyama K., and Fujimoto Y.
	Journal:	***Steroids*, 67**: 555-558 (2002) [1,2]
2.	*Title:*	Oleanane glycosides from the leaves of *Diploclisia glaucescens*
	Authors:	**Jayasinghe U.L.B., Jayasooriya C.P.**, and Fujimoto Y.
	Journal:	***Fitoterapia*, 73**: 424-427 (2002)[2]
3.	*Title:*	Antimicrobial activity of some Sri Lankan Rubiaceae and Meliaceae
	Authors:	**Jayasinghe U.L.B., Jayasooriya C.P.**, Ekanayake S.P., Bandara B.M.R., Merlini L., and Assante G
	Journal:	***Fitoterapia*, 73**: 406-410 (2002) [2]
4.	*Title:*	Bidesmosidic saponins from the fruits of *Diploclisia glaucescens*
	Authors:	**Jayasinghe U.L.B.**, Hara N., and Fujimoto Y.
	Journal:	***Phytochemistry*** (in press)[1,2]
5.	*Title:*	Antifungal constituents of *Bridelia retusa*
	Authors:	**Jayasinghe U.L.B.**, **Kumarihamy B.M.M.**, Jayaratne K.H.R.N., Udishani N.W.M.G., Bandara B.M.R., Hara N., and Fujimoto Y.
	Journal:	***Phytochemistry*** (in press)[1,2]
6.	*Title:*	Nematicidal activity of some Sri Lankan plants
	Authors:	**Jayasinghe U.L.B.**, **Kumarihamy B.M.M.**, Bandara A.G.D., Vasquez E.A., and Kraus W.
	Journal:	***Natural Product Letters*** (in press)[2]

7. *Title:* Antifeedant activity of some Sri Lankan plants
Authors: **Jayasinghe U.L.B., Kumarihamy B.M.M.**, Bandara A.G.D., Waiblinger J., and Kraus W.
Journal: ***Natural Product Letters*** (in press)[2]

**** Reported as " in press" in the Annual Research Report 2001***
[1] Listed in the science citation index 2002.
[2] Listed in the science citation index-expanded 2002

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1. **Jayasinghe U.L.B., Balasooriya B.A.I.S.**, and Fujimoto Y.
Flavone C-glycoside from *Grewia damine,*
Proceedings of the Sri Lanka Association for the Advancement of Science, December (p. 246).

2. **Jayasinghe U.L.B., Kumarihamy B.M.M.**, Jayaratne K.H.R.N., Udishani N. W.M.G., Bandara B.M. R., and Fujimoto Y.
Antifungal constituents of *Bridelia retusa,*
Proceedings of the Sri Lanka Association for the Advancement of Science, December (p. 247).

3. **Jayasinghe U.L.B.**, Arundathie B.G.S., **Kumarihamy B.M.M.**, Dissanayake D.M.L.K., and Fujimoto, Y.
Ecdysones from the fruits of *Diploclisia glaucescens,*
Proceedings of the Sri Lanka Association for the Advancement of Science, December (p. 262).

4. **Jayasinghe U.L.B., Jayasooriya C.P.**, and Fujimoto Y.
Oleanane saponins from *Diploclisia glaucescens,*
Proceedings of the Sri Lanka Association for the Advancement of Science, December(p. 248).

5. Iqbal M.C.M., **Jayasinghe, U.L.B.**, Herath H.M.T.B., Wijeysekara K.B., and Fujimoto Y.
A fungistatic chromene from *Ageratum conyzoides,*
Proceedingsof the Sri Lanka Association for the Advancement of Science, December (p. 34).

6. Dallavalle S., **Jayasinghe U.L.B.**, **Kumarihamy B.M.M.**, Scaglioni L., and Merlini L.
A novel seco-3,4-lupeol derivative from *Lasianthus gardneri,*
23rd International Symposium on the Chemistry of Natural Products, Florence, Italy, 28th July – 2nd August, (p. 175).

BOOKS AND MONOGRAPHS IN 2002:

1. **Iqbal M.C.M.** and **Jayasinghe U.L.B.** Antifungal activity in seeds of some selected Sri Lankan Plants, *In Modern Fungicides and Antifungal Compounds III:* Chapter 41, pp. 373 – 377, (Editors: H. W. Dehne, U. Gisi, K. H. Kuck, P. E. Russell and H. Lyr)); AgroConcept GmbH, Bonn, Germany.

POST-GRADUATE DEGREES COMPLETED IN 2002:

1.	Kumarihamy B. M. M.	- Chemistry and bioactivity of some Sri Lankan Buxaceae and Rubiaceae.
	M. Phil. degree	- Awarded by the University of Peradeniya, Sri Lanka.

PROJECT: **BIOCHEMISTRY**

COMMENCEMENT: 1997

INVESTIGATORS (2002):

Dharmaratne H.R.W., *Associate Research Professor* **(Project Leader)**
Fernando W.I.T., *Research Assistant*
Perera S.M., *Laboratory Technician*
Wanigasekera W.M.A.P., *Visiting Scientist*

PROGRESS ACHIEVED *(Since inception)*:

Two acid proteinases present in the juice of pitchers of *Nepenthes distillatoria* were purified to near homogeneity using DEAE cellulose chromatography, sephacryl S-200 chromatography, pepstatin-sepharose chromatography and mono Q chromatography. Partial amino terminal amino acid sequences of both proteinases were determined and compared with reported sequences of other known plant aspartic proteinases such as rice, barley and cardoon. Antibodies to both enzymes were produced by immunizing rabbits with purified enzymes. Proteolytic action of *Nepenthes* major proteinase at different pH levels was investigated on natural proteins.

Based on the characteristics, it is suggested that both proteinases have similar properties. Purified enzymes are likely to be aspartic proteinases as reflected by the complete inhibition of proteolytic activity by 0.1mM pepstatin. Both proteinases were inhibited by diazoacetyl-DL norleucine methyl ester (DAN) and the pattern of inhibition is completely different with that of porcine pepsin suggesting that they are non-pepsin type aspartic proteinases. Molecular weights of major and minor enzymes are 43 kDa and 35 kDa as per SDS-PAGE separation. Purified enzymes have an optimum pH of 3.0 with 2% denatured haemoglobin as substrate. Optimum temperatures for activity of major and minor enzymes are 55^0C and 45^0C respectively. Both enzymes show a remarkable stability at higher temperatures (50^0C) and at a wide pH range (pH 2-10) compared to porcine pepsin. Low homology of both major and minor proteinases with the amino acid sequences of known aspartic proteinases suggest the unique structural features of *Nepenthes* proteinases.

Immunohistochemical staining suggest that both enzymes are produced by the cells located in the inner wall of the lower 1/3 part of the pitcher. Proteolytic action of *Nepenthes* major acid proteinase on dhal and other proteins at acidic as well as neutral pH levels were remarkable.

PROJECT OUTPUT 2002:

The Biochemistry project at the IFS involves efficacy and toxicological studies on herbal remedies in veterinary practice in Sri Lanka. During the past six months a number of plants which are used in herbal veterinary practice in Sri Lanka were

identified, collected, extracted, and their anthelmintic and anti-protozolal activity studies are in progress.

Our attention is mainly focused on identification of anthelmintic active plants with the idea of developing herbal preparations and/or pure natural products to cure ruminant diseases.

Further, our studies on anti-protozolal active herbal preparations and natural products are mainly focused on controlling the protozoa population of ruminants, with the hope of improving the growth, reproduction rate and milk production.

POST-GRADUATE DEGREES COMPLETED IN 2002:

1.	Rajapakse R. G. S. C.	- Purification and characterization of Acid Proteinases from *Nepenthes distillatoria.*
	M. Phil. degree	- Awarded by the University of Peradeniya, Sri Lanka.

PROJECT : **PLANT BIOTECHNOLOGY**

COMMENCEMENT: 1988

INVESTIGATORS (2002):

Kovoor A., *Honorary Research Professor*
Meemaduma V.N., *Research Assistant*
Ramanayake S.M.S.D., *Senior Research Fellow* **(Project Leader)**
Weerawardene T.E., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)* :

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

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

Initially 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 their in vitro responses with developmental stages and phenology.

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

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*.

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

Axillary shoots of *Bambusa atra* were proliferated and flowering induced. Causes of flowering are under investigation. Rooting of the axillary shoots yielded plantlets that

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

Total DNA from 130 individuals of *D. giganteus* was extracted and RAPD markers were developed with six selected primers. DNA from 25 related species was extracted for a study in identification and characterization of species. Most of these bamboo species have not been taxonomically defined.

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 field. 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 2002:

Further studies in improving of somatic embryogenesis, rhizogenesis and flowering in *D.giganteus* are ongoing.

Axillary shoots of two more species of bamboo, *D. strictus* and *B. tuldoides* (ventricosa) as well as *B. vulgaris* have been established for studies on induction of flowering and rhizogenesis.

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

The RAPD markers were used to compute the genetic distances that w ere generated and dendrogams in a *D.giganteus* population. RAPD markers were also generated from DNA extracted from 25 related species of bamboo. The data have been partially analyzed and will be used in identification and characterization of species. Most of these Sri Lankan species have not been taxonomically defined.

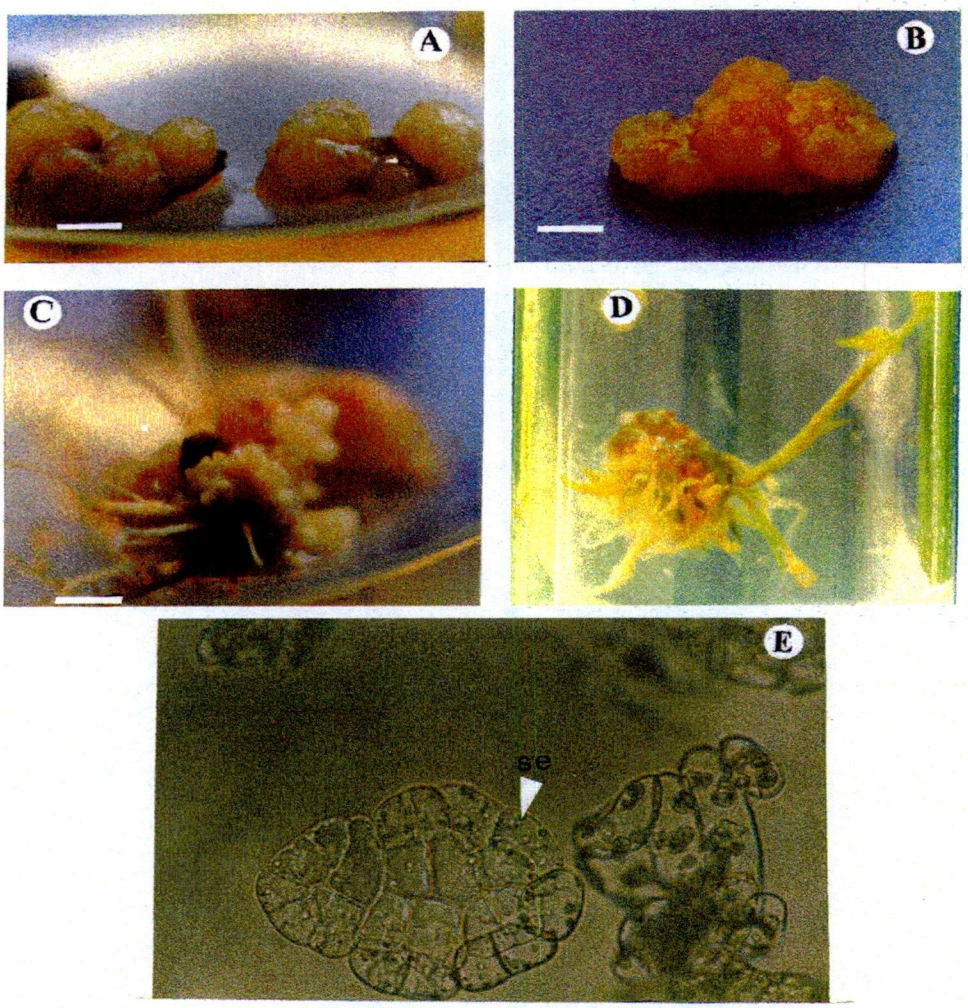


Figure. 1. Callus induction and regeneration in ***D. giganteus.***

A. *Globular callus initiated from in vitro shoots (Bar = 2mm).*
B. *A mass of mucilaginous callus (Bar = 4mm).*
C. *Nodular callus regenerating roots (Bar = 2mm).*
D. *Nodular callus regenerating a shoot and roots (Bar = 4mm).*
E. *A pro embryo-like structure (se) formed in cell suspensions (x 200).*

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* Organogenesis in callus derived from an adult giant bamboo (*Dendrocalamus giganteus* Wall. Ex Munro)
   Authors: **Ramanayake S.M.S.D.** and Wanniarachchi W.A.V.R.
   Journal: ***Scientia Horticulturae*** (in press)[1,2]

[1] ***Listed in science citation index 2002***
[2] ***Listed in science citation index-expanded 2002***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1. **Ramanayake S.M.S.D., Meemaduma V.N.,** and **Weerawardene T.E.**
   Genetic diversity of nine bamboo species characterized by Random Amplified Polymorphic DNA (RAPD) analysis,
   Proceedings of the Sri Lanka Association for the Advancement of Science. 58th Annual Session, December 2002, Sri Lanka.

2. **Meemaduma V.N.** and **Ramanayake S.M.S.D.**
   De novo shoot regeneration in excised embryos of *Mormodica dioica* in the presence of thidiazuron,
   Proceedings of the Sri Lanka Association for the Advancement of Science. 58th Annual Session, December 2002, Sri Lanka.

3. **Weerawardene T.E.** and **Ramanayake S.M.S.D.**
   Role of thidiazuron on in vitro shoot multiplication and rooting of Dendrocalamus giganteus Wall. Ex Munro (giant bamboo),
   Proceedings of the Sri Lanka Association for the Advancement of Science. 58th Annual Session, December 2002, Sri Lanka

PROJECT: **PLANT REPRODUCTIVE BIOLOGY**

COMMENCEMENT: 1997

INVESTIGATORS (2002):

Christie M.P., *Research Assistant*
Iqbal M.C.M., *Senior Research Fellow* **(Project Leader)**
Kovoor A., *Honorary Research Professor*
Wijesekera K.B., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)*:

A. **Androgenesis and pollen development**: Since establishing the experimental conditions for androgenesis in *Datura metel,* the role of a temperature shock was investigated in the induction process. In other species, temperature shock is imposed on the anthers or microspores for a few days using either a warm (30° – 35°C) or cool (4° – 20°C) temperature. We found a combination of warm and cool temperatures in quick succession, for a total duration of 1 min, significantly enhanced androgenesis.

The unusual development of parenchyma cells in the connective tissue of anthers in *Gordonia* species showed the apparent migration of these cells into the anther sacs. These cells were larger than the regular pollen with a distinct surface architecture were termed pseudopollen. Their role in reproductive biology remains speculative.

Haploid embryo development: The body organization of angiosperm seedlings was studied using haploid embryos of *D. metel.* The basic embryo pattern (shoot apical meristem, cotyledons, hypocotyl, root apical meristem) is controlled by specific genes during embryogenesis. Deletions in this basic pattern were observed in haploid embryos which were characterized histologically.

Secondary embryogenesis in rice: Indica rice (*Oryza sativa*) is generally recalcitrant to tissue culture which is a barrier to biotechnological improvement of rice in Asia. We screened Sri Lankan rice varieties for their ability to induce callus and regenerate plants. All the genotypes produced scutellar callus from mature rice embryos.

Secondary metabolism in vitro (in collaboration with Dr. C. Möllers, University of Göttingen): Glucosinolates, a secondary metabolite, is accumulated in the seeds of Brassica species duration plant maturation. Genotypes are classified into high and low glucosinolate varieties, the latter being desired. The synthesis and uptake of glucosinolates was determined in vitro using microspore derived embryos from Brassica varieties with a high and low content of glucosinolates.

PROJECT OUTPUT 2002:

Androgenesis: The microspores within the anthers of *Datura metel* were sensitive to changes in the external temperature for exposure periods as brief as 30 s. Under the experimental conditions the physiological range within which a significant enhancement of androgenesis occurred was 5° – 45°C.

Secondary embryogenesis in rice: There was a significant genotypic difference amongst the genotypes for callusing and subsequent phenolic oxidation and browning. This contributed to callus mortality. Genotypes producing early shoot buds on their calli regenerated plantlets.

Secondary metabolism in vitro: The active accumulation of glucosinolates by microspore derived embryos against a concentration gradient was shown independent of the mature glucosinolate profile of genotypes that have a high and low content of glucosinolates.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* Cells of the connective tissue differentiate and migrate into pollen sacs
   Authors: **Iqbal M.C.M.** and **Wijesekara K.B.**
   Journal: ***Naturwissenschaften,*** **89**: 39-42 (2002)[1,2]

2. *Title:* Cytological aspects of pollen embryogenesis in anther culture of *Datura metel* L.
   Authors: **Wijesekara K.B.** and **Iqbal M.C.M.**
   Journal: ***Ceylon Journal of Science (Biological Sciences),*** **30**: 89-98 (2002)

3. *Title:* Uptake and distribution of sinigrin in microspore derived embryos of *Brassica napus* L.
   Authors: **Iqbal M.C.M.** and Möllers C.
   Journal: ***Journal of Plant Physiology*** (in press)[1,2]

* ***Reported as "in press" in Annual Report 2001***
[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1.* **Iqbal M.C.M.** and Jayasinghe U.L.B.
Antifungal activity in seeds of some selected Sri Lankan plants. In: Modern fungicides and Antifungal compounds III. Ed: H.-W. Dehne et al., *13th International Reinhardsbrunn Symposium, May 14-18, 2001, Friedrichroda, Germany. Verlag Th. Mann GmbH & Co. Gelsenkirchen.*

(Book Chapter)

2. **Wijesekara K.B.** and **Iqbal M.C.M.**
Enhanced androgenesis in *Datura metel* L. by temperature gradient treatment of anthers,
Proceedings of Sri Lanka Association for the Advancement of Science, Part I (Abstracts). 58th Annual session, 2 - 7 December, Colombo 2002(p. 33)

3. **Iqbal M.C.M.**, Jayasinghe U.L.B., Herath H.M.T.B., **Wijesekara K.B.**, and Fujimoto Y.
A fungistatic constituent from *Ageratum conyzoides*.Page 34, *Proceedings of Sri Lanka Association for the Advancement of Science, Part I (Abstracts) 58th Annual session, 2 - 7 December, Colombo 2002(p. 34)*

* *Reported as "in press" in the Annual Research Report 2001*

POST-GRADUATE DEGREES COMPLETED IN 2002:

1.	Wijesekara K.B.	-Study of microsporogenesis and haploid induction in selected species of Theaceae and Solanaceae
	M.Phil. degree	-Awarded by the University of Peradeniya, Sri Lanka.

PROJECT: **PLANT CELL BIOLOGY**

COMMENCEMENT: 2001

INVESTIGATORS (2002):

Jeyanandarajah P., *Research Fellow* **(Project Leader)**
Kovoor A., *Honorary Research Professor*
Magana-Arachchi D.N., *Research Fellow*
Wimalasena T.T., *Research Assistant*

PROGRESS ACHIEVED *(Since inception)*:

Scope of the project: Isolation and identification of cyanobacteria with a view to selecting appropriate species for stimulating the regeneration of artificial higher-plant seeds; to study all aspects of mycotrophy and to find methods for the introduction of mycorrhizal fungi for the optimization of plant growth; investigations on biofilm development and the organisms involved.

PROJECT OUTPUT 2002:

Studies on cyanaobacteria, biofilms and mycotrophy were done with whatever facilities that could be availed of.

Phytoplankton
Isolations were made from water samples collected from the Kandy Lake, Sri Lankan waters of the Indian Ocean, and local paddy fields on different culture media using different techniques including tube dilution and dilution plate methods.

Fresh water: Microscopic observations revealed the presence of the following microorganisms in fresh water, tentatively identified to their genus level using illustrations from references: *Anabaena, Ankistrodesmus, Chlamydomonas, Chlorococcum, Chroococcus, Cyclotella, Eudorina, Gloeocapsa, Lyngbya, Melosira, Merismopedia, Microcystis, Pandorina, Schizothrix, Scytonema* and *Vaucheria.* Two different Bacillariophytes were also detected.

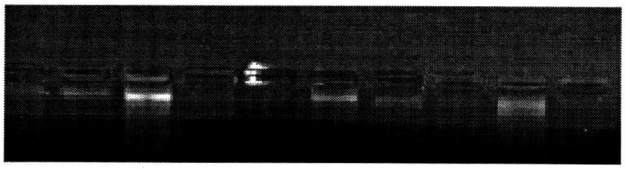


Figure 1. Genomic DNA of isolates from the Kandy Lake

Genomic DNA was extracted from selected isolates using poteinase K. Lane 3 of Figure 1 shows a particularly clear band. The isolate is a unicellular organism; its position in an appropriate phylogenetic line can now be determined after PCR amplification of 16S rRNA sequences contained in the band (Operations discontinued temporarily following the departure of one of us).

Sea water:

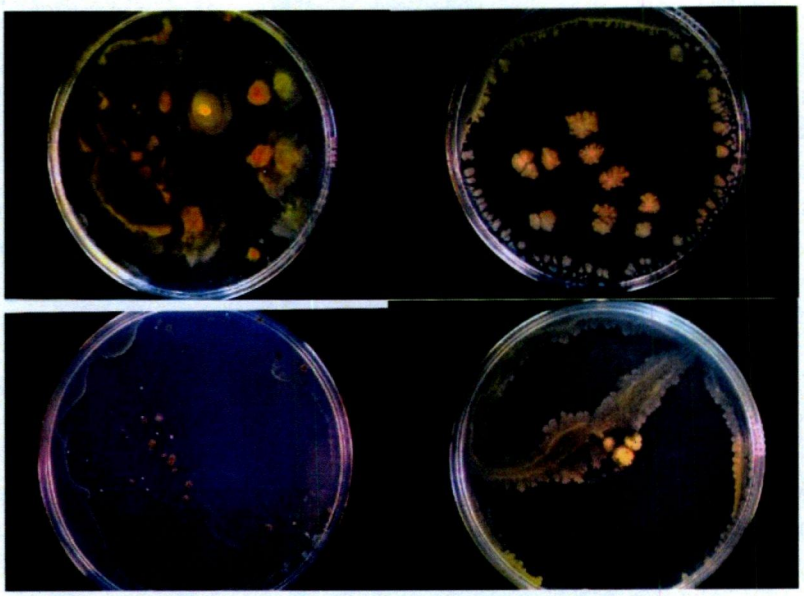


Figure 2. Colonies from sea water samples on solid media

Isolates from sea water were cultured on a range of media and a number of colonies were identified based on their culture characteristics (Figure 2). Flow cytometer measurements made by one of us at the Alfred Wegener Institute, Bremerhaven confirmed the presence of the following organisms: *Chaetocerous radicans, Chroomonas* sp. and *Emiliana* sp. (Figure 3) at 232° nautical miles from Beruwela, beyond the continental shelf (005°31.00′ N and 078°45.00′ E, collected by kind courtesy of NARA).

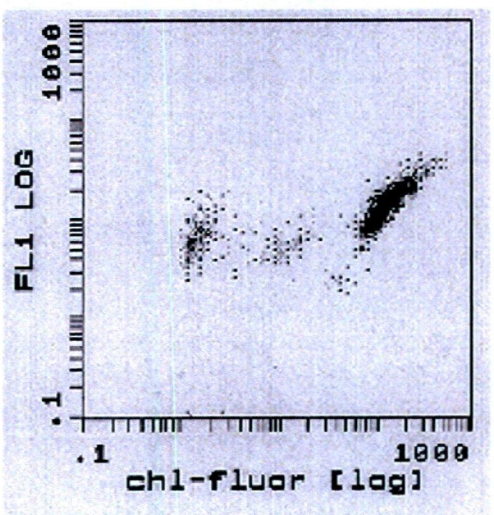


Figure 3. Flow cytometric scatter diagram of an isolate from off Beruwela

[*Each dot represents a single-cell in the flow through. The instrument records the fluorescence emission of each cell (in this case the natural fluorescence of chlorophyll or its derivatives). Their numbers are plotted logarithmically on the ordinates, representing their concentration in the sample of known dilution. Their intensities and hence size by chloroplast content, are plotted logarithmically on the abscissae. From*

such parameters the isolate was tentatively identified to consist mainly of a Chroomonas *sp. Irrefutable identity could be demonstrated by using a species specific sequence of DNA as a probe appropriately bound to a different fluorescent ligand*].

Biofilms:
Investigations were carried out with different substrates left submerged in various sites for different periods of time. Isolates were then transferred from the substrate on to different culture media to determine the adhering microorganisms in the formation of biofilms. Surface association is an efficient means of lingering in a favourable microenvironment and biofilm-associated cells are more resistant to adverse conditions (e.g. temperature, toxic chemicals, radiation). The cyanobacterial biofilm community on the surface of the substrates was composed mainly of filamentous forms - *Schizothrix* and *Lyngbya*.

Mycotrophy:
A study of the mycorrhizosphere was initiated. Microorganisms were isolated from the rhizoplane as well as the soil surrounding the roots. Dilution techniques were chosen to study the rhizoplane population diversity. Soil dilution and direct soil plating techniques were used to study population. Endomycorrhizal mycelia were detected in the cortical tissues (Figure 4) of a grass.

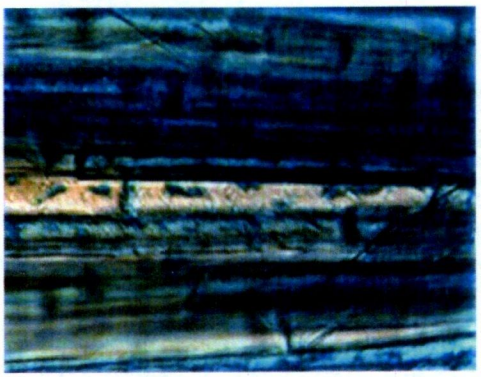


Figure 3. Mycelia in the cortical tissue of a Poaceae

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2002:

1. **Wimalasena T.T** and **Jeyanandarajah P.**
   Isolation techniques of phytoplankton species from Kandy Lake. Proceedings of the workshop on "*Single cell analysis of phytoplankton species*" held at Alfred Wegener Institute, Bremerhaven, 15-21 April 2002, 7.presented the work done on phytoplankton in Kandy Lake at the workshop on "Single cell analysis of phytoplankton species" held at Alfred Wegener Institute, Germany, 15-21 April 2002.

PROJECT: **BIOLOGICAL NITROGEN FIXATION**

COMMENCEMENT: 1986

INVESTIGATORS (2002):

Karunaratne R.C.K., *Laboratory Technician*
Morawaka Arachchi A.P., *Research Assistant*
Ratnayake R.R., *Research Assistant*
Seneviratne G., *Senior Research Fellow* **(Project Leader)**
Sepalika J.A.H, *Research Assistant*

PROGRESS ACHIEVED *(Since inception)*:

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

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

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

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

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

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

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

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

PROJECT OUTPUT 2002:

1. A study on rhizobial-fungal biofilms was initiated to examine their effects on the survival and effectiveness of rhizobia under adverse conditions. Effects of pH, phenolic acids and tannins on the biofilmed rhizobia are being tested.

2. Soil organic matter decomposition was studied under different land-use patterns of Sri Lanka. Soils were collected and analyzed for a number of soil parameters and soil respiration, CH_4 and N_2O emissions. Data have been analyzed and a manuscript was submitted for publication.

3. An experiment was commenced to examine soil carbohydrate controls on nutrient dynamics. Soil samples are being collected from different agroclimetic zones of the country. They are analysed for basic soil parameters and, macro and micronutrients. Data analysis commenced.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* Litter controls on carbon sequestration
   Author: **Seneviratne G.**
   Journal: ***Current Science,*** **82:**130-131 (2002) [1,2]

2. *Title:* Planting trees for C sequestration: a reality?
   Author: **Seneviratne G.**
   Journal: ***Current Science,*** **82:** 777 (2002) [1,2]

[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1. **Seneviratne G.**
   Variability in universal deuterium enrichment explained,
   Proceedings of the World Space Congress, Houston, Texas, USA, October (2002). (Abstract).

INVITED LECTURES/CONFERENCES ATTENDED IN 2002:

1. **Seneviratne G.**
   Chief Guest of the 2002 Science Day Celebration of the Ferguson High School, Ratnapura, and delivered the key note address on Global Warming (4th September 2002)

POST-GRADUATE DEGREES COMPLETED IN 2002:

1.	Rizvi E.M.J.M.	-Effect of some carbon substrate supplementation on associative dinitrogen fixation of rice
	M. Phil. degree	-Awarded by the University of Peradeniya, Sri Lanka.

PROJECT: PRIMATE BIOLOGY

COMMENCEMENT: 1983

INVESTIGATORS (2002):

Dittus W.P.J., *Visiting Scientist* **(Project Leader)**

PROGRESS ACHIEVED *(Since inception)*:

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

In practice, to investigate such phenomena we have identified more than three thousand macaque individuals (living plus dead), distributed among 33 different social groups at our dry evergreen forest study site, at Polonnaruwa. For each macaque, we have traced its behavioural, genealogical, ecological and demographic history. Such large samples are required to assure statistical soundness.

It was not clear by which physiological and similar mechanisms behaviour affected mortality. Therefore, the research was expanded (with the aid of collaborators from a variety of institutions) to investigate the potential role of disease (parasitism) and physiology (milk composition, hormone levels) in relation to behaviour and demography.

Furthermore, genetic studies (begun 1987) have shown how behaviour affects population genetic structure. Currently, we are continuing to monitor this population with a special emphasis to establish patrilineal genealogies, using DNA fingerprinting techniques. This allows us to define the role of paternal (father-son, etc.) behaviours on the survival and breeding success of males and females, and so on the overall genetic distributions. Recent work has focused on conservation management as well.

PROJECT OUTPUT 2002:

Routine demographic, ecological and behavioral monitoring. The entire population of over 1,100 identified macaques was censused on a monthly basis. New recruits (newborns & immigrants) were identified and some were tattooed. The hierarchical relationships within groups was tested and documented. Intergroup relations, shifts in ranging pattern, and diets were recorded.

Ecology of three sympatric primates. On a regular monthly schedule we sampled the diets, home ranges and interspecific interactions among the toque macaque, a nd the two langur species *Semnopithecus entellus* and *S. vetulus*. The aim of this study is to clarify the ecological relations that allow these three potentially competing species to co-exist in sympatry. A further aim is to document the variability in di et of these species in relation to differences in habitat.

Morphometric, genetic and epidemiological sampling. About 200 macaques were trapped and released unharmed. Extensive simiamorphometric measures were taken, as were blood samples for genetic and epidemiological testing. We examined anatomical asymmetry in relation to cumulative injuries and age, sex and social factors in macaques.

Parasitism. In collaboration with Ms. Dilrukshi Ekanayake, Madura Sanjeevani, and Prof. Neil Horadagoda of the Vet erinary Faculty, University of Peradeniya, we had identified and quantified the protozoan parasites cryptosporidia, microsporidia and cyclospora in the three specie s of primates at Polonnaruwa. Experts at the US Food and Drug Administration (Washington, D C, USA) are currently doing the molecular characterization of these parasites.

Hematology. The aim of this research is establish not only the normal range of these values for this species, but also to examine outliers in relation to know age and gender and individual histories of injury, reproductive condition, genealogy and environmental quality.

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1. Ekanayake D.K., Horadagoda N.U., Sanjeevani G.K.M., Arulkanthan A., and **Dittus W.P.J.**
   Occurrence of *Cryptosporidium* oocysts in a natural population of non-human primates in Sri Lanka,
   Proceedings of the Annual Research Sessions, University of Peradeniya, Volume 6, November 16, 2002.

2. **Dittus W.P.J.** Some basics of toque macaque society. Nature Sri Lanka (in press).

BOOKS AND MONOGRAPHS IN 2002:

1. **Dittus W.P.J.** Toque macaques of Sri Lanka. In "Mammals of South Asia: (in press). Eds. Johnsingh A.J.T. and Sukumar R. Permanent Black: New Delhi.

2. Dela J., **Dittus W.P.J.**, Gunatilake S., Kodithuwakku N., Liyanage K., Watson A., Weerasinghe N., Wijemohan S. Conservation assessment and management plans for Sri Lankan primates, (in press). 13 chapters, IUCN Primate Specialist Group, India.

INVITED LECTURES / CONFERENCES ATTENDED IN 2002:

1. Lecture: "Primate Social Evolution", Veterinary Faculty, University of Peradeniya

2. Workshop: Primate Population Biology for students of the Veterinary Faculty, University of Peradeniya

3. Workshop: Photographing Animal Behavior, Nature Camp, Institute of Sri Lankan Photographers and Department of Wildlife Conservation.

4. Focus Group: Resolving Problems of South Asian Primates as Pests. Conservation Assessment and Management Plan for South Asian Primates, Coimbatore, India.

PROJECT: **ECOLOGY AND ENVIRONMENTAL BIOLOGY**

COMMENCEMENT: 1989

INVESTIGATORS (2002):

Athukorale N., *Laboratory Technician*
Karunathilake K.M.B.C., *Research Assistant*
Sharaff F.F., *Research Assistant*
Silva E.I.L., *Associate Research Professor* **(Project Leader)**
Thumpela I., *Laboratory Technician*

PROGRESS ACHIEVED (*Since inception*):

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

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

Towards the end of 1996, a systemic limnological study was launched in the Kandy Lake with view to identifying the eutrophic process of tropical urban water bodies. This study was intensified from May 1999, with the emergence of a cyanobacteria bloom (*Microcystis aeruginosa*) in Kandy Lake. A parallel study was also started in the Hulu Ganga, the major tributary of the Mahaweli River in the central Mahaweli Valley to

determine the ecological structure and functioning of a tropical stream draining and intensively exploited watershed. A broad limnological study was commenced in August 1998 to compare the primary productivity and nutrient dynamics of three morphologically and functionally different reservoirs namely Victoria, Minneriya and Udawalawe. This was a component of the research project 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 manmade water bodies, which is currently being considered as an important aspect of land-ocean nutrient fluxes. In 2002, detail studies on material fluxes in three adjacent river basins namely Maha Oya, Deduru Oya and Mi Oya was carried out. 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.

PROJECT OUTPUT 2002:

Major emphasis was paid on analysis of data and preparation of manuscripts during the year 2002. Two manuscripts submitted to the FISHSTRAT volume in Developments in Hydrobiology which is simultaneously published in Hydrobiologia have been accepted for publication. Further, I received the co-authorship for two more papers accepted for publication in the same volume. A multi authored paper on photosynthetic primary productivity of Sri Lankan irrigation tanks submitted to Hydrobiologia has been accepted and received the reprints of the paper appeared in the Journal of Crustacean Biology. In addition, papers were presented at three international meetings held in Pondicherry (India), Vienna (Austria) and Negombo (Sri Lanka). Further, presentations on different aspects of ecology and environment (eg. water chemistry, population and environment, conservation of headwater streams etc.,) were delivered on invitations at universities, schools, government organization etc. I was also to participated in the final users meeting of the FISHSTRAT project held in Bangkok. An invited lecture was delivered at the Institute of Botany, University of Innsbruck, Austria on "Limnology of Sri Lanka with special emphasis on phycology". A collaborative research (M.Sc. students thesis) arranged with the Institute of Tropical Marine Eocology of the University of Bremen is pending approval of the Board of Governor although recommended by the Research Council. Ms R. Gamlath submitted the M.Phil thesis, entitled " Some aspects of Limnology of Hulu Ganaga a tributary of the Mahaweli River" to the University of Kelaniya.

R. Gamlath submitted the M.Phil thesis, entitled "Some aspects of Limnology of Hulu Ganga a tributary of the Mahaweli River" to the University of Kelaniya.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1.* *Title:* Photosynthetic primary productivity of eleven perennial irrigation reservoirs in Sri Lanka.
Authors: **Silva E.I.L.,** Amarasinghe U.S., De Silva S.S., Nissanka C., and Schiemer F.
Journal: ***Hydrobiologia,* 485**: 19-33 (2002) [1,2]

2.* *Title:* Some aspects of the reproductive biology of three exotic cichlid species that colonize the Victoria Reservoir in Sri Lanka
Authors: Nathaneal S. and **Silva E.I.L.**
Journal: ***Journal of Aquatic Science,* 7:** 22-31(2002)

3.* *Title:* The role of Non-cichlid exotics in the fishery of the Victoria reservoir in Sri Lanka
Authors: Nathanael S. and **Silva E.I.L.**
Journal: ***Journal of Aquatic Science***, 7:15-22 (2002)

4. *Title:* The male of Halmyrapseudes Sri lankensis (B Cescu, 1981) COMB. NOV. and an analysis of the Genus Halmyrapseudes B Cescu and Gutu, 1974 (Pericardia, Tanaidacea)
Authors: Bamber R N., Ariyananda T., and **Silva E.I.L.**
Journal: ***Journal of Crustacean Biology,* 22**(2): 287- 297 (2002) [1,2]

5. *Title:* Structure of micro-crustacean zooplankton communities in five south-east Asian water bodies
Authors: Vijverberg J., Amarasinghe P.B., Chittapalapong T., Pagulayan R.C., Ariyaratne M.G., Pamanian E.R., **Silva E.I.L.**, and Nagelkerke L.A.J.
Journal: ***Hydrobiologia*** (in press) [1,2]

6. *Title:* Phytoplankton community structure (species composition, diversity, chlorophyll, seasonal variations and key stone variables) in four reservoirs and a volcanic lake in Monsoon Asia
Authors: Rott E., **Silva E.I.L.,** Enriquez E., and Igthamjitr S.
Journal: ***Hydrobiologia*** (in press) [1,2]

* ***Reported as "in press" in Annual Report 2001***
[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

ABSTRACTS / CONFERENCE PROCEEDINGS IN 2002:

1. Hettiarachchi S., Jayatissa L.P., Singappuli M.S., and. **Silva E.I.L.**
   Species composition, distribution, and biomass of sea-grass in Rekawa lagoon in Sri Lanka (extended abstract),
   Proceedings of Sri Lanka Association for the Advancement of Science, 58th Annual session, 2 – 7 December 2002, Colombo.

2. Hettiarachchi S., Singappuli M.S., Jayatissa L.P., and **Silva E.I.L.**
   Primary production of sea-grasses in Rekawa, an estuarine lagoon in Sri Lanka (extended abstract),
   Proceedings of Sri Lanka Association for the Advancement of Science, 58th Annual session, 2 – 7 December 2002, Colombo.

3. Rott E., Peerapornpisal Y., and **Silva E.I.L.**
   Applied phycology for water quality monitoring and management of reservoirs and running water in SE-Asia (extended abstract/poster), *International Workshop on Environmental Research for Sustainable Development, a review and outlook on Austrian co-operation with (sub-) tropical and Mediterranean partners, held in Vienna, Austria. 22-23 November 2002*

4. Rott E., Peerapornpisal Y., Igthamjitr S., and **Silva E.I.L.**
   Phytolankton seasonality in reservoirs under monsoon climate in Sri Lanka and Thailand (Abstract/Poster),
   International meeting on Research in limnology, Budweise, Czcech Republic, 14-16, August 2002.

5. **Silva E.I.L.**
   Advancement of Limnology in Sri Lanka (extended abstract/oral presentation), *Austrian Intervention. International Workshop on Environmental Research for Sustainable Development, a review and outlook on Austrian co-operation with (sub-) tropical and Mediterranean partners, held in Vienna, Austria. 22-23 November 2002.*

6. **Silva E.I.L.**
   Physico-chemical characteristics of Rekewa lagoon in Sri Lanka (oral presentation),
   International Conference on Assessment of mangrove degradation and resilience in the Indian sub-continent : The cases of Godavari Estuary and southwest Sri Lanka French Institute Pondicherry, India. 21 – 22 October 2002.

7. **Silva E.I.L.**
Photosynthetic characteristics and primary production of phytoplankton and sea-grasses in Rekawa lagoon (oral presentation),
International Conference on Assessment of mangrove degradation and resilience in the Indian sub-continent : The cases of Godavari Estuary and southwest Sri Lanka French Institute, Pondicherry, India. 21 – 22 Oct. 2002.

8. **Silva E.I.L** and **Karunatilake K.M. B.C.**
Silica fluxes in three river systems in Sri Lanka (Abstract) APN/SASCOM/LOICZ ,
International meeting on material fluxes to costal waters, Negombo, Sri Lanka.

9. **Silva E.I.L., Karunatilake K.M. B.C.**, and **Sharaff F.F.**
Silica retention and fluxes in Maha Oya, Deduru Oya and Mi Oya three river systems in Sri Lanka,
LOICZ Reports and Studies (in press).

INVITED LECTURES / CONFERENCES ATTENDED IN 2002:

1. Conducted a lecture series on Limnology for undergraduate students at Sagara Vishvavidyalaya, Colombo (January – March 2002) at National Institute for Fisheries and Nautical Engineering and also prepared a course module for Limnology.

2. Participated in the FISHTRAT-User Work of the European Union funded Regional Project held in Bangkok, Thailand, February 19-25, 2002.

3. Conducted a lecture series and practical sessions on Water Quality Management for the Post Graduate Diploma in Environmental management conducted by the University of Kelaniya (February – April, 2002).

4. Delivered a lecture on Central Province Environmental Problems at Kandy YMBA on 13th March 2002 as an invited speaker.

5. Delivered a lecture on Kandy Lake at Two-day Training Course on Water Quality Management, organized by the Water Resources Secretariat/SMEC International and University of Moratuwa. 30th May, 2002.

6. Chaired the Technical Session on Aquatic Environment, Eight Annual Sessions of Sri Lanka association for Aquatic Resources (SLAFAR). 4th July 2002.

7. Delivered a public lecture on Environmental Problems of Kandy District, at D.S. Senanayake Library, Kandy, 18th July 2002.

8. Delivered a lecture on Population and Environment at Divisional Secretariat Kandy, 29th July 2002.

9. Delivered a lecture on water quality of Deduru Oya Basin at the Consultation Workshop on Water Quality Issues and Priority Actions, sponsored by Water Secretariat and held at Kandian Reach Hotel, Kurunegala. 28th August 2002

10. Invited lecture on Silica Retention in man-made lakes in Sri Lanka at the Seminar /Workshop on Material Fluxes to the Coastal Zone : Synthesis of Sri Lankan Studies and Plan for the Future held at SLASS Auditorium, Organized by APN/START/LOICZ project on Material Fluxes to the Ocean. 13th September 2002.

11. Chief Guest of the 2002 Science Day Celebration of the Rahula College, Katugastota, and delivered the key note address on Global Changes and Local Trends. 26th September 2002.

12. Invited lecture on What Factors Affect the water quality and how they be detected ?, at the meeting on Discussion Monitoring Actives to Maintain Kandy Lake at safe level. Organized by the Irrigation Department, 12th October 2002.

13. Invited Speaker, International Conference on Assessment of Mangrove Degradation and Resilience in the Indian Subcontinent : The cases of Godavari Estuary and Southwest Sri Lanka. (Final Workshop, INCO-DC : IC18-CT98-0295 Project), Pondicherry, India, 22 -25 October 2002.

14. Delivered an invited lecture on Limnology in Sri Lanka with a special reference to phycology at the Institüte Botanik, University of Innsbrüch, Austria, 25 November, 2002.

15. Participated in the A*nnual Sessions of Oceanography Division* of National Aquatic Resources Research and Development Agency held on 23, December, 2002.

PROJECT: **CHEMICAL MODELING OF AQUATIC SYSTEMS**

COMMENCEMENT: 1992

INVESTIGATORS (2002):

Aluthpatabendi D., *Laboratory Technician*
Kasturiarchchi H., *Volunteer Research Assistant*.
Makehelwala M., *Volunteer Research Student*
Nanayakkara A., *Senior Research Fellow*
Wijesekara H.K.D.K., *Research Assistant*
Weerasooriya R., *Associate Research Professor* **(Project Leader)**

Collaborating laboratories:

X-ray spectroscopy and Molecular modeling
Tobschall H.J. and Hoch M. (School of Applied Geology) University of Erlangen, ***Germany (1995 to to-date)***

Vibration spectroscopy
Bandara A. (Dept of Chemistry) University of Peradeniya, ***Sri Lanka (1999 – to date)***

Anode stripping voltametry
Pathiratne, K.A.S. (Dept of Chemistry) University of Kelaniya, ***Sri Lanka (1998- to date)***

PROGRESS ACHIEVED *(Since inception)*:

1. Detection of reactivity sites of kaolinite for of tributyl tin (TBT) from molecular modeling methods.
2. Calibration of TBT – kaolinite interactions using mechanistic and molecular modeling methods
3. Retention of lead, cadmium and arsenic on gibbsite was quantified mechanistically.
4. Experimental evidence for site heterogeneity was obtained for gibbsite using a chemical method.
5. 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 chromium binding on goethite.
6. Chemical characterization of the kaolinite-water interfacial processes was completed. The proton, halide ion binding on kaolinite based on surface complexation was completed.
7. Chemical kinetic modeling for the complexation of copper-organic polymer systems was developed. Kinetic modeling of Fe-F system under acidic conditions was completed.

8. A direct method for the quantification of copper –fulvate complexation was developed.
9. SEM of Cd(II) adsorbtion on model minerals at different experimental conditions was completed.
10. Determination of near-surface solid composition of the goethite-copper system to elucidate Cu-inter-particle diffusion from surface precipitation on external surfaces was completed. X-ray photon spectroscopy was used to achieve these results.
11. Essential unit processes of drinking water treatment for fluoride, nitrate, and selected organic-Cl were completed. These processes have also been modeled with ENVIRONPRO software (Project objectives were revised to meet with the current IFS reorientation towards themes of basic science).
12. A precise mechanistic model was developed to understand the formation of N-nitrosation (project objectives were revised to meet the current IFS reorientation towards basic science)

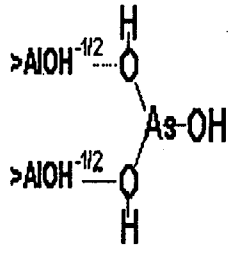
PROJECT OUTPUT 2002:

1. *TBT and proton retention* on pure kaolinite and natural kaolinite-rich sediments were examined at differing experimental conditions. The generalized diffused layer model quantified both proton and TBT adsorption on solids. Following intrinsic acidity and TBT binding constants were used;

$>ALOH = >AlO^- + H^+$ $\quad log\ K = -5.39,$
$>AlOH + H^+ = >AlOH_2^+$ $\quad log\ K\ 4.60$
$>AlO^- + TBT = >AlOTBT$ $\quad log\ K\ 3.46$

The reduction of surface coverage values in TBT adsorption modeling is in agreement with the results of ab initio molecular model calculations of the system which showed preferential orientation of TBT molecules along the edges of kaolinite crystal. For the first time, the data generated from the modeled pure phased kaolinite system was used to calculate TBT adsorption onto natural sediments.

2. <u>*Arsenite adsorption on gibbsite*</u> was examined as a function of pH, ionic strength (I) and contact time (t_C). As(III) showed a weak affinity for gibbsite surface. The trends of pH = f (Γ_{ads}) curves have showed a marked deviation from a typical anion adsorption edge showing a maximum Γ_{ads} around pH ~8.2. The experimentally derived proton exchange ratio has always converged to zero when $0.26 < \Sigma[As(III)] < 7\mu M$ and $6.2 < pH < 8.2$. The isosteric heat of adsorption, ΔH_r, exhibited invariant behavior with respect to Γ_{ads}. The As(III) adsorption data was quantified by charge distribution multi site complexation (CD MUSIC) model using the surface complex postulated below:



PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1*. *Title:* Surface complexation modeling of cadmium adsorption on gibbsite
Authors: **Weerasooriya R., Wijesekara D.**, and Bandara A.
Journal: ***Colloids and Surfaces A:Physicochemical and Engineering Aspects*** , **207**:13-24 (2002)[1,2]

2*. *Title:* Charge distribution multi-site complexation modeling of Pb(II) adsorption on gibbsite
Authors: **Weerasooriya R., Aluthpatabendi D.**, and Tobschall, H.J
Journal: ***Colloids and Surfaces A:Physicochemical and Engineering Aspects,*** **189**:131-144 (2001) [1,2]

3. *Title:* On the mechanistic modelling of As (III) adsorption on gibbsite
Authors: **Weerasooriya R.**, Tobshcall H.J., **Wijesekara D.**, and Pathiratne K.A.S.
Journal: ***Chemosphere*** (In Press) [1,2]

* ***Reported as "in press" in Annual Report 2001***
[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

1. **Wijesekara D.**, Bandara. A., and **Weerasooriya R.**
Mechanistic, Spectroscopic and Molecular Model Probing of the Arsenic-Gibbsite Interface *(poster presentation),*
Summer School of Ab initio Solid State Chemistry, University of Torino, Italy

2. **Weerasooriya R.**, Tobshcall H.J., **Wijeskara D.**, Bandara A.
Mechanistic modelling of arsenic – gibbsite interactions*(poster presentation),*
Annual Sessions of the School of Applied Geology, University of Erlangen-Nurenberg Germany

INVITED LECTURES/CONFERENCES ATTENDED IN 2002:

1. **Weerasooriya R.**
   Mechanistic modelling methods of solid-solution interface,
   Department of Mineralogy and Geology, Universitat Erlangen Germany, Annual Colloquia

PROJECT: STRUCTURAL GEOLOGY

COMMENCEMENT: 1995

INVESTIGATORS (2002):

Kehelpannala K.V.W., *Senior Research Fellow* **(Project Leader)**
Kleinschrodt R., *Visiting Associate Professor*
Kröner A., *Visiting Senior Professor*
Ratnayake R.M.J.W.K., *Research Assistant*
Yoshida M., *Visiting Senior Professor*

PROGRESS ACHIEVED *(Since inception)*:

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. The 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 the 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. The major and trace element geochemistry of metasomatic rocks from Ambagaspitiya was studied at the University of Cologne, Germany in order to understand the role of shear zones in the lower crust on fluid-controlled metasomatism of high-grade gneisses. (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 which 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 a 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 tremor 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.)

The 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.

The enrichment and depletion of major and trace elements in the wall rock granulites of graphite veins from the Kahatagaha-Kolongaha graphite deposit were studied at the University of Cologne, Germany in order to understand the fluid-rock interaction during vein graphite mineralization. The mineral chemistry of sulphides associated with the vein graphite mineralization at the Kahatagaha-Kolongaha graphite deposit was studied at the University of Mainz, Germany with a view to establish the role of sulphur fugacity in the precipitation of carbon as graphite. (This work will be continued).

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 a multi-stage development of leucosomes with varying modal compositions and that they have a polygenetic origin. Our study clearly demonstrates that migmatites may be classified or differentiated on the basis of their genetic relationships. The influence of deformation on the development of different

types of leucosomes of migmatites in layered basic rocks was studied, and the chemical analysis of some layers 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. Geochemical analysis confirmed that different leucosomes in some migmatites studied from central Sri Lanka have different chemical compositions. (This work is being continued).

The study of magmatic and deformational events in Sri Lanka related to the formation and breakup of the suppercontinent Rodinia (which existed about 750-800 Ma ago) and to the assembly of the supercontinent Gondwana revealed that there were two major magmatic events in the Wanni Complex; the older event occurred at about 1000-1100 Ma ago and the younger one at about 790-750 Ma ago. The older magmatic event was related to the final assembly of Rodinia supercontinent, and the second event occurred during the breakup of this supercontinent. (This work is being carried out in collaboration with Prof. A. Kröner, University of Mainz, Germany).

A study of the origin of scapolite-bearing pyroxenites was initiated, and the preliminary findings show that pyroxenites with euhedral megacrysts of scapolite and sphene in the lower crustal rocks of Sri Lanka have a magmatic origin. (This work will be continued).

A study of the 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 multi-stage precipitation from CO_2-bearing fluids in the orthogneiss at Digana was studied on the basis of stable carbon isotopes of graphite from diverse occurrences in the above rock. This study confirmed that graphite in the Digana orthogneiss has been precipitated from externally derived CO_2-rich fluids, which have migrated along the Digana shear zone. (This work is being carried out in collaboration with Prof. H. Wada, University of Shizuoka, Japan).

PROJECT OUTPUT 2002:

During the year 2002, the work started in the previous year was continued.

1. The study of migmatites was continued, and the polygenetic origin of leucosomes in migmatites in the Kandy basic layered complex was confirmed by age determination.

2. The preliminary study of geology and structure in some areas in the eastern, southeastern and southern parts of Sri Lanka started, and the work so far carried out provided new data on the nature of the boundaries of the three crustal units in Sri Lanka. (This work will be continued).

3. The mechanism of multistage graphite precipitation form deep crustal CO_2-rich fluids migrated along a crustal-scale shear zone (the Digana shear zone) in Sri Lanka was elucidated, and the stable carbon isotope composition of graphite precipitated in different forms from the above fluids along the shear zone was determined.

4. Based on new U/Pb zircon data, the occurrence of two major magmatic events, one at about 1000 Ma and the other at 790-750 Ma, and a possible deformation event that occurred between 969 Ma and 924 Ma in the Wanni Complex of Sri Lanka were established.

PUBLICATIONS IN REFEREED JOURNALS IN 2002:

1. *Title:* Multistage graphite precipitation through protracted fluid flow in sheared metagranitoid, Digana, Sri Lanka: evidence from stable isotopes
   Authors: Binu-Lal S.S., **Kehelpannala K.V.W.,** Satish-Kumar M., and Wada H.
   Journal: ***Chemical Geology*** (in press) [1,2]

2. *Title:* Ca. 750-1100 Ma magmatic events and Grenville-age deformation in Sri Lanka: relevance for Rodinia supercontinent formation and dispersal, and Gondwana amalgamation.
   Authors: Kröner A., **Kehelpannala K.V.W.,**and Hegner H.
   Journal: ***Journal of Asian Earth Sciences*** (in press)[2]

[1] ***Listed in the science citation index in 2002***
[2] ***Listed in the science citation index-expanded in 2002***

BOOKS AND MONOGRAPHS IN 2002:

1. *Title:* Geological structure of the middle to lower crust in Sri Lanka. (invited paper) (Accepted)
   Author: **Kehelpannala K.V.W.**
   In the Book: *Geology and Mineral Resources of Sri Lanka*
   Editors: Cooray P.G., Prame W.B., and Herath M.M.J.W.
   Publisher: Geological Survey and Mines Bureau, Sri Lanka.

2. *Title:* Lithotectonic units of the Proterozoic high-grade terrain of Sri Lanka (invited paper) (Accepted)
   Author: **Kehelpannala K.V.W.**
   In the Book: *Geology and Mineral Resources of Sri Lanka*
   Editors: Cooray P.G., Prame W.B. and Herath M.M.J.W.
   Publisher: Geological Survey and Mines Bureau, Sri Lanka.

3. *Title:* Deformation induced fluid pathways in the lower crust
   Author: Kleinschrodt R. and **Kehelpannala K.V.W.**
   Journal: ***Erlanger Geologische Abhandlungen,*** Special Volume 9, TSK IX, 51-52 (Extended Abstract).

4. *Title:* Role of Pan-African events in the Circum-East Antarctic Orogen of East Gondwana: a critical review

Author: Yoshida M., Jacob J., Santosh M. and Rajesh H.M.

In the Book: *Proterozoic East Gondwana: Supercontinent Asembly and Breakup.* ***Geological Society, London, Special Publication, 206 (In press)***

Editors: Yoshida M. and Windley B.

SCIENCE DISSEMINATION

Tilakaratne C.T.K. and Sellam S.

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

(A) Research meetings, research colloquia, special lectures, and public lectures

Research meetings: Research meetings were conducted by the research assistants of the IFS. These meetings provide a platform to present their research findings and discuss their research problems with the experts in the field. It also enable generation of new ideas that helps to solve these research problems.

Research colloquia: Scientists with expertise in their fields of research were invited to talk to their colleagues at research Colloquia.

Special lectures: These were intended to provide a quick forum for eminent scientists visiting the institute or other institutions in country.

Public lectures: These promote the public understanding of science.

(B) Awareness and educational programmes for students

School Science Programme:
The IFS conducts an annual School Science Programme to bring together bright young minds from diverse regions in the country to expose them to a novel intellectual experience designed to promote thinking, imagination, curiosity, wonder and excitement at new ideas discovered. Since the inception of this programme in 1987, a total of 1684 students who have excelled at the GCE (Ordinary Level) examination have participated in this activity. 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 to 180 students, the selection procedure ensured that students from underprivileged schools were well represented.

Special lectures were given by the IFS Scientists at Ranabima Royal College, Gannoruwa, Ferguson High School, Ratnapura, Rahula College, Katugastota, and Holy Family Convent, Wennappuwa.

Lab visits : Lab visits were organised for undergraduate students and for School children. Special lecture on IFS and its activities were prepared in advance to enable these students to understand the IFS activities better.

(C) Publication and reports

Annual research report for the year 2001 was compiled.

Reprints of research papers published in scientific journals in 2000 by IFS scientists were compiled in a book form.

In addition, a booklet describing the ongoing research projects at the IFS, was compiled in English, Sinhala and Tamil and distributed among the students. Leaflets and posters describing the analytical instruments in the institute were prepared, in order to give a better understanding about the working of these instruments and their applications.

Pragñā- IFS Science Bulletin: Two volumes of the Bulletin were published this year. These were distributed to schools (With A/L classes), research institutes, universities and scientists.

(D) Documentary about IFS: The very first documentary about IFS was prepared by the Science Dissemination Unit. Dr. A. Nanayakkara, Ms. S. Ramanayake, Dr. M.C.M. Iqbal, Mr. P.V.V. Jayaweera, Mr. V.P.S. Perera, Mr. Jayasekara Banda, Mr. Y. Ramanayake, Ms. K.M.P. Bandaranayake, and many others gave their fullest cooperation to make the documentary a success.

(E) Exhibition: We had a stall at "DEST Exhibition" at the Science Faculty, University of Colombo. Our participation was mainly to give a broad picture about the IFS and its activities to the general public.

IFS EVENTS 2002

RESEARCH MEETINGS, RESEARCH COLLOQUIA AND PUBLIC LECTURES

RESEARCH MEETINGS

06.02.2002 **ENHANCED ANDROGENESIS IN *Datura Metel* BY A TEMPERATURE GRADIENT HEAT SHOCK**
Mr. Wijesekara K.B., Research Assistant, IFS

06.03.2002 **CONSTRUCTION AND DESIGNING OF COMPUTER CONTROLLED 8 CHANNEL MULTIPLEXER FOR LABORATORY INSTRUMENTS**
Mr. Jayaweera P.V.V., Research Assistant, IFS

26.03.2002 **COMBINATORIAL CHEMISTRY FOR 2-DIMENSIONAL DEVICE SIMULATION: APPLICATION FOR FABRICATION AND TREATMENT OF a-Si:H BASED TFTs**
Mr. Perera V.P.S., Research Assistant, IFS

15.05.2002 **DEVELOPMENT OF DFT BASED MOLECULAR STRUCTURE PROGRAM**
Ms. Ranatunga N., Research Assistant, IFS

25.09.2002 **INVESTIGATION ON THE BACTERIAL CONSORTIA IN KANDY LAKE AN INDICATION OF POLLUTION**
Ms. Sharaff F.F., Research Assistant, IFS

09.10.2002 **CHAOS IN NEURAL NETWORKS**
Mr. Selvarajan S., Computational Physics Project, IFS and Department of Physical Science, Vavuniya Campus of the University of Jaffna

13.11.2002 **RHIZOBIAL-FUNGAL BIOFILMS; NITROGEN FIXING SYSTEMS?**
Ms. Jayasinghearachchi H.S., Research Assistant, IFS

RESEARCH COLLOQUIA

12.06.2002 **MAKING OPTIMAL DEDUCTIONS FROM INCOMPLETE INFORMATION: MAXIMUM ENTROPY METHOD AND ITS APPLICATION**
Prof. Saldin D.K., Department of Physics, University of Wisconsin, USA

24.07.2002 **SEMICONDUCTOR NANOSTRUCTURES AND DYE SENSITIZATION.**
Prof. Tennakone K., IFS

02.10.2002 **BLACK HOLES IN BRANE WORLDS**
Prof. Wijewardane L.C.R., Professor of Physics, University of Cincinnati, USA and Visiting Research Professor, IFS

PUBLIC LECTURES

05.06.2002 **LOGIC, SCIENCE AND REALITY**
Dr. Nanayakkara A., Senior Research Fellow, IFS

23.09.2002 **DARK MATTER AND DARK ENERGY**
Prof. Wijewardane L.C.R., Professor of Physics, University of Cincinnati, USA and Visiting Research Professor, IFS

16.10.2002 **RESEARCH IN SRI LANKA**
Prof. Samarajeewa U., Senior Professor, Department of Food Science & Technology, University of Peradeniya

SPECIAL LECTURES

12.02.2002 **MULTILAYER ASSEMBLY OF ZEOLITE CRYSTALS ON GLASS WITH MOLECULAR LINKERS**
Prof. Kyung Byung Yoon, Department of Chemistry, Sogang University, Korea and Director, Center for Microcrystal Assembly (Creative Research Initiative Program of the Ministry of Science and Technology)

10.04.2002 **DEEP SEISMICS IN EAST GONDWANALAND: THE "LEGENDS" INITIATIVE**
Prof. Brown L., Professor of Geophysics, Department of Geology, Cornell University, USA

14.06.2002 **NOVEL IR DEVICES**
Dr. Perera U., Georgia State University, USA

18.06.2002 **HOW TO FIND WHEN BONES MAY BREAK**
Prof. G.H. Gunaratne, Department of Physics, University of Houston, USA and Visiting Research Professor, IFS

VISIT TO IFS

18.02.2002 Students from Ananada Balika Maha Vidyalaya, Colombo.
05.03.2002 Undergraduate students from Rajarata University of Sri Lanka, Anuradhapura.
10.06.2002 Students from University of Colombo.
26.07.2002 Students from Ferguson Balika Maha Vidyalaya, Ratnapura.
31.07.2002 Students from Meegahakivula M.M. Vidyalaya.
01.08.2002 Students from B/Keppetipola Maha Vidyalaya, Keppetipola.
02.10.2002 Students from Faculty of Agriculture, Rajarata University, Puliyankulama.

EXHIBITION

20.06.2002 DEST Exhibition at Science Faculty, University of Colombo.
To
23.06.2002

SPECIAL PROGRAMME FOR STUDENTS

06.03.2002 **Lecture** conducted by Dr. Nanayakkara A., Senior Research Fellow, IFS on **Vishmitha Lokaya** at Ranabima Royal College, Kandy.

04.09.2002 **Keynote address** by Dr. Seneviratne G., Senior Research Fellow, IFS on **Global Warming** at Ferguson High School, Ratnapura.

26.09.2002 **Keynote address** by Prof. Silva E.I.L., Associate Research Professor, IFS on **Global Changes and Local Trends** at Rahula College, Katugastota.

10.10.2002 **Keynote address** by Dr. A. Nanayakkara, Senior Research Fellow, IFS on **Mysteries in Modern Physics** at Wennappuwa Holy Family Convent.

11.11.2002 **Keynote address** by Dr. A. Nanayakkara, Senior Research Fellow, IFS on **Astronomy** at Vidyartha College, Kandy.

12th –14th December ***School Science Programme***

12th December

SOME SIMPLE EXPERIMENTS IN PHYSICS AND CHEMISTRY
Prof. Tennakone K., IFS

CONTROLLING APPARATUS BY COMPUTERS
(Lecture & Demonstration)
Mr. Jayaweera P.V.V., IFS

About IFS and its activities

13th December

WONDERS IN PHYSICS
Dr. Nanayakkara A., IFS

SINHALA WORD PROCESSING PACKAGE FOR VISUALLY CHALLENGED PEOPLE ***(Demonstration)***
Dr. Nanayakkara A., IFS.

VETERINARY MEDICINE AND VETERINARIANS
Dr. Fernando W.I.T., IFS

HERBAL MEDICINE
Prof. Dharmaratne H.R.W., IFS

MARINE BIODIVERSITY
Prof. L. Kannan, Professor of Marine Biology, Annamali University, Tamil Nadu

Saturday 14th December

PLANT TISSUE CULTURE
Ms. Ramanayake S.

GLOBAL CHANGES AND LOCAL TRENDS
Prof. Silva E.I.L.

RESEARCH STAFF 2002

Kovoor A.	Honorary Research Professor
Kroner A.	Honorary Research Professor
Tennakone K.	Research Professor
Yoshida M.	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
Perera U.	Visiting Research Professor
Rajasekeran K.N.	Visiting Research Professor
Wijewardena L.C.R.	Visiting Research Professor
Dharmaratne H.R.W.	Associate Research Professor
Keinschrodt R.	Visiting Associate Research Professor
Silva E.I.L	Associate Research Professor
Weerasooriya S.V.R.	Associate Research Professor
Dittus W.P.J.	Honorary Senior Research Fellow
Jayasinghe J.H.M.U.L.B.	Senior Research Fellow
Kehelpannala K.V.W.	Senior Research Fellow
Nanayakkara A	Senior Research Fellow
Ramanayake S.M.S.D.	Senior Research Fellow
Senevirathne P.R.G.	Senior Research Fellow
Bandara J.	Research Fellow
Iqbal M.C.M.	Research Fellow
Jeyanandarajah P.	Research Fellow
Magana Arachchi D.N.	Research Fellow
Senadeera G.K.R.	Research Fellow
Wanigasekera W.M.A.P.	Visiting Scientist

Research Assistants

Jayaweera P.V.V.	Research Assistant (Grade I)
Perera V.P.S.	Research Assistant (Grade I)
Ratnayake R.R.	Research Assistant (Grade I)
Sepalika J.A.H.	Research Assistant (Grade I)
Balasooriya B.A.I.S.	Research Assistant (Grade II)
Bandaranayaka K.M.P.	Research Assistant (Grade II)
Christie M.P	Research Assistant (Grade II)
Fernando W.I.T	Research Assistant (Grade II)
Jayasooriya C.P.	Research Assistant (Grade II)
Karunathilake K.M.B.C.	Research Assistant (Grade II)
Kumarihmay B.M.M.	Research Assistant (Grade II)
Meemaduma V.N.	Research Assistant (Grade II)
Morawaka Arachchi A.P.	Research Assistant (Grade II)
Napagoda M.T.	Research Assistant (Grade II)
Pitigale P.K.D.D.P.	Research Assistant (Grade II)
Piyasena K.G.N.P.	Research Assistant (Grade II)
Ranatunga R.M.N.N.	Research Assistant (Grade II)
Ratnayake R.M.J.W.K.	Research Assistant (Grade II)
Sharaff F.F.	Research Assistant (Grade II)
Weerawardena T.E.	Research Assistant (Grade II)
Wijeratne D.N.R.	Research Assistant (Grade II)
Wijesekara H.K.D.K	Research Assistant (Grade II)
Wijesekera K.B.	Research Assistant (Grade II)
Wimalasena T.T.	Research Assistant (Grade II)

Project Leaders are responsible for the authenticity of information they have provided to compile this document.