

Annual Research Symposium 2000

November 24, 2000

Abstracts of Papers



Faculty of Graduate Studies

University of Kelaniya

Kelaniya

Sri Lanka

Message from the Vice-Chancellor

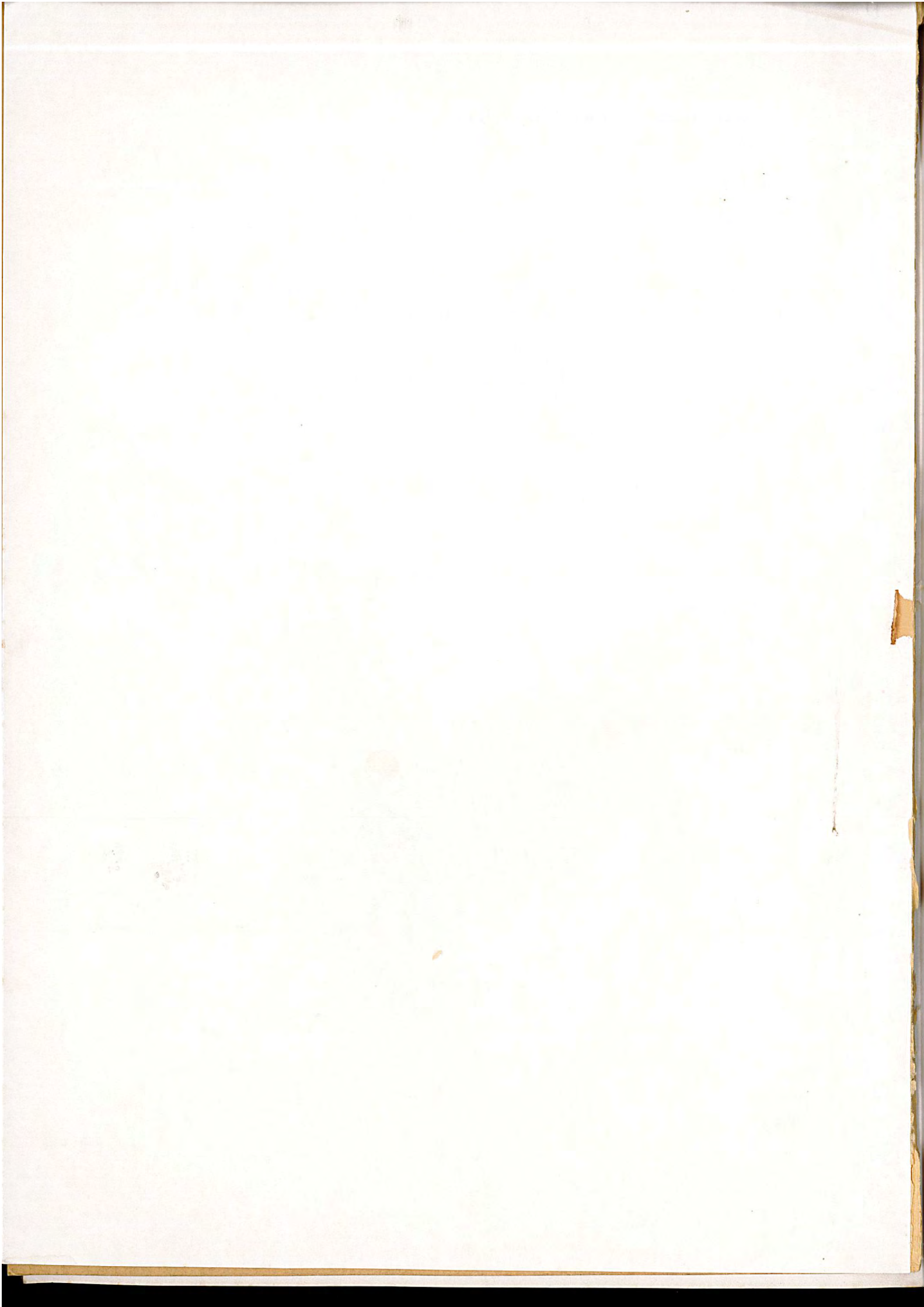
It is with grate pleasure that I send this message of felicitation to the Faculty of Graduate Studies on the occasion of its first Annual Research Symposium.

The Faculty of Graduate Studies is barely two years old and it is very encouraging that the Faculty has been able to organize its first Research Symposium so soon. With the active support of the academic community of the University, I am sure that from now on, the Faculty would be able to have annual sessions on a regular basis.

I wish them success.

Prof. K Tillekeratne

Vice - Chancellor



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Soil fertility status in five vegetations in an abandoned agriculture land in Sri Lanka

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ABSTRACT

Large areas of agricultural lands where crop plantations established during past hundred years had been abandonment are present in the wet zone of Sri Lanka. Hantana is one such area regenerated with *Paraserianthes* (PAW), *Alstonia* (ALW), mixed species (MSW), *Pinus* plantation (PIW) and natural forest (NF). Though information is available on floristic diversity of woodlands, very little is known about the soil. Soil studies will help in understanding soil fertility status, and provide necessary information to manage vegetation with soil degradation.

Using stratified random sampling 15 plots were selected in each vegetation. Top soil was collected in zig zag manner and was analyzed for total N, NO_3^- , available P, exchangeable K, Ca and Mg, C.E.C., pH, organic matter (o.m.) and saturation capacity. Vegetation - specific differences among the parameters were compared by Turkey's test after ANOVA.

The highest and the lowest values were shown by the NF and PIW respectively for most of the parameters. MSW showed higher C.E.C., K, NO_3^- and Mg than ALW and PAW. Except for NO_3^- and o.m., all the other parameters showed no significant differences between MSW and NF. However, between ALW/NF and PAW/NF some other parameters also showed significant differences. Nitrate and o.m. contents of the NF were significantly higher than all secondary woodland types. Apart from NO_3^- , all other parameters were significantly lower in PIW than in all broad-leaved woodlands.

In conclusion, soil nutrient levels of the NF were found to be higher than that of the other woodlands. Soil fertility under PIW appears to be less than that of other woodlands. MSW had higher nutrient levels than the other secondary woodlands and a better soil rehabilitation process seems to be taking place in MSW towards NF.

Therefore, this study reveals that use of mixed species seems to be more effective than mono-species pine plantations for soil rehabilitation.

Research grant no RP/03/02/01/01/98 from University of Kelaniya, laboratory facilities provided by Rubber Research Institute, Agalawatte and assistance by KDS Swarnalatha, Miss MM Anunayake Menike and Mr. AMWW Samarasinghe of Department of Botany are gratefully acknowledged.

Fungal community structure of fast decomposing and slow decomposing leaf litter at the upper montane rain forest, Sri Lanka

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ABSTRACT

Michelia nilagirica (Magnoliaceae) and *Semecarpus coriaceae* (Anacardiaceae) are two common tree species, which are the major litter contributors in the lower elevation of the Hakgala natural forest. Leaves of *Michelia nilagirica*, a fast decomposing species requires 9-10 months to show an 80% decomposition whereas leaves of *Semecarpus coriaceae*, a slow decomposing species requires about two and half years even for a 38% decomposition. The return of nutrients to the soil from the litter via decomposition represents an important link in plant nutrient cycling. The availability of these nutrients to plants will vary with the rates of decomposition, which are regulated by both abiotic (climate) and biotic (substrate quality, microbes and fauna) factors. The microbial decomposition of leaf litter is carried out mainly by fungi. Therefore, a comparative study of the fungal community structure and its changes during leaf litter decomposition for the two leaf species was carried out. Freshly fallen leaves of both species were initially collected in large nets. Thereafter litterbag technique was applied for *Michelia* leaf litter and the bags were sampled at 3, 6 and 9 months after placement in the field representing the decomposition stages 1, 2 and 3 of the leaf litter respectively. The analogous decomposition stages for *Semecarpus* leaf litter were selected from the forest floor. Fungi were isolated from the leaf litter of 4 decomposition stages *i.e.* freshly fallen, stages 1, 2 and 3 of both leaf species using the washing and plating method (Harley and Waid, 1955). A total of 120 litter particles (1 mm) from each decomposition stage of both leaf types were placed on 2% MEA supplemented with 0.01% streptomycin sulfate (one particle per petri dish). After 7 - 10 days of incubation, fungi that grew from each litter particle were separated into pure cultures and identified using keys (Barron, 1983 and Domsh and Gams, 1993). The percentage frequency of isolation of

each fungus and the percentage frequency of occurrence of fungi isolated in the leaf particles were calculated to each decomposition stage of both leaf species. Shannon Weiner diversity index was also calculated for each leaf decay stage of both leaf types separately. The ability of the fungi isolated at higher frequencies of utilizing substrates such as cellulose, starch, chitin, pectin and lignin was tested by plate assays.

Different fungal species were isolated at low frequencies from the fresh fallen stage of both leaf species and their distribution within the replicate samples was heterogeneous. *Acremonium strictum*, *Cylindrocarpon magusianum*, *Broomella acuta* and *Penicillium variable* were common to both leaf species. The fungal species common to the 1st decomposition stage of both leaf species were *Broomella acuta*, *Trichoderma viride* and *Acremonium* sp. 1. Many fungi isolated from this stage were able to utilize cellulose, starch and lignin. In the 2nd and the 3rd decomposition stages of both leaf species, the percentage frequencies of occurrence of the fungal species and the percentage frequencies of cellulose and lignin utilizers increased in both leaf types with the advancement of decomposition. *Trichoderma piluliferum* was common to the 2nd decomposition stage of both leaf species and the common species of the 3rd decomposition stage of both leaf species were *Trichoderma viride*, *Trichoderma piluliferum*, *Cladosporium cladosporioides*, *Broomella acuta* and *Cuvularia lunata*. In both leaf species *Broomella acuta* appeared in every decomposition stage but in higher frequencies in the latter stages. *Trichoderma* was isolated from the 1st decomposition stage of both species.

The present study showed common as well as different fungal sp. in the analogous decomposition stages of both leaf species. Higher frequencies of cellulose and lignin decomposers were isolated from both leaf types at the latter stages of decomposition. Therefore the difference of the decomposition rates between the two leaf types might not be mainly due to the occurrence of different fungal communities but may be due to the substrate quality (physical) of the two types of leaves and utilization by different fungal species (as shown by another experiment).

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Estimation of agricultural drainage and phosphorus loading to Embilikala and Malala lagoons in the Bundala wetland system

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ABSTRACT

Objectives of this research are to estimate the volume of water and phosphorus loading to Embilikala and Malala lagoons in the Bundala wetland system. Water from Tract 5 (1020 ha), Tract 6 and Tract 7 (670 ha) feed Embilikala lagoon while 6 and 7 (670 ha) and Bandagiriya drainage (850 ha) feed Malala lagoon.

Monitoring stations were established to measure the flow volume and water quality in drainage before entering the lagoons. Water levels (flow volumes) were measured daily and the quality of water was tested biweekly. Ascorbic acid method was used to measure phosphate concentrations. US Army Corps of Engineers FLUX model was used to compute the volume of water and loads of phosphate.

Average monthly total phosphate loading to the Malala lagoon was 1000 kg and 43% of that was orthophosphate. Tract 6 and 7 drainage contributed 63% of the total phosphate loading to Malala while Bandagiriya drainage contributed the remaining 37%. Average drainage volume to Malala lagoon is 2.2 hm³ per month. Drainage to Embilikala lagoon delivered 750 kg total phosphate per month with 77% as orthophosphate and the corresponding drainage volume was 1.4 hm³ per month.

Between March 1999 and August 2000 the average monthly delivery of total phosphate from Tract 5, Tract 6 & Tract 7, and Bandagiriya were 0.94 kg/ha, 0.73 kg/ha and 0.44 kg/ha respectively. The amount of phosphate received by the Malala lagoon is about 1.3 times as that of the Embilikala lagoon.

Taxonomic key for direct identification of some mayfly nymphs (Order: Ephemeroptera) of Sri Lanka

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ABSTRACT

Mayfly nymphs (Order: Ephemeroptera) are very common among the macro invertebrate assemblages in lotic on freshwater habitats of Sri Lanka. Identification of mayfly nymphs to lower taxons including the family level is a difficult task due to the unavailability of references and keys relevant to Sri Lanka. The nymphs were collected from several streams, i.e., Hakgala Dola, Pitawala Dola, Somerset Estate tributary, a tributary of Mahaweli Ganga in Peradeniya, Aswathu Oya in Puwakpitiya, and two other streams in Ruwanwella and Karawanella. The morphology of nymphs were studied at suitable magnifications and they were identified to the lowest possible taxa using the existing information.

The nymphs belonging to the families Baetidae, Leptophlebiidae, Caenidae and Prosopistomatidae were identified during the percent study. Baetids included the genera *Baetis* (*B. collinus* and *B. frequentus*), *Indobaetis* (*I. costai*) and *Centroptella* (mainly *C. ceylonensis*). A total of four genera of leptophlebiids, namely, *Choroterpes*, *Kimminsula*, *Megaglena* and *Isca* were also identified. A taxonomic key was prepared for the quick identification of the nymphs collected during this study.

This research was funded by the Kelaniya University Research Grant RP/03/02/07/03/97.

Chemotaxonomy and medicinal properties of *Sida* spp: flavonoids

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ABSTRACT

The genus *Sida* L. (Family: Malvaceae) comprises 120 cosmopolitan species. According to Dassanayake and Fossberg (1998), seven species of *Sida* have been found in Sri Lanka. *S. acuta* (Gas - baviya) is a common species, which is mostly distributed in road sides, specially in the low country. Although this species is considered as a weed in most countries, it is widely used as a medicinal plant in Sri Lanka. Leaves, seeds, flowers, and a triterpenoid (saponin) have been isolated from this species ("sepal" data base - Kew herbarium, UK.) However, no information is available on its flavonoid chemistry. This paper reports the results of a preliminary study of an ongoing research program on flavonoid chemistry of *Sida*.

Flavonoids share a basic C₆-C₃-C₆ structure and are one of the largest and most diverse range of naturally occurring phenolics, and these are widely used as chemosystematic marker compounds (Harborne, 1973).

In this work, flavonoid composition of the leaves was studied using paper chromatography and UV-Vis spectroscopy. Methanolic extractions of the leaves were chromatographed two dimensionally (2-D pc) using solvents BAW (Butanol: HOAc: Water, 4:1:5) and 15% HOAc. Isolation and purification of these compounds were done using repetitive 1 - D Paper chromatography in BAW, 15% HOAc and distilled water as solvents (Harborne, 1973). UV - Vis absorption spectra for the purified compounds were obtained. Using shift reagents such as aq.NaOH, NaOAc, and H₃BO₃, their glycosylation patterns were also studied (Markham, 1982).

According to the chromatographic properties, R_f values and UV - Vis absorption spectra, three flavonoid glycosides, i.e. kaempferol 7 - glycoside, luteolin 3' - glycoside and a minor flavonoid glycoside were identified. For the confirmation of the identity, acid hydrolysis and sugar analysis is to be carried out. This preliminary work will be useful in identifying and assaying the bioactivity of the flavonoid compounds in the genus *Sida*.

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Experimental transmission of white spot disease virus (SEMBV) to tiger shrimp, *Penaeus monodon* under different salinity and hardness levels in water

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ABSTRACT

Repeated occurrence of white spot disease outbreaks, causing heavy mortalities in cultured *Penaeus monodon*, has severely affected the shrimp farming industry in Sri Lanka. Systemic Ectodermal and Mesodermal Baculo Virus (SEMBV) is the pathogen responsible for this disease. Our field investigations over the last 3 years revealed that the occurrence of the disease was associated with the low levels of salinity and hardness of the grow-out pond water. The present study was conducted to examine the susceptibility of *P. monodon* to white spot disease when the shrimps were challenged with SEMBV by oral exposure under optimal and sub optimal levels of salinity and hardness in water.

P. monodon, free of SEMBV were acclimated to sub optimal levels of salinity (5 ppt) and hardness (800 ppm) and optimal conditions (20 ppt salinity and 3200 ppt hardness) separately and were fed with infected shrimp tissues. Occurrence of the disease in test animals was monitored by gross clinical signs and histopathology. Time taken to show signs of the disease by shrimp in the sub optimal salinity or hardness conditions ranged between 27 and 34 hours and that of the shrimp under optimal conditions took only 72 hours post exposure to the virus. Shrimp that were in sub optimal levels of salinity and hardness experienced 100% mortality within 160-198 hours post exposure whereas the shrimp in optimal salinity and hardness survived until 252 hours. Results indicate that *P. monodon* under sub optimal salinity and hardness conditions are highly susceptible to the SEMBV compared to the susceptibility of the shrimp in optimal salinity and hardness in water.

Use of geographical information systems as a tool for fish yields prediction in tropical reservoirs: case study on Sri Lankan reservoirs

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ABSTRACT

Use of geographical information systems (GIS) in inland fisheries has hitherto been by and large restricted to evaluation of site suitability for aquaculture development, and assessment of limnological changes with time and space in individual water bodies. In the present study, GIS analysis was conducted on the land use pattern of the catchments of nine reservoirs in Sri Lanka, for which detailed fishery data, viz, yield, fishing intensity, landing size of major constituent species together with selected limnological data such as conductivity, chlorophyll-*a* (Chl-*a*) were available. Potential statistical relationships of fish yield (FY) to different land-use patterns such as forest cover (FC in km²), shrub-land (SL in km²), etc. either singly, or in combination, and/or the ratio of each land use type to reservoir area (RA in km²) and reservoir capacity (RC in km³) were explored.

Highly significant relationships were evident in fish yield (kg ha⁻¹yr⁻¹) to SL/RC, FC+SL/RC, FC/RC i.e.,

$$FY = 0.009 \text{ SL/RC} + 85.297 \text{ (} r = 0.70; P < 0.05 \text{)}$$

$$FY = 0.007 \text{ FC} + \text{SL/RC} + 81.729 \text{ (} r = 0.73; P < 0.05 \text{)}$$

$$FY = 0.027 \text{ FC/RC} + 72.860 \text{ (} r = 0.81; P < 0.01 \text{) and}$$

$$FY = 10.972 \text{ FC/RC} + 56.134 \text{ (} r = 0.81; P < 0.01 \text{)}.$$

Similarly, the above land use types to RA and RC ratios were significantly related to limnological features of the reservoirs. Examples of some such relationships are: MEI_c = 4.537 SL/RA + 30.686 (*r* = 0.91; *P* < 0.001), MEI_a = 0.003 SL/RC + 26.038 (*r* = 0.84; *P* < 0.01) and Chl-*a* = 0.785 SL/RA + 16.079 (*r* = 0.79; *P* <

0.02), where MEI_c is the morphoedaphic index (Conductivity to mean depth) and MEI_a is the ratio of alkalinity to mean depth.

The above relationships of fish yield to various parameters obtained in this study are much better correlated than those relationships of fish yield to limnological and biological parameters used in the yield-prediction in lacustrine waters, tropical and temperate, previously. It is, therefore suggested that utilisation of GSI may provide a far superior indicator of yield prediction in reservoirs.

(Work reported in this abstract has been presented at "Reservoir fisheries and limnology" conference in University of Hull, UK in April 2000 by SS de Silva)

Food habits and dietary overlap between an indigenous species, *Puntius dorsalis* (Cyprinidae) and three exotic species, *Labeo rohita* (Cyprinidae), *Catla catla* (Cyprinidae) and *Oreochromis niloticus* (Cichlidae) co-occurring in Udawalawe reservoir, Sri Lanka during high water level

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ABSTRACT

Food habits and dietary overlap between indigenous species, *Puntius dorsalis* (15-18 cm) and three exotic species, *Labeo rohita* (21-27 cm) *Catla catla* (21-27 cm) and *Oreochromis niloticus* (12-15 cm) were examined in Udawalawe reservoir during the season of high water level when terrestrial vegetation was submerged. During the high water level, *C. catla* and *L. rohita* are caught in significant numbers in this reservoirs perhaps due to the reason that they migrate to the inshore areas where submerged vegetation is abundant.

Results of the analyses of gut contents show that *C. catla* and *O. niloticus* are mainly detritivores with a wide spectrum of other food items. *L. rohita* predominantly feeds on macrophytes and detritus while *P. dorsalis* feeds mainly on insects and detritus. As such, it appears that these species share somewhat similar food items in the reservoir ecosystem.

Diel feeding patterns of the four species were determined by MAXIMS software package, by analyzing the changes of gut content weight of the four species during a 24-hour cycle. Two maxima of food intake were found for *L. rohita*, *O. niloticus* and *P. dorsalis*, one in the morning and the other in the afternoon while one maximum was observed for *C. catla* which lasted from dawn till night.

A high dietary overlap as determined by Schoener's index (0.68) was found between *C. catla* and *O. niloticus*. The dietary overlap of *C. catla* / *L. rohita* and *L. rohita* / *O. niloticus* were moderate (0.33 - 0.66). A low overlap was found between *C. catla* / *O. dorsalis*, *L. rohita* / *P. dorsalis* and *O. niloticus* / *P. dorsalis*.

Although some of these species have similar feeding habits, as evident from diel feeding patterns, the peak feeding periods during the day do not overlap considerably. This relaxes competition for food between the species, which are co-occurring in the reservoir ecosystem. As such it is unlikely that any adverse impact on the indigenous fish species has taken place due to introduction of the exotic into the reservoir.

Acknowledgements

This study is part of a detailed investigation on the trophic evaluation in Asian reservoirs and lakes carried out under a research grant awarded by the European Commission INCODC Programme (Project Number: IC18-CT-0190). We are grateful to DMCD Dissanayake for his assistance in the field as well as in the laboratory.

Invertase of *Woodfordia fruticosa* (Malitta); purification and its properties

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ABSTRACT

Fermented Ayurvedic drugs known, as "Arishta" are very popular in Sri Lanka. During the preparation of Arishta, fermentation is generally set off by the addition of flowers of *woodfordia fruticosa* (Lythraceae, Malitta) into a decoction of plant material supplemented with sugar. It has been reported that hydrolysis of sucrose during this fermentation is mainly due to the endogenous invertase present in the above flowers. In this communication, we describe the purification and properties of Invertase of *woodfordia fruticosa* (Malitta).

Enzyme was extracted from surface sterilized *Woodfordia* flowers, fractionated with ammonium sulphate, purified by Sepharose 4B gel filtration and DEAE Cellulose chromatography. Enzyme activity was assayed by Nelson's Method.

The enzyme was purified 507.8 fold with a 5.32% recovery. M.W. of the enzyme was ~ 110 kDa on SDS-PAGE and ~ 250 kDa on Sepharose 4B gel filtration. Similar to other invertases this enzyme also could be a glycoprotein which contain ~ 50% of carbohydrate of its molecular mass.

Above purified enzyme was used to study the following properties of the enzyme.

Kinetics of the product formation was continued over 5 min and was linear for an initial period of 3 min. Optimum pH and temperature were 2.9 - 3.5 and 37°C respectively. At a temperature above 40°C enzyme activity slowly declines and almost inactivated around 80°C. Approximate Km of the enzyme for sucrose was 160mM. Further, it was found that urea and fructose were competitive inhibitors, where as mercury was a noncompetitive inhibitor and manganese, semicarbazide hydrochloride, N-bromosuccinamide, zinc and cadmium were mixed inhibitors for the enzyme.

Please note that part of the above work has been published in SLASS Proceedings Part I, 54, p. 309, 1998

Food, feeding chronology and seasonal changes in the diet of green frog *Euphlyctis hexadactylus* (Lesson, 1834)

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ABSTRACT

Metamorphs, juveniles and adults of green frog *Euphlyctis hexadactylus* (Lesson 1834) were collected from the permanent water bodies at Wedamulla, Kelaniya to study the food and feeding habits of various life history stages.

The collected tadpoles and adults were killed immediately and gut contents were analyzed. The analysis of gut contents showed that about 80% of the diet by volume consisted aquatic leafy matter, mostly *Hydrilla* and *Ipomea aquatica*. Rest consisted aquatic insects, shrimps, molluscs and small vertebrates. Before the reproductive season, adult females consumed variety of invertebrates and some small vertebrates. Large frogs take large animal prey and more prey types when compared to small frogs.

E. hexadactylus has a feeding periodicity with more intensive feeding at dawn. Prey diversity was generally high during wet months. The herbivorous larva metamorphoses to an insectivorous frog and a second dietary switch from insectivory to folivory occurs in adults.

Influence of rainfall and lunar rhythm on daily catches in the fisheries of three Sri Lankan reservoirs: A fresh view of management

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ABSTRACT

The status of the fisheries was studied in three Sri Lankan reservoirs namely Minneriya, Victoria and Udawalawe. Monthly fish yields were 29.9-38.9, 3.96-25.36 and 10.17-171.62 ($\times 10^3$ kg) in the three reservoirs respectively. Two cichlid species (*Oreochromis mossambicus*, and *O. niloticus*) represented the majority of the commercial fish catches in Minneriya and Victoria Reservoirs but in Udawalawe reservoir, native cyprinids and introduced Indian carps formed significant proportions in the landings. The highest (1165.80) and the lowest (212.18) values of catch per unit effort (CPUE in $\text{kg fisher}^{-1} \text{ month}^{-1}$) were recorded in Udawalawe and Minneriya reservoirs respectively.

It was noted that there was a significant daily variation in CPUE so that the mean monthly CPUE did not reflect the actual contribution of the fishery to the maintenance of living standards of fishing communities. Attempts were therefore made to investigate the influence of rainfall and lunar rhythm on the daily CPUE. Linear regression analysis carried out with a one-day time lag, indicated that in Udawalawe reservoir, CPUE of indigenous cyprinid *Labeo dussumieri* ($R^2 = 0.055$; $p < 0.05$) has significantly increased with rainfall. Kruskal Wallis test indicated that CPUE of cyprinids (*Labeo dussumieri* and *Catla catla*) varied significantly ($H = 15.60$ and $H = 10.84$; $p < 0.05$ respectively) with lunar phase, the highest CPUE being in the first quarter phase in Udawalawe reservoir. The same trend was observed in Victoria reservoir for exotic cichlids (*Oreochromis mossambicus*, and *O. niloticus*). As the fishers usually have the habit of spending the entire daily income, it is essential to take daily variation in CPUE into account in defining management strategies for the fishery. This should involve introducing a money savings system based on rural banking.

Population dynamics of five endemic fresh water fish species inhabiting two river basins in Sri Lanka

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ABSTRACT

Most of the endemic fresh water fish species of Sri Lanka are highly popular as ornamental fish. They are exported to more than 25 countries. The population dynamics of five endemic fish species inhabiting Kalu and Kelani river basins namely, *Belontia signata*, *Puntius cuningii*, *Puntius titteya*, *Puntius nigrofasciatus* and *Rasbora vaterifloris* were studied from October 1998 to September 1999. Sampling was carried out at monthly intervals in fifteen sites in each of the two river basins. The length frequency data were analyzed using FiSAT software package. The asymptotic lengths (L_{∞}) of *Puntius titteya* and *Belontia signata* were found to be higher in the Kelani river basin than in Kalu river basin while that of *Puntius cuningii* and *Puntius nigrofasciatus* were high in Kalu river basin than in Kelani river basin. The growth coefficients (K) of *Puntius titteya* and *Belontia signata* were greater than 2 year^{-1} while those of *Puntius cuningii* and *Puntius nigrofasciatus* were less than 1 year^{-1} in both river basins. However, the K values of *Puntius titteya* and *Belontia signata* were found to be higher in Kelani river basin than in the Kalu river basin. The results indicate that the production per biomass of these two species in Kelani river basin is higher than in Kalu river basin. The total mortality coefficient of these species were found to range from 0.82 year^{-1} in *Puntius nigrofasciatus* in Kelani river basin to 7.27 year^{-1} in *Puntius titteya* in the same river basin. These results indicate that there is a higher potential to harvest *Puntius titteya* and *Belontia signata* from Kelani river basin than from Kalu river basin.

Financial assistance provided by the National Science Foundation (Research Grant No. RG/98/MAB/03) is gratefully acknowledged.

Habitat preference, food and feeding habits of five endemic fresh water fish species in two river basins in Sri Lanka

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ABSTRACT

The nature of the habitats, food and feeding habits of five endemic fresh water fish species namely *Belontia signata*, *Puntius cuningii*, *Puntius titteya*, *Puntius nigrofasciatus* and *Rosbora vaterifloris* inhabiting the Kalu and Kelani river basins were studied from October 1998 to September 1999. Samplings were carried out in fifteen sampling stations in each of the two river basins. *Puntius titteya* and *Belontia signata* were found mainly in heavily shaded, shallow streams with slow following water and leaf debris while *Puntius nigrofasciatus* and *Puntius cuningii* were abundant in clear, cool streams where the margins were densely covered with submerged aquatic vegetation. *Rosbora vaterifloris* which was found only in the Kalu river basin, was abundant in shallow, cool, clear and heavily shaded forest streams with slow flowing water. *Puntius titteya* and *Rosbora vaterifloris* were found to feed mainly on aquatic insects and crustaceans while *Puntius cuningii* and *Belontia signata* were found to feed mainly on filamentous algae crustaceans and aquatic insects. *Puntius nigrofasciatus* feeds mainly on filamentous algae and aquatic macrophytes. These diverse feeding habits enable these species to co-exist in the same habitat with least overlap in their niches.

Financial assistance provided by the National Sciences Foundation (Research Grant No. RG/98/MAB/03) is gratefully acknowledged

Language contact and language evolution: A case of derivational affixes

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ABSTRACT

Language change takes place due to various reasons. One of them is language contact, i.e. language borrowing. It is a result of intercultural relationships, commercial exchange and social development. With these, new goods, instruments, technology, knowledge and concepts are introduced from one speech community to another, members of which have to borrow necessary words or coin new terms for naming them. This causes gradual change of language concerned.

The present paper discusses how language contact affects the systems of a language with special reference to derivational affixes in Sinhala. They are either borrowed from the donor language where they occur, or are newly formed on the basis of the semantic specification of the derivational affixes of the donor language. As a result, the total number of affixes in the borrowing language will expand and semantic change of the existing affixes may take place within the borrowing language.

This type of study provides a valuable contribution to realize the nature and the current trends in languages. Further, it sheds light on theoretical and historical linguistics and grammatical study of Sinhala in particular.

The Changing role structure of English

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ABSTRACT

This study deals with language change from a socio linguistic perspective. It deals with the changing role of English from changing models to varieties as in the case of the dethroning of Standard British English within the last half-century. Additionally, the changes in the structure of English in relation to the different varieties or Englishes will also be analyzed. This will include changes in phonology as in the case of /ae/ the open front vowel, which has come "up market" in Standard Sri Lankan English, although looked down on as a class marker for generations. The implications of change in terms of teaching English in Sri Lanka with emphasis on notions of correctness are analyzed; as in the case of the overuse of Prepositions in syntax, compounding of borrowed roots and English affixes in morphology.

සිංහල දුරකථන සංවාද පිළිබඳ අර්ථ විචාරාත්මක අධ්‍යයනයක්

ආර්. එම්. ඩබ්. රාජපක්ෂ

වාග්විද්‍යා අධ්‍යයන අංශය, කැලණිය විශ්වවිද්‍යාලය, කැලණිය.

සාරාංශය

භාෂණය මූලික වශයෙන් සංවාද මගින් ඉදිරිපත් වේ. ශාස්ත්‍රීය දේශන, ආගමික දේශන, දේශපාලන කථා ඇතුළු භාෂාමය කායඝී කිපයක් හැරුණු විට එදිනෙදා ජීවිතයේ බහුලව භාවිත වනුයේ සංවාදයි.

භාෂණයේ එන සංවාද අතුරින් දුරකථන සංවාද විශේෂ වෙයි. මුහුණට මුහුණලා කෙරෙන සංවාදවලට වඩා මේවා බෙහෙවින් වෙනස් වේ. සාමාන්‍ය සංවාද වලදී වාග්‍යාලාපවලට අමතරව හස්ත සංඥා, ඇස, නාසය, මුහුණේ මස් පිඩු විවිධාකාරයෙන් චලනය කිරීමෙන් මුහුණෙහි ඇති කරන සංඥා ඇතුළු විවිධ අංග වලන මාර්ගයෙන්ද කියන දේ තහවුරු කිරීම, කියන දේට පරස්පර දේ දැන්වීම ආදී වශයෙන් විවිධ අදහස් ඉදිරිපත් කෙරේ. දුරකථන සංවාදවල දී මෙබඳු අභාෂක සංකීර්ණ මාධ්‍ය ක්‍රියාත්මක නොවේ. හඬ හේදය ද ස්වාභාවික සංවාදවල දී තරම් ප්‍රබල නොවේ.

භාෂා සංස්ථිතිය වශයෙන් ද දුරකථන සංවාද වෙනස් වේ. කෙටි බව එක් කරුණකි. දුරකථන සංවාදයන් සඳහා ව්‍යාකරණයක් ද ඉදිරිපත් කළ නොහැකිය. බොහෝ විට ව්‍යාකරණ වශයෙන් පරිපූර්ණ සංස්ථිති එහි නොමැති බැවිනි. කෙසේ වෙතත් සංකීර්ණ වශයෙන් ඒවායෙහි කිසිදු අඩුවක් නැත. අර්ථපූර්ණ වේ.

එහි ඇති අර්ථාන්විත භාවය අධ්‍යයනය කළ හැක්කේ ප්‍රකරණ විචාරයට අනුවය. භාෂා සංස්ථිතිය පිළිබඳව පමණක් අවධානය යොමු කොට එය කළ නොහැකිය. ප්‍රකරණ විචාරයේ එන ආදේශක වචන (Dexis) සංවාද ඉංගන (Conversational Implicature), පූර්ව ඉංගන (Pre-Supposition) ආදී කරුණු පදනම් කොටගෙන එබඳු සංවාද පිළිබඳව අර්ථ විචාරාත්මක අධ්‍යයනයක් කළ යුතුය. භාෂක-ශ්‍රාවක දෙදෙනා අතර ඇති සම්බන්ධතාවය, දෙදෙනා අතර පූර්වයෙන් කරන ලද සංවාද පිළිබඳ දැනුම, අතීතය, සිතිය, භාෂා පාඨ හා සාමාජික අවස්ථා පිළිබඳව ඇති දැනුම, එවැනි මාර්ගයෙන් කෙරෙන සන්නිවේදනයේ දී වැදගත් වේ.

සමුද්‍රාශ්‍රිත භායනය: ශ්‍රී ලංකාවේ නිරිත වෙරළ ඉම ඛාදනය පිළිබඳ ප්‍රායෝගික අධ්‍යයනයක්

ඒ. පී. අමරසිංහ

භූගෝල විද්‍යා අධ්‍යයන අංශය කැලණිය විශ්වවිද්‍යාලය, කැලණිය.

සාරාංශය

අරමුණ :

වෙරළ ඉම ඛාදනයේ අවකාශය හා කාලීන ව්‍යාප්තිය ප්‍රමාණාත්මක දත්ත ඇසුරින් පරීක්ෂා කිරීම හා ඒ කෙරෙහි බලපාන භෞතික සාධක හඳුනා ගැනීම මෙම පර්යේෂණයේ අරමුණයි. වෙරළ සංරක්ෂණ කාර්යයන් සඳහා මෙවැනි අධ්‍යයන මගින් සොයාගනු ලබන දත්ත විවිධ ඇසුරින් ප්‍රයෝජනයට ගත හැකිය.

පර්යේෂණ ක්‍රමය:

ප්‍රධාන වශයෙන්ම දත්ත රැස්කරන ලද්දේ ක්ෂේත්‍ර පර්යේෂණ මගිනි. මෙහිදී 1998 නිරිතදිග මෝසම් සෘතු අවරණය වන පරිදි තෝරාගත් ස්ථානවල වෙරළ ඉම හරස් පරීක්ෂා මාසයකට වරක් ලබා ගන්නා ලදී. වෙරළ ඉම ව්‍යුහාත්මක ලක්ෂණ හා වෙරළාශ්‍රිත මානව කටයුතු පිරික්සීම ද ක්ෂේත්‍ර පර්යේෂණ මගින් සිදු කෙරිණි.

දත්ත විශ්ලේෂණය කාර්යයන් වලදී “Excel” පරිගණක මෘදුකාංග යොදා ගන්නා ලදී. එමගින් වෙරළ ඉම හරස් පරීක්ෂා ගැලපීමෙන් සමුද්‍ර මට්ටමේ දී සිදු වූ වෙරළ ඉම වෙනස්කම් (ඛාදනය හෝ නිධි සාධනය) ගණනය කෙරිණි. මෙම වෙනස්කම් හා ඊට බලපාන ලද සාධක සැසඳීමෙන් හා විශ්ලේෂණය කිරීමෙන් නිගමනවලට එළඹීමට උත්සාහ දරන ලදී.

සොයා ගැනීම් :

1. වෙරළ ඛාදනය හා නිධි සාධනය එකම ක්‍රියාවලියක් ලෙස ගතහොත් නිරිතදිග මෝසම් සෘතුවේදී නිරිතදිග වෙරළ කලාපයෙන් 63% ක් වූ වෙරළ ඉම ප්‍රදේශයක් ඛාදනය වේ. ඉතිරිය නිධිසාධනය වන ප්‍රදේශයන් ය.
2. මෙම වෙරළ කලාපයෙන් 1998 නිරිතදිග මෝසම් සෘතුවේදී මීටර් 2.7 ක පමණ පළලැති වෙරළ තීරුවක් ඛාදනය වී තිබේ.
3. ඛාදනය හා නිධිසාධනය වන ප්‍රදේශ මාරුවෙන් මාරුවට පිහිටා තිබේ. මෙයින් පැහැදිලි වන්නේ වෙරළ ඛාදනය හා නිධිසාධනය අතර අන්තර්ගත වශයෙන් සම්බන්ධතාවයක් ඇති බව ය.
4. මෝසම් ක්‍රියාකාරීත්වය හා වෙරළ ඉම ඛාදනය අතර අනුලෝම සම්බන්ධතාවයක් පවතී.
5. සමුද්‍ර ඛාදනය තිවුරු කිරීමට තුඩුදිය හැකි වෙරළාශ්‍රිත මානව කටයුතු වැඩි වෙමින් පවතී. තවද ගෝලීය උෂ්ණත්වය ඉහල යෑමෙන් සමුද්‍ර ජල මට්ටම වසරකට මි.මී. 2.5 බැගින් ඉහල යෑම ද අඛණ්ඩව සිදුවේ. මෙම තත්ත්වයන්ගේ ඵලදායී බලපෑම මත වෙරළාශ්‍රිත භායන ක්‍රියාවලිය හුදුරු අනාගතයේ දී තව දුරටත් සිදු වනු ඇත.

නිගමනය :

වෙරළ ඉම බාදනය වැලැක්වීමේ ක්‍රමෝපායන් යෙදීමේ දී කාලීන හා අවකාශීය ව්‍යාප්තිය පිළිබඳ ව පුළුල් අවබෝධයක් ලබාගත යුතුය. එහිදී මෙම පර්යේෂණයෙන් සොයා ගන්නා ලද දත්ත පදනම් දත්ත ලෙස උපයෝගී කර ගැනීමේ හැකියාවක් පවති, උදාහරණ වශයෙන් වෙරළ ඉම බාදන ප්‍රමාණය හා බාදන ප්‍රදේශ නිවැරදි ව හඳුනාගැනීමේ දත්ත දැක්විය හැකිය. වෙරළාශ්‍රිත භායන ක්‍රියාවලිය තවදුරටත් අවබෝධ කර ගැනීම සඳහා බාදන වක්‍රය පිළිබඳ ව වැඩිදුර පර්යේෂණ කිරීමේ අවශ්‍යතාවය මෙම අධ්‍යයනයෙන් හුවා දැක්විය හැකිය.

Effect of vitamin E supplementation on adriamycin induced changes in oxido-reductive status of mouse red blood cells

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ABSTRACT

The effect of oral vitamin E supplementation on the oxido-reductive status of red blood cells in normal mice and those subject to oxidative stress by chronic administration of the anti-tumour drug Adriamycin was investigated. Mice were randomly separated into three groups of 20 animals each and maintained on diets identical in all respects except for vitamin E content. Group 1 received a low vitamin E diet that provided 10mg vitamin E/kg body weight/day, Group 2 received a normal mice chow diet (45mg vitamin E/kg body weight/day) while group 3 received a high vitamin E diet (200 mg Vitamin E/kg body weight/day)

In comparison with the normal mice in group 1, their counterparts in groups 2 and 3 exhibited significantly higher ($P < 0.001$) activities of superoxide dismutase (SOD) in red blood cells (79.4% higher in group 2 and 114.2% higher in group 3, respectively) and produced lower concentrations of malondialdehyde (MDA) (22.9% less in group 2 and 51.2% less in group 3, respectively), with little difference in the glutathione peroxidase (GPX) activity. In Adriamycin-treated animals on the low vitamin E diet (group 1) the red blood cell SOD activity and MDA production were 46.2% and 200.7% higher ($P < 0.001$), respectively, and the GPX activity was 39.1% lower than in the red blood cells of untreated (normal) animals in the same group. The Adriamycin-induced changes were significantly less in animals receiving higher doses of vitamin E (groups 2 and 3). Thus, in the group maintained on the high vitamin E diet (group 3), Adriamycin administration resulted in only a 38.9% increase in the MDA production above that generated by red blood cells of normal mice in the same group, with no significant change in the SOD or GPX activities. Thus, in normal conditions as well as in condition of oxidative stress, high doses of vitamin E appear to be able to protect the oxido-reductive status of red blood cells by modulating the extent of lipid peroxidation as the activities of antioxidant enzymes.

Lipid parameters in young adults in Sri Lanka to identify high-risk persons for coronary heart disease

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ABSTRACT

Foundations of coronary heart diseases (CHD) are laid in infancy and in early childhood with strong associations between antimortem risk factors and post-mortem observation in young individuals. This study was designed to examine the relationship between lipoprotein abnormalities and risk factors in a group of young adults in Sri Lanka and to identify indicators for possible early intervention in childhood. A total of 503 subjects, 281 male and 222 female medical students (24±1.5 yrs.) were studied. They represented a sample from all district of Sri Lanka. A complete lipid profile consisting of total cholesterol (Chol), HDL-Chol, LDL-Chol and TG was done on all subject from venous blood obtained after a 14 hour fast. No Significant relationship between lipid parameters and risk factors (self, family histories) were observed.

LDL-Cholesterol greater than 110mg/dl was found in 50% of both 21-26 yrs old males and females indicating the increased incidence of borderline and high-risk subject in these young adults.

Higher total Chol and LDL-Chol were observed in females at all percentiles 5th-95th with significantly higher means ($P<0.05$).

TG, however were significantly higher in males with significantly higher means ($P<0.05$).

These values are higher than the values reported for an equivalent population of Western males and females.

Since increasingly higher incidence of CHD have been reported among Sri Lankans, these observations in young adults suggest the need for early intervention in childhood in the risk groups identified on the basis of total Chol, and LDL-Chol.

These results represent stage-1, and in stage -111 the same subjects are being examined into their final years, (5th year) to track changes due to variations in lifestyles.

Density of *Aedes aegypti* and *Aedes albopictus* in some dengue endemic areas

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ABSTRACT

The incidence of Dengue fever (DF) / Dengue haemorrhagic fever (DHF) has increased cyclically since the first outbreak in Sri Lanka in 1989. *Aedes aegypti* is identified as the predominant vector of DF/DHF and *Aedes albopictus* is identified as an important vector in the absence of *Ae. aegypti*. In this study, larval surveillance was carried out in fixed monitoring stations and random monitoring stations in order to assess the role of two *Aedes* species in some dengue endemic areas. The fixed monitoring stations were selected based on the recorded incidence of DF/DHF in and around Kurunegala district (North Western Province) during 1996-1998. Ten premises within one fixed monitoring station were checked weekly for mosquito breeding using ovitraps and average monthly ovitrap index (%) was calculated. During outbreaks, larval surveillance was conducted in 25 random monitoring stations including 109 houses, which were selected, based on serologically confirmed DF/DHF cases. Observations on average monthly ovitrap index (%) of the fixed monitoring stations showed that highest ovitrap index of *Ae. aegypti* was in Kurunegala town area. Ovitrap index of *Ae. albopictus* was higher than that of *Ae. aegypti* throughout the study period in all fixed monitoring stations. Data obtained from random monitoring stations in North Western and Western Provinces revealed that only *Ae. albopictus* larvae were present in 13 out of 22 stations monitored. There were no stations in which only *Ae. aegypti* were present. Results suggest that *Ae. albopictus* may play a major role in transmitting dengue in some localities in Sri Lanka.

Extending the 007 benchmark for deductive object-oriented databases

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ABSTRACT

Database performance benchmarks play an important role in evaluating the performance of different database systems. In particular, for relational database systems, a number of different benchmarks have been designed to assess the relative behaviour of different systems. Well known examples include TPC-B (a benchmark with simple queries with updates), TPC-C (a benchmark with more complex MIS queries) and AS3AP.

With the development of object-oriented database systems, new benchmarks have been designed which can be used for assessing their performance. The most widely used of these is the 077 benchmark, which is based on an engineering database.

The recent emergence of database systems, which combine both deductive and object-oriented capabilities, so-called Deductive Object-Oriented Database system (DOODs), creates new type of database system with more advanced functionality. However, their performance is poor and needs improvement. Furthermore, no single benchmark exists for evaluating the performance of this combination of paradigms. Currently one can use benchmarks such as 007, 001 or Hyper Model for evaluating the performance of object-oriented characteristics and some other benchmarks to assess the performance of the rule-based component.

This paper presents an extension to the well-known 007 benchmark, which can be used to evaluate the performance of deductive queries in a deductive object-oriented database. To the best of our knowledge, no such benchmark exists. The cost of setting up the benchmark is a minimal addition to that of setting up the 007

benchmark. Some results of applying the benchmark to the ROCK & ROLL (Rule Object Computation Kernel & Rule Object Logic Language) system are also presented.

Work reported in this abstract has been presented at the International IT Conference, Colombo, October 1999.

I-V and C-V characterization of semiconductor thin films

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ABSTRACT

Cuprous oxide (Cu_2O) and ZnSe thin films were potentiostatically electrodeposited on indium-doped tin oxide (ITO) substrates in order to investigate the I-V and C-V characteristics of ITO/n- Cu_2O /(p- Cu_xS or metal or electrolyte) and ITO/p-ZnSe/electrolyte systems. An electrochemical cell containing aqueous solutions of 0.1 M sodium acetate and 1.6×10^{-2} M cupric acetate was used for electro deposition of Cu_2O thin films on ITO-coated glass substrates. Potentiostatic condition of -250 mV against standard calomel electrodes (SEC) was used for the electro deposition. To convert the top layers of the Cu_2O to Cu_xS by sulphidation, exposed the surface to a spray of aqueous solution of sodium sulphide or to a mixture of hydrogen sulphide and nitrogen gases to form ITO/n- Cu_2O /p- Cu_xS system. For the system ITO/n- Cu_2O /metal, metal layer was evaporated on to the n- Cu_2O surface. An electrolyte of 0.1 M sodium acetate was used in the ITO/n- Cu_2O /electrolyte system. Electro deposition of ZnSe thin films were carried out under potentiostatic condition at -550 mV against SCE using aqueous solutions of 0.1 M ZnSO_4 and 10^{-5} M SeO_2 at the temperature of 65°C . The theoretical and experimental I-V characteristics of ITO/n- Cu_2O /(p- Cu_xS or metal or electrolyte) system suggest that Cu_2O films made on ITO substrate form Schottky type junctions at the back contact in addition to the Cu_2O /(p- Cu_xS or metal or electrolyte) junctions. Furthermore, C-V characteristics suggest that the doping concentration of the Cu_2O layer is in the order of 10^{18} . Light and dark I-V measurements of doped and undoped ITO/ZnSe in KI electrolyte suggest the p-type photoconductivity in this system and C-V measurements confirmed it.

Financial assistance by the University of Kelaniya (RP/03/02/05/01/98) is gratefully acknowledged.

Sulphurisation of sequentially electrodeposited Cu-In alloy for the preparation of semiconductor thin films

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ABSTRACT

Copper indium disulphide thin films were fabricated by sulphurisation of Cu-In alloy prepared by a sequential electrodeposition method. Thin film layers of copper and indium were sequentially electrodeposited on a well-cleaned Ti substrate and on Ti/Cu thin film respectively. The Ti/Cu/In films were then heated at 130⁰C for 4 hours in air to form Cu-In alloy. Sulphurisation of Cu-In alloy was carried out at 550⁰C for 30 minutes in 100% H₂S gas with a constant flow rate. XRD measurement revealed that the chalcopyrite structure of single phase CuInS₂ can be obtained by adopting a proper In concentration in Cu-In alloy. The photoresponse of the CuInS₂ films in polysulphide showed the n-type behavior of the films. A p-type ZnSe thin film was deposited on CuInS₂ by electrodeposition to produce Ti/CuInS₂/ZnSe heterostructure. XRD measurement also revealed that the ZnSe films were amorphous. Spectral response of Ti/CuInS₂/ZnSe structure in a PEC cell containing sodium acetate showed the photoactivity of both interfaces n-CuInS₂/p-ZnSe and P-ZnSe/electrolyte. This study reveals that the thin film solar cell structure Ti/CuInS₂/ZnSe/metal may be developed to an efficient solar cell device. The solar cell parameters that we have observed so far are V_{oc}=330mV and I_{sc}=2mA/cm².

Financial assistant by the University of Kelaniya (RP/03/02/05/01/98) is gratefully acknowledged.

A study of temperature and salinity variations with depth in salt pans at Palavi in the North-Western region of Sri Lanka

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ABSTRACT

This work present measurements of temperature and density variation with depth in salt pans having stable salinity gradient. Measured density variation of brine has been correlated to the temperature variation with depth. The convective and nonconvective zones were identified. Gradients in salinity and temperature in the nonconvective zone were observed. Temperature and salinity were observed to remain constant throughout the convective bottom layer of brine in the ponds. The investigation has been extended to different ponds filled to different depths and storage periods of brine. A maximum temperature of around 55°C was observed in the bottom layers while the surface remained as low as 29°C . This is a consequence of positive salt-density gradient which suppresses convection and allows a temperature gradient to develop downwards. In this work, salt pans were studied as salt-gradient solar ponds where collecting and storing of solar energy are possible.

The result obtained with the experimental laboratory pond constructed to study the effect of the thickness of nonconvective layer on bottom temperature show the requirement of having a convective layer of optimum thickness to obtain higher temperatures at the pond bottom. On the basis of our investigation the introduction of nonconvective gradient zone of optimum thickness will give higher bottom temperatures than those recorded in this work. The temperature measurements of different ponds filled to different heights indicate that the convective bottom layer temperature of a pond will increase if the pond is filled with brine to a higher level.

Based on the results obtained from this work, large area deep salt pans with long term storage periods can be used as solar ponds to collect and store solar energy in addition to the usual salt production. Thermal energy stored in the convective bottom layer of these ponds could be extracted for many applications. The desalination of seawater especially in the areas where fresh water is in short supply is identified as one of the promising applications of thermal energy stored in solar pond-salt pans.

Residual properties of groups

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ABSTRACT

A group G is called a residually P group if, for each non-identity element g in G , there exists an epimorphism f from G to a group in P such that the image of g under f is not the identity in P . There are several other equivalent definitions also.

One important and interesting property worthy of investigation is that of residual finiteness. Accordingly, a group G is residually finite, if for each $1 \neq g \in G$, there is an epimorphism f from G to a finite group A (say) such that $f(g) \neq 1$ in A . From the very definition, it is clear that all finite groups are residually finite. Further, the cyclic group of integers under addition is residually finite. It can be proved that subgroups as well as direct products of residually finite groups are residually finite. Also, any free group, any polycyclic group and any subgroup of a general linear group $GL(n, F)$ are residually finite. Nevertheless homomorphic image of a residually finite group need not be residually finite. Further, a

- Finitely presented residually finite group has a solvable word problem
- Finitely generated residually finite group is Hopfian
- Group of automorphisms of a finitely generated residually finite group is residually finite.
- Free product of two residually finite groups is residually finite.
- Free product of two finite groups amalgamating only one subgroup is residually finite.

A simple example of a group that is not residually finite is the additive group of rationals.

Presented at Carleton University, Ottawa, Canada on December 20, 1999.

An algorithmic method for the solution of the Lane Emden equation

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ABSTRACT

The Lane Emden Equation, which was first studied by the astro-physicist Emden is as follows

$$\frac{d^2 y}{dx^2} + \frac{2}{x} \frac{dy}{dx} + y^m = 0, \quad m \in N$$

With boundary conditions, $y(0) = 1$, $y'(0) = 0$, the following solution satisfying the boundary conditions was obtained by J.R. Airey.

$$y = 1 - \frac{x^2}{3!} + m \frac{x^4}{5!} + (5m - 8m^2) \frac{x^6}{3 \cdot 7!} + (70m - 183m^2 + 122m^3) \frac{x^8}{9 \cdot 9!} \\ + (3150m - 10805m^2 + 12642m^3 - 5032m^4) \frac{x^{10}}{45 \cdot 11!} + \dots$$

We extend this solution up to the term in x^{12} .

Leibniz's formula was used to obtain the following recurrence relation (RR)

$$y_{n+2} = -\frac{n+1}{n+3} (y^m)_n$$

Here $y_n = \frac{d^n y}{dx^n}(0)$ and $(y^m)_n = \frac{d^n (y^m)}{dx^n}(0)$

Now a Taylor's expansion about $x=0$, will produce the solution. Computational difficulties arise in evaluating $(y^m)_n$. We have discovered the following algorithm, which will make the computation less tedious.

$$(y^m)_n = \sum^m C_r \frac{n!}{S_1! S_2! \dots S_r!} N(S_1, S_2, \dots, S_r) y_{s_1} y_{s_2} \dots y_{s_r}$$

Where $N(S_1, S_2, \dots, S_r)$ is the number of possible arrangements of $S_1, S_2, \dots, S_r$ such that $S_1 + S_2 + \dots + S_r = n$, $S_r \geq S_{r-1} \geq \dots \geq S_1$. The summation is over at all the distinct partitions of n .

As the equation is unchanged when $-x$ is substituted for x the expansion contains only even powers of x and the derivatives of y of odd order evaluated at $x=0$ are all zero. From this it follows that only even partitions of even integers have to be considered.

For the prescribed boundary conditions, it can be shown by other methods that the solutions, given by the following particular m are

$$m=0: \quad y = 1 - \frac{x^2}{6}; \quad m=1: \quad y = \frac{\sin x}{x}; \quad m=5: \quad y = \left(1 + \frac{x^2}{3}\right)^{-\frac{1}{2}}$$

These are very useful, since they can be used to verify the expansion obtained by our method. The Taylor expansion of the solution is given by putting $n=0$ in the recurrence relation (RR),

$$y_2 = -\frac{1}{3}$$

$$n=2 \text{ gives, } y_4 = -\frac{3}{5} (y^m)_2$$

Using the algorithm (even partitions of 2 are (2))

$$(y^m)_2 = {}^m C_2 \frac{2!}{2!} N(2) y_2$$

$$= m y_2$$

$$= -\frac{m}{3}$$

$$\text{Hence, using the RR, } y_4 = -\frac{3}{5} \left(-\frac{m}{3}\right) = \frac{m}{5}$$

$$n=4 \text{ gives, } y_6 = -\frac{5}{7}(y^m)_4$$

Using the algorithm (even partitions of 4 are (2,2), (4))

$$(y^m)_4 = {}^m C_2 \frac{4!}{2!2!} N(2,2) y_2 y_2 + {}^m C_1 \frac{4!}{4!} N(4) y_4,$$

$$= \frac{m(m-1)}{2!} \frac{4!}{2!2!} \left(-\frac{1}{3}\right) \left(-\frac{1}{3}\right) + m \frac{4!}{4!} \frac{m}{5}; \quad N(2,2) = 1, \quad N(4) = 1,$$

$$= \frac{m}{15} (8m-5)$$

From the RR for $n=4$ we have,

$$y_6 = -\frac{5}{7}(y^m)_4$$

$$= -\frac{5}{7} \frac{m}{15} (8m-5)$$

$$= \frac{1}{21} (5m-8m^2)$$

Using the algorithm (even partitions of 6 are (2,2,2), (2,4), (6))

$$(y^m)_6 = {}^m C_3 \frac{6!}{2!2!2!} N(2,2,2) y_2 y_2 y_2 + {}^m C_2 \frac{6!}{2!4!} N(2,4) y_2 y_4 + {}^m C_1 \frac{6!}{6!} N(6) y_6,$$

$$N(2,2,2) = 1, \quad N(2,4) = 2!, \quad N(6) = 1$$

$$\text{From the RR for } n=6, \quad y_8 = -\frac{7}{5}(y^m)_6$$

It is clear that this procedure can be followed to evaluate any y_{2n} . A computer program and a package like the Mathematica can be used effectively to obtain a Taylor expansion up to any power of x , with the use of RR and the algorithm.

