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OF
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2002

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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).


* 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)

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<td>Bulletin of the Chemical Society of Japan</td>
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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.

2.* Title: A model of Bone and applications to Osteoporosis
Authors: Gunaratne G.H., Mohanty K.K., and Wimalawansa S.J.

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.

4. Title: Strength reduction in Electrical and Elastic networks
Authors: Espinoza-Ortiz J., Rajapaksa C.S., and Gunaratne G.H.
5. **Title:** Using Nonlinear Response to Estimate the Strength of Elastic Networks  
**Author:** Gunaratne G.H.  
**Journal:** *Physical Review E, 67: 061904 (2002)*

* 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 $\eta$-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 provided by Lyapunov exponents. If the Lyapunov exponent is positive, corresponding motion is identified as classically chaotic. Otherwise, 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 $\eta$-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 these 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.  

2. **Title:** Semiclassical quantization of complex Henon-Heiles systems  
   **Authors:** Nanayakkara A. and Abayaratne C.  

3. **Title:** A new quantization method for evaluation of eigen energies  
   **Authors:** Nanayakkara A. and Ranatunga N.  
4. **Title:** Asymptotic behavior of the eigen energies of anharmonic oscillators \( V(x) = x^{2n} + bx^3 \)  
**Authors:** Nanayakkara A. and Bandara V.  
**Journal:** *Canadian Journal of Physics, 80*(9): 959-968 (2002) \(^1\)

5. **Title:** Analytic Semiclassical Energy Expansions of general Polynomial Potentials  
**Authors:** Nanayakkara A. and Dasanayake I.  

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

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 06\(^{th}\) 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 10\(^{th}\) October, 2002.

3. Chief Guest of Astro Day 2002 at Vidyartha College, Kandy and delivered the keynote address on Astronomy on 11\(^{th}\) 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:

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)

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)

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.  

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.  

5. **Title:** Cobalt (II)-bis-(1,10-phenanthroline)-triphenylmethane dye complexes and their photo-sensitization properties in nanoporous photovoltaic devices  
   **Authors:** Jayaweera P.M., Palayangoda S.S., Tennakone K., and Gamage R.G.C.R.  

6. **Title:** Effect of Imidazolium Salts on the Performance of Solid-state Dye-sensitized Photovoltaic 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)

7. **Title:** Nanocrystalline TiO₂ films for dye-sensitized solid-state solar cells  
   **Authors:** Kumara G.R.R.A., Kaneko S., Okuya M., and Tennakone K.  

8. **Title:** Dye-sensitized semiconductor nanostructures for solar energy conversion  
   **Author:** Tennakone K.  
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) 

11. **Title:** The Effect of MgO on the Enhancement of the Efficiency in Solid-State Dye-Sensitized Photocells Fabricated with SnO2 and Cul.  
   **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) 

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

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) 

† 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:**


**ABSTRACTS / CONFERENCE PROCEEDINGS IN 2002:**

   Important properties of the Cul film Dye-Sensitized Solid-State Solar Cells,  
   14th International Conference on Photochemical Conversion and Storage of Solar Energy, Sapporo, Japan, August 4-9, 2002

   Solid-state dye-sensitized photocells fabricated with nanocrystalline SnO2 covered with a thin layer of MgO,  
   Centennial Meeting, Electrochemical Society, Philadelphia, USA, 11-17 May, 2002
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**

Improved Performance of Dye-Sensitized Solar Cells by Hybridization of Nano-Sized Metal Oxides,
**Centennial Meeting Electrochemical Society, Philadelphia, USA, 11-17 May 2002**

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**

The effect of aluminium on photocurrent increment in dye-sensitized photoelectrochemical cells based on nanocrystalline SnO$_2$ films,

p-4CuBr.3S(C$_2$H$_5$)$_2$ Promising material as the hole collector in solids-state dye-sensitized photovoltaic cells with TiO$_2$, 

**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:

   Ph.D degree - 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.


   **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 properties 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 silane 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.  

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., Kilamura T., Wada Y., and Yanagida S.  
**Journal:** *Bulletin of the chemical society of Japan (in press)*

* Reported as ‘in press’ in Annual Report 2001  
† This also appears in the Publication List in Condensed Matter Physics  
† Listed in the science citation index in 2002  
† 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 phoekuklectrochemical cells based on nanocrystalline SnO$_2$ films,  

$p$-$4CuBr$_2$.3Si(C$_2$H$_5$)$_2$: promising material as the hole collector in solid state dye sensitized photovoltaic cells with TiO$_2$.  

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 its use as sensitizer in photocells,

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

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 o xo, 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(l) complexes (e.g., [HB(3,5-(CF3)2Pz)3]AgC2H4) are excellent catalyst for various carbene transfer reactions. We have also reported the synthesis of silver(l) and copper(l) pyrazolates [(3,5-(CF3)2Pz)Cu] and [(3,5-(CF3)2Pz)Ag], using 3,5-(CF3)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 Chemistry-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(l) and silver(l) 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.


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


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.

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.

3. Title: (-)-3β, 4β-Epoxyvalerenic acid from Valeriana officinalis
Authors: Dharmaratne H.R.W., Nanayakkara N.P.D., and Khan I.A.

4. Title: Antibacterial Activity of Calozejyloxanthone 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.
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 extinia* 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 hederaeginin 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, ecystestrioloids, 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, diketoucaric acid and diacetoucaric 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 ecystestroid:

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) 3-0-β-D-glucopyranosylecdosterone,
(2) 3-0-β-D-glucopyranosyl-(1→2)-β-D-glucopyranosylserajanic acid 28-0-β-D-glucopyranosyl ester, and
(3) 3-0-β-D-xylopyranosyl-(1→2)-β-D-glucopyranosyl-(1→2)-β-D-glucopyranosylserajanic acid 28-0-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 Diplolisia glaucescens
   **Authors:** Jayasinghe U.L.B., Jayasooriya C.P., Oyama K., and Fujimoto Y.

2. **Title:** Oleanane glycosides from the leaves of Diplolisia glaucescens
   **Authors:** Jayasinghe U.L.B., Jayasooriya C.P., and Fujimoto Y.
   **Journal:** Fitoterapia, 73: 424-427 (2002)

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

4. **Title:** Bidesmosidic saponins from the fruits of Diplolisia glaucescens
   **Authors:** Jayasinghe U.L.B., Hara N., and Fujimoto Y.
   **Journal:** Phytochemistry (in press)

5. **Title:** Antifungal constituents of Bridelia retusa
   **Journal:** Phytochemistry (in press)

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)
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)*

* Reported as “in press” in the Annual Research Report 2001  
* Listed in the science citation index 2002.  
* 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).

   Antifungal constituents of *Bridelia retusa,*  
   *Proceedings of the Sri Lanka Association for the Advancement of Science,* December (p. 247).

   Ecdysones from the fruits of *Diplocisia 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 *Diplocisia glaucescens,*  
   *Proceedings of the Sri Lanka Association for the Advancement of Science,* December (p. 248).

   A fungistatic chromene from *Ageratum conyzoides,*  
   *Proceedings of the Sri Lanka Association for the Advancement of Science,* December (p. 34).

   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:


POST-GRADUATE DEGREES COMPLETED IN 2002:

   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°C and 45°C respectively. Both enzymes show a remarkable stability at higher temperatures (50°C) 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-protozoal 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-protozoal 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 propague 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 atrata* 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. ovoides*, *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. microcarpus*, *Garcinia mangostana*, *Pentadesma butyracea*, *Durio zibethinus* and *Adansonia digitata*. A technique of in vitro micrografting each 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 were generated and dendrograms 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.

![Images of callus induction and regeneration](image)

**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 REFEREEED 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 Horticultrae (in press)\textsuperscript{1,2}

\textsuperscript{1} Listed in science citation index 2002
\textsuperscript{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.
   58\textsuperscript{th} 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.
   58\textsuperscript{th} 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.
   58\textsuperscript{th} Annual Session, December 2002, Sri Lanka.
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. Deviations from 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 during 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.

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)

* Reported as “in press” in Annual Report 2001
* Listed in the science citation index in 2002
* Listed in the science citation index-expanded in 2002

ABSTRACTS/CONFERENCE PROCEEDINGS IN 2002:

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

   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):

- Jeyanandarakaj 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 cyanobacteria, 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, Chroococcum, 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](image)

Genomic DNA was extracted from selected isolates using protease 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).
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: *Chaetoceros radicans*, *Chroomonas* sp. and *Emiliania* 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).

[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 abscissa. From]
such parameters the isolate was tentatively identified to consist mainly of a Chromonas 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 N₂ 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 N₂O 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 biofilm 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, CH₄ and N₂O 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 agroclimatic 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,

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.I., 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, and 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 diet 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 Veterinary Faculty, University of Peradeniya, we had identified and quantified the protozoan parasites cryptosporidia, microsporidia and cyclospora in the three species 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:


   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.*

BOOKS AND MONOGRAPHS IN 2002:


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


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 (e.g. 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 Ecology of the University of Bremen is pending approval of the Board of Governor although recommended by the Research Council. Ms R. Gamalath 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. Gamalath 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 Schiermer 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.

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.

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.

5. Title: Structure of micro-crustacean zooplankton communities in five south-east Asian water bodies
   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:

   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.

   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., Igthamjit 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, Budweisse, Czech 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),
7. Silva E.I.I.L.

    Silica fluxes in three river systems in Sri Lanka (Abstract) APN/SASCOM/LOICZ, *International meeting on material fluxes to costal waters, Negombo, Sri Lanka.*

    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.


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.

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


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
Tobachell H.J. and Hoch M. (School of Applied Geology) University of
Erlangen, Germany (1995 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-
todate)

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) adsorption 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 reoritientation 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 reoritientation 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:

\[ \text{log } K = -5.39 \]
\[ \text{log } K = 4.60 \]
\[ \text{log } K = 3.46 \]

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. Arsenite adsorption on gibbsite was examined as a function of pH, ionic strength (I) and contact time (tC). As(III) showed a weak affinity for gibbsite surface. The trends of pH - f (Γads) curves have showed a marked deviation from a typical anion adsorption edge showing a maximum Γads around pH ~8.2. The experimentally derived proton exchange ratio has always converged to zero when 0.26 < Σ[As(III)] < 7μM and 6.2 < pH < 8.2. The isosteric heat of adsorption, ΔH, exhibited invariant behavior with respect to Γads. 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., Tobschall 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., Tobschall H.J., Wijesekara D., Bandara A.**  
   Mechanistic modelling of arsenic – gibbsite interactions (poster presentation),  
   *Annual Sessions of the School of Applied Geology, University of Erlangen-Nuremberg 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 (σ1) and the least principal palaeostress (σ3) during the second strongest deformation (D2) were nearly E-W and N-S, respectively. By applying this, at least six types of mineralizers were identified in the area 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 supercontinent 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 CO₂-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 CO₂-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 CO₂-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 1600 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:** Rinn-Tal S.S., Kehelpannala K.V.W., Satish Kumar M., and Wada H.  
   **Journal:** Chemical Geology (in press)  

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)

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  
   **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  
   **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.


**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, Rahul 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.
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, Puliyanakulama.

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.  
Kroner A.  
Tennakone K.  
Yoshida M.  

Honorary Research Professor  
Honorary Research Professor  
Research Professor  
Honorary Visiting Research Professor  

Ananthan Jeeva S.  
de Silva A.P.  
Dias H.V.R.  
Fernando G.W.  
Gunaratne G.H.  
Perera U.  
Rajasekeran K.N.  
Wijewardena L.C.R.  

Visiting Research Professor  
Visiting Research Professor  
Visiting Research Professor  
Visiting Research Professor  
Visiting Research Professor  
Visiting Research Professor  
Visiting Research Professor  
Visiting Research Professor  

Dharmaratne H.R.W.  
Keinschrodt R.  
Silva E.I.L  
Weerasooriya S.V.R.  

Associate Research Professor  
Visiting Associate Research Professor  
Associate Research Professor  
Associate Research Professor  

Dittus W.P.J.  
Jayasinghe J.H.M.U.L.B.  
Kehelpannala K.V.W.  
Nanayakkara A  
Ramanayake S.M.S.D.  
Seneviratne P.R.G.  

Honorary Senior Research Fellow  
Senior Research Fellow  
Senior Research Fellow  
Senior Research Fellow  
Senior Research Fellow  
Senior Research Fellow  

Bandara J.  
Iqbal M.C.M.  
Jeyanandarajah P.  
Magana Arachchi D.N.  
Senadeera G.K.R.  

Research Fellow  
Research Fellow  
Research Fellow  
Research Fellow  
Research Fellow  

Wanigasekera W.M.A.P.  

Visiting Scientist
<table>
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<tr>
<th>Name</th>
<th>Position</th>
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<tr>
<td>Jayaweera P.V.V.</td>
<td>Research Assistant (Grade I)</td>
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<tr>
<td>Perera V.P.S.</td>
<td>Research Assistant (Grade I)</td>
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<td>Ratnayake R.R.</td>
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<td>Balasooriya B.A.I.S.</td>
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<tr>
<td>Bandaranayaka K.M.P.</td>
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<tr>
<td>Christie M.P</td>
<td>Research Assistant (Grade II)</td>
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<td>Fernando W.I.T</td>
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<td>Research Assistant (Grade II)</td>
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*Project Leaders are responsible for the authenticity of information they have provided to compile this document.*