“If ever a community of young and old sought the tranquility and inspiration of a natural environment in which to engage themselves in the pursuit of knowledge, they could not have found a place where nature was more kindly or more anxious to please them than the valley of Peradeniya. You pass ugly little towns all the way, Yakkala, Warakapola, till you come to the bridge that goes over the Mahaweli. Then, through the arches formed by the bamboo branches that droop over the river from both its banks, you catch a first glimpse of the archaic-looking buildings of the university, built there only a quarter of a century ago. You turn right after crossing the bridge, and enter into a world that you would never have believed to have been there”.

Prof.Ediriweera Sarachchandra
Former Chancellor
University of Peradeniya
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MCR Peiris and MY Udugala-Ganehenege
MESSAGE FROM THE VICE CHANCELLOR
UNIVERSITY OF PERADENIYA

It is indeed with great pleasure that I write this message on the occasion of Peradeniya University Research Sessions (PURSE) 2011. PURSE has become a regular and second most important event in the university calendar. Generating new knowledge through research is one of the main functions of a university and is of immense value to enhance the primary function, namely, undergraduate training. Thus, research is an inseparable part of academic life in a university. Research is not an end in itself but it is only a means to an end. The benefits of research are realised only when its results are disseminated and effectively utilised to solve real life problems.

In this context, the PURSE is an ideal forum where the results of the latest research by the staff and students of the university are presented, discussed and evaluated. It is also an occasion for the university academics to interact with researchers from other institutions and representatives of industries, paving ways for building up partnerships for further research and development.

A total of 236 papers and posters will be presented in PURSE 2011. Following the recent global trends, this year, the paper presentations are grouped into eight (8) different interdisciplinary themes as opposed to groupings according to the Faculties, to foster better interactions and exchange of ideas among the staff and students of the university.

On behalf of the University of Peradeniya, I wish to express my deepest gratitude to Her Excellency Kathy Klugman, the High Commissioner for Australia in Sri Lanka, for accepting our invitation to be the Chief Guest of PURSE 2011. My sincere appreciation also goes to the Guest Speaker of this memorable occasion, Dr. Ayona Silva-Fletcher, Course Director for MSc Veterinary Education, Royal Veterinary College of the University of London. I wish to congratulate the Chairperson Prof. H.B.S. Ariyaratne and all other members of the committee for organizing this significant event in keeping with the standards and traditions of the university. Without their continued dedication, excellent commitment, and untiring hard work, an event of this magnitude would not have been a reality. I express my gratitude to all those who contributed in numerous ways to make this event a success. Finally, I wish the paper presenters all success and the participants a rewarding experience.

S.B.S. Abayakoon
Vice-Chancellor & Senior Professor in Civil Engineering
MESSAGE FROM THE CHAIRPERSON, ORGANIZING COMMITTEE

Peradeniya University Research Sessions 2011

The Peradeniya University Research Session (PURSE) is one of the highlights of the University calendar and this year the Faculty of Veterinary Medicine and Animal Science is honoured by the opportunity given to organize this event. The Peradeniya University research sessions provides an excellent opportunity for academics from different Faculties to present their research activities and engage in intellectual discussions analysing the importance of the findings. This forum brings together researchers from all Faculties who have engaged in research studies on multitude of themes and subjects, which will encourage interaction among intellectuals from different disciplines, that will lead to multidisciplinary research, which will immensely beneficial to mankind.

As in the previous years, this year too, to facilitate interdisciplinary interaction further, the presentations are categorised under 9 broad themes, viz. Education, Engineering, Food, Nutrition and Livestock, Health and Hygiene, Information Technology, Mathematics and Statistics, Natural Sciences, Plant Science and Forestry and Social Sciences and Humanities instead of faculty-based academic disciplines. A total of 236 peer reviewed research papers, 217 as oral presentations and 19 as posters, will be presented and discussed at PURSE-2011. Further, Her Excellency Ms. Kathy Klugman, the Australian Ambassador to Sri Lanka will be the Chief Guest at this important event. The programme for the Opening ceremony will include a presentation by Dr. Ayona Silva-Fletcher from the Royal Veterinary College of the University of London, who will be the Guest of Honour for the occasion.

The work associated with organizing an event of this magnitude cannot be shouldered by one individual. The success of PURSE lies in the collaborative efforts of the Organizing Committee, the various Sub-Committees and the quality of the research papers that will be presented. I consider myself privileged to Chair the Organizing Committee – an experience which has afforded me a unique opportunity to work with colleagues from different faculties as well as those from my own. We have worked together during the past several months to reach our goal and the results of these collaborative efforts are rewarding. The Organizing Committee joins me in extending our appreciation to the Vice Chancellor, University of Peradeniya for the fullest cooperation that he extended to us at all times and the Deans of all faculties for their concern in making PURSE a success. I wish to express my appreciation and gratitude on behalf of the Organizing Committee to Her Excellency the Australian Ambassador to Sri Lanka for gracing this occasion as well as to Dr. Ayona Silva-Fletcher for accepting our invitation to be the Guest of Honour. I also wish to thank the Chief Editor, Co-editors, and the panel of reviewers for their untiring efforts in completing the work on the proceedings. PURSE-2011 would not have been a reality if not for the researchers who shared their findings through their presentations. I acknowledge them with gratitude and wish them success in their future endeavours. We sincerely appreciate the generous support shown by non-academic members of the Faculties in various ways and the financial contribution made by Postgraduate Institute of Science (PGIS) towards the printing of the proceedings of PURSE-2011.

The Faculty of Veterinary Medicine and Animal Science welcomes you to PURSE-2011 and wish you a memorable and productive day.

Professor H.B.S. Ariyaratne
Chairperson, Organizing Committee, PURSE-2011
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EDUCATION
Reported Use of Learning Strategies among B.Sc. Nursing Students

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A shift in the reported learning strategies towards meaningful learning is expected during undergraduate training. Student performance has been linked with the reported cognitive processing and regulation strategies. The curriculum of the B.Sc. Nursing program of the Faculty of Allied Health Sciences (FAHS) is a four-year traditional curriculum. The regulation of learning and processing strategies of B.Sc. Nursing students in the Sri Lankan setting has not been investigated yet. Thus, the aims of the study were, to assess the processing and regulation strategies of B.Sc. Nursing students of the FAHS and to investigate the relationship between these strategies with their academic performances.

Processing and regulation strategies of B.Sc Nursing students of 2nd, 3rd and 4th years were assessed using the 55 item version of the Adyayana Rata Prakasha Malawa (ARPM). Kruskal Wallis tests were performed to investigate the variation in ARPM scores between each academic year. Correlations between ARPM scale scores and Grade Point Average (GPA) were tested using Spearman’s correlation tests. The response rate was 86%. In relation to the processing strategies, the students of 2nd and 3rd year batches showed an increase in scores of relating and structuring, critical processing, analyzing, concrete processing and self-regulation. The reported score for self-regulation scale was significantly higher among the senior groups of students. Subscale scores of relating and structuring, critical processing, analyzing, concrete processing and self-regulation showed significant positive correlation with GPA. Subscale of memorizing and rehearsing showed a negative correlation with the GPA value of the students.

As expected, positive associations were observed in deep learning strategies and self-regulation with the academic performances among the B.Sc nursing students. Third and fourth year students reported higher scores for the elements of deep learning and self-regulation. Thus, observed results should be used to encourage teachers and students to further improve the B.Sc. nursing program.
Innovative Market Oriented Advisory Services for Agro-Enterprise Development in Sri Lanka

K.K.P Perera and S. De Silva

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High transaction costs, inefficient value chains and lack of capacity to meet market demands for quality, quantity and timeliness have put small farmers in a disadvantaged position in the highly unpredictable market environment in Sri Lanka. Hence, strengthening the small scale agro-enterprises through market oriented advisory services become inevitable. The objective of this paper is, therefore, to determine how advisory services can be changed so that they contribute to the improvement of the market orientation (product, price, place and promotion) of small producers. Five cases of private organizations and/or public-private partnerships, already practicing innovative market oriented advisory services (MOAS) were selected and both quantitative and qualitative data were collected by using a pre-tested interview schedule, key informant discussions and observations to achieve the research objective. Innovative MOAS activities and performance of agro–enterprises were analysed.

The results revealed that in the conventional agricultural extension system, many producers attempt to produce higher volumes at lower costs (cost leadership) in contrast to MOAS where producers attempt to gain competitive advantage through product differentiation (organic and natural products, premium quality, value addition etc.) and niche marketing at local and international markets. Combination of scientific knowledge obtained through better advisory service with traditional indigenous knowledge help the farmers in the MOAS system to focus on both production (crop selection, planning, and cultural practices) and marketing (post-harvest handling, quality standards, packing, transportation, hygiene, etc) aspects of their enterprise. Better linkages and coordination of business activities such as production, marketing, distribution and finance, as well as continuous research and development in respective areas help the actors in the value chain to increase their profits. The weaknesses of the traditional farmer organizations have been addressed in the new system through forming empowered, networked and profit-oriented farmer groups. Innovative and differentiated products with high quality standards; additional benefits or services that justify higher prices; focus on high-end supermarkets, final processors, and export markets; and promotion through branding and value addition in various advertising media help the farmers to gain profitability, sustainability and equity.

In conclusion, MOAS can provide better solutions to all the actors in the agricultural value chain. Capacity building of the producers and making them more market-oriented would provide more competitive advantages to the small farmers. Collaboration of private and public partners would facilitate this process.
Trend of Blended Learning in University Education: A Study in the Faculty of Engineering, University of Peradeniya

S.H.I.P. Ratnapala
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Blended Learning is learning which is facilitated by several teaching modes and techniques in an effective way. This paper presents survey results related to the evaluation of the present status and the future trend of blended learning in the Faculty of Engineering. This survey was conducted on 856 students who actively accessed the Faculty of Engineering e-Learning System (FEeLS) during the period January 2011 to June 2011. The survey response rate was 30%. Several environmental constraints caused the low response rate. The sample (142) was selected using a stratified random sampling method. The three batches of E09, E08 and E07 were considered as strata.

The survey result shows 73% of the respondents prefer to continue their studies with the combination of a live, active, efficient, up-to-date and easily accessible e-learning environment plus traditional classroom teaching. Only 2% rejected online learning while the others were more biased towards online-based learning. More than 60% of the respondents prefer to use online forum discussions, online feedback forms, online assignment submissions, online content repositories, Wikis, digital libraries and online notice boards. However, nearly 60% of them prefer to have their exams in the traditional way rather than by online quizzes. Further, more than 75% students believe it is easy to contact lecturers or instructors through online forums or messages. 98% of the respondents indicated that learning with combined modes will enhance their learning satisfaction.

The most preferred existing feature of the FEeLS is online notes. This feature obtained the highest rank among the features available in the system such as Forums, References, Quizzes, etc. There are nine learning techniques, namely; Digital Libraries and Content Repositories (A), Online Simulations (B), Web-casting and Video Streaming (C), Cell Phones and Other Mobiles (D), Wireless Technologies (E), Pod Casting and iPods (F), Weblogs and Online Diaries (G), Wikis (H), Language Training and Support Tools (I). These were used to evaluate trends of blended learning. The students’ votes for the above techniques are depicted in Figure 1.

![Figure 1. Students’ votes for given learning techniques](https://example.com/figure1.png)

The results of this survey show that the students’ prefer to learn in a blended learning environment. They prefer to learn through the latest web technology. Thus, there is a need of extending this study to evaluate and understand the importance of the blended learning process and its capability of enhancing the quality and efficacy of the university education system. It will definitely help to introduce a competitive, remarkable, efficient university education system for Sri Lanka.
Effect of Instructional Method on Physics Concept Achievement at Grade Six

N.G.P. Samarasekara¹ and P.R.K.A. Vitharana²

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Concepts of Physics, Chemistry and Biology are included in the curriculum of grades six to eleven. It is assumed that the Physics-based concepts are relatively difficult to be understood. Therefore, this study was conducted to investigate the effect of instructional methods on the achievement level of Physics-based concepts of Force, Energy and Work. Two common instructional methods, 5E and Traditional, and a method combining these two which is practically used by teachers were used. The combined method is a teacher-adapted method from the 5E model in which the exploration in 5E is done by the teacher, leaving the rest of the steps as they are. In addition, a summary note of the content is also given by the teacher for future reference. The study was conducted using 78 female students in grade 6. They were randomly divided into three classes and one experienced teacher for each instructional method was employed for the classroom teaching process of the selected Physics unit. Two specially formulated tests; namely ‘Force, Energy and Work Concept Achievement Test’ (FEWCAT) comprising questions with equal weights; were administered as the pre-test for assessing their prior knowledge and as the post-test for assessing the achievement level. The reliability of test items had a Cronbach \( \alpha \) estimate of above 0.7. Classroom observations were also conducted to further investigate the teaching-learning process. The quantitative data were statistically analysed using the Analysis of Covariance test (ANCOVA) and Tukey’s test in which pretest scores were considered as the covariate.

The statistical analyses revealed that the combined method of instruction was better than two other methods in achieving abstract concepts of Physics. Further, the effectiveness of the traditional and the 5E instructional methods are found to be the same. The qualitative data revealed that the students were very active under 5E method but they learn the content limited to their group and had no written materials for refreshing their knowledge. In the traditional method, students were passive but had a very good content note. The combined method provided active learning while receiving a systematic content note at the end of the lesson. This combination was more effective for scientific concept achievement than traditional style instruction or 5E model.
A Path Model for Mathematics Achievement and Sources of Self-Efficacy

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Researchers have constructed a number of models and confirmed that mathematical achievement is a result of inter-relation between a number of complex processes. These researchers have also pointed out that mathematics self-efficacy or students’ belief in their ability to solve mathematical problems lead them to achieve good results and also they become masters in problem solving. Furthermore, Bandura (1986, 1994) points out four major sources of self-efficacy beliefs, namely, mastery experience, vicarious experience, verbal persuasion and physiological state. The specific objectives of this study were to examine the nature of mathematics achievement of G.C.E. (O/L) students, to examine the nature of sources of mathematics self-efficacy, to build a model between mathematics achievement, mastery experience, vicarious experience, verbal persuasion and mathematics anxiety.

This study was carried out by using a systematically selected sample (n=1397) which represented all the variables and adopting a multi-stage sampling method. Also, it was proved that the scales, which obtained data for the research, such as sources of mathematics self-efficacy scale (SMSES) and mathematics achievement test (MACH), have high reliability and validity.

The dependent variables being studied were the four sources of self-efficacy. The independent variable was mathematics achievement. To find the coefficients for those paths a multiple regression analysis was conducted. The specified parameter between expectation and mastery experience was significantly large, even though three other sources of self-efficacy were present. With respect to the predicted direct paths, mathematics achievement was significantly and positively predicted by mastery experience (β = 0.651, t =19.998 ), verbal persuasion (β = 0.107, t = 3.239 ), but the effect of vicarious experiences (β = - 0.110, t = - 4.314 ), mathematics anxiety (β = -0.083, t = - 3.863 ) were significantly and negatively predicted. The predicted accounted for 51% of variance in mathematics achievement. With respect to the predicted direct paths, mastery experience was significantly and positively predicted by vicarious experiences (β = 0.187, t = 9.178), verbal persuasion (β = 0.598, t = 27.227) But, the effect of mathematics anxiety was negatively significant (β = - 0.174, t = -10.24).

The results of the path analysis revealed that mastery experience and verbal persuasion have positive and significant direct impact on mathematics achievement. But, it was proved that vicarious experiences and mathematics anxiety have negative significant direct impact on mathematics achievement. Also vicarious experiences and verbal persuasion have positive and significant indirect impact on mathematics achievement. But, mathematics anxiety has negative and significant indirect impact on mathematics achievement. The findings of the research provided evidence that by giving mastery experience, vicarious experiences and verbal persuasion to students, their mathematics achievement could be improved.
Changes of Student Performances During and After the Ragging Period

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When I was interviewing the students for the special degree program, I noticed that students’ second semester results are better than first semester results. When I asked them reasons for the low results in the first semester they replied that lack of freedom during the first semester due to ragging could be the main reason.

There are a lot of studies which addressed the social and psychological aspects of ragging but there are hardly any studies which examine the consequences of ragging on academic performances of students. Studying the impact of ragging on the academic performance of students is important because when students start their university career with low performances it will affect their future academic success. Therefore, I have attempted to study the impact of ragging on the academic performance of students using non-parametric statistics.

This study was performed using first year Arts Faculty students of the 2009/2010 academic year of the University of Peradeniya. Students’ Grade Point Averages (GPA) for the two semesters and ragging related information were gathered from questionnaires administered to the students. A proportionate sample was taken and sample size was 30. To compare first and second semester students’ performance, I used the Sign test and Wilcoxon Signed-Rank Test. To analyse the association between ragging and student performances, I used a Chi-Square test.

The second semester GPA was significantly higher than the first semester GPA \( (p < 0.0001) \). The \( p \) values \( (p < 0.000) \) for students in Sinhala and Tamil medium streams were similar and it was concluded that second semester GPA is better than the first semester GPA in both mediums. However, results for English medium students were different from the other two mediums. There was no significant difference between first and second semester GPAs in English medium students \( (p = 0.9331) \). Results of the Chi-square test for Sinhala \( (p = 0.030) \) and Tamil medium \( (p = 0.002) \) students indicated that there is an association between ragging and the performance of the Sinhala and Tamil mediums students but there was no such association for English medium students.

In the Arts Faculty undergraduate programme, there are two semesters for one academic year. When new students come to the University, there is a period which is known as a ragging period. This period is not well defined and it may be as long as three months or more. During this period, new students are not allowed to go to the library and most of their time is wasted and they are under various stresses. However, there are some students who are against ragging and the above situation does not affect them. Almost all the Sinhala and Tamil mediums students are subjected to ragging while English medium students are not affected.
A Bibliometric Study on W.H.O. Publications Available in the Peradeniya Medical Library

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The collection of publications by the World Health Organization (WHO) in the Medical Library contains documents since 1950 to date. It provides valuable information and is available to the library free of charge. The collection is very much under-used. A bibliometric study on the collection was carried out with the objective of making the readership and the library staff aware of what is available in the collection, as a means of indirectly improving the usage.

The entire collection of WHO publications in the Medical Library as at end-of-July 2011 was used for the study. A head count on the total publications was obtained, excluding journals. The numbers of items in major subject divisions and in popular subject areas within these divisions were counted separately. Various types of publications (excluding journals) were also counted separately when numbers of those types were large. Contents of the publications in the collection were carefully perused in order to identify any specific topic or aspect of health on which the coverage was dominant. Geographical coverage of the publications also was examined when it was possible. A chronological evaluation of the collection was done by counting publications in each decade from 1950 to 2011.

The total number of publications in the WHO collection was 2791 (excluding journals). Various types of publications within the collection were identified. Disciplines which were covered by the collection substantially, with respect to the total number are: Statistics 1.1%; Social services 1.3%; General Medicine 9.4%; Health care 8.2%; Environmental health 30.5%; Pharmacology 11%; Clinical Medicine 19.7%; Surgery 1.8%; and Gynaecology and Obstetrics 1.5%. Further analyses for specific topics covered by the publications in Clinical Medicine showed that there are 40 publications on AIDS; 22 on Tuberculosis; 18 on Cancer; 19 on Mental health; 14 on Malaria; 15 on Medical education; and 4 publications on Dengue. General topics which were prominent in coverage were: World Tobacco Control; Global Alcohol Control; Public Health; Reproductive Health; Control of Tropical Diseases; Global AIDS Epidemic; Influenza Epidemic; Family Health; Health System Planning and Services; and Drug Information. The study revealed that the content of 70 publications had relevance to global issues; 24 publications were on issues relevant to developing countries; 17 publications were on South East Asian regional matters; and there were four publications specifically on Sri Lanka. The rest of the publications had an international coverage. Distribution of publications according to year of publication showed that 20% of the WHO collection was published after 2000 and around 48% of it is published after 1990 indicating that the content provides information relating to recent times. There were only 20 publications (0.72%) published in 2010/2011.

The study provides an insight into a valuable, though much under-used, collection of health information that has been made available by the World Health Organization. The collection contains information on various health-related topics at international, regional and global levels; in addition, it contains information on developing countries, tropics and South East Asian regional countries. The collection needs to be improved by acquiring current publications.
School-Based Assessment: Facilitation or Inhibition of Effective Science
Teaching

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School-based assessment (SBA) was introduced to the Sri Lankan education system in 1997 along with proposals of education reforms to produce a “total child.” SBA was implemented in the whole island since 1998 with the expectation of developing many skills and attitudes with the knowledge component. Although, SBA helps both the learner as well as the teacher, this anticipated objective was not met, because teachers have used SBA as an alternative way of testing. This study explores how SBA is implemented in Science classrooms.

Two schools from all educational zones were selected to cover all types of schools (except type-3, elementary schools), urban/semi-urban/rural and unisex/mixed schools. The total sample consisted of 175 schools. Data were gathered by administering questionnaires for education officers, principals, sectional heads, teachers, students and parents. They were also interviewed. Science teaching in grades 8, 9 and 10 was observed. Data gathered from questionnaires were analysed quantitatively and observations and interviews were analysed qualitatively.

Responses of the questionnaires revealed that all education officers, principals and teachers believed that SBA facilitates teaching and learning Science. All education officers stated that they monitor the SBA programme in schools frequently. All teachers have stated that they do SBA in their Science classrooms very frequently. Students also mentioned that they were doing assessments frequently. However, observations of doing Science and assessments in classrooms gave a different picture. It was not observed that teachers were doing SBA by following the guidelines given to them and failed to produce their records of assessments. Student portfolios enable a teacher to identify strengths and weaknesses of students and provide positive feedback to students for their development. The most common practice of an assessment was to give a quiz with 2-3 questions.

Teachers did not have a clear idea about the modalities of assessments. According to the teachers they have not received training on how to do SBA. In all the provinces there were in-service sessions for subject teaching and others but not for SBA. Although there was internal and external supervision, interviews with teachers revealed that they have not received feedback to improve their practice of doing SBA. Education officers who come for annual inspection collect SBA records of candidates of G.C.E. ordinary level examination. Students mentioned they do assessments referring to activities that they had to do, but those activities were not assessed. Parents did not have a clear idea about SBA. They were happy to see the term test marks. There was no significant difference in implementing SBA by teachers with different qualifications, years of service, type of school or gender of the school. Although SBA facilitates teaching and learning Science, the way it is implemented at present inhibits the effectiveness of Science teaching.

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Changing Behaviours of Prospective Science Teachers

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Prospective teachers have many beliefs and unique behaviours about teaching and learning Science at the beginning of the pre-service training programme. These beliefs and behaviours may result from their experiences as students in their schooling period. Similarly, prospective teachers’ experiences acquired during the pre-service training period are also influential in developing their perceptions and behaviours about teaching and learning Science. The purpose of this study was to find out the prospective teachers’ perception of Science teaching, and how their behaviours changed over the two-year institutional training period.

The sample consisted of 58 Science English medium prospective teachers, both male and female, who were recruited for the academic year 2010/2012. Ten prospective teachers out of the above number were randomly selected for lesson observation. Data were collected by conducting random informal discussions and administering a questionnaire for the whole group at the beginning, middle and by the end of the programme; and by interviewing and observing teaching of ten prospective teachers during the four blocks of teaching practice.

Data gathered from various sources were analysed by triangulation and grounded theory. At the beginning, prospective teachers were not aware of current learning-teaching techniques, approaches and methodology used in the field of teaching Science. In addition, due to inadequacy of practical experience and laboratory skills prospective teachers failed to use effective classroom techniques to help students construct their own knowledge. The prospective teachers had planned lessons to be done under the student-centred approach, but there were no plans of providing opportunities for the students to build up their knowledge about the concept. Most of the lessons, which were observed, reflect that teachers have to get themselves equipped with the theoretical and methodical aspects related to teaching Science.

In order to change their perceptions and behaviours of teaching Science, reflective and counselling methods, workshops on teaching through constructivism, model lessons and micro-teaching sessions were employed during the first year. The data gathered showed that prospective teachers faced problems about lesson planning, organization, classroom management, assessment and evaluation, giving feedback and feed-forward. A special workshop on designing activities and practical lessons was conducted to show how to use assessment and evaluation followed by informal discussions with individual prospective teachers. As a result, a gradual change in their perceptions and behaviours of teaching Science was observed. Even after six months, there was no significant behavioural change in their understanding and applying the student-centered lessons. At the end of the institutional training programme, majority of them were inclined to implement student-centered lessons and have changed their thoughts gradually toward the profession. It is recommended that the professional development programmes include more student-centred learning activities to develop a community of good Science teachers in our country.
Enhancing Student Learning in Advanced Level Biology through Problem Based Learning

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Most teachers complain that although they teach with their fullest effort, students fail to succeed. Successful learning should provide hands-on and minds-on experiences for the students. Problem Based Learning (PBL) is an effective method to overcome this challenge where learning is driven by the problem. The main objective of this study was to develop the problem solving ability of students to face real life problems through the classroom activities. The achievement of students in the unit - Nutrition in G.C.E. Advanced Level Biology syllabus was very poor. Hence, PBL was used to improve achievement.

Six parallel Biology classes from three schools in Kandy and Matale districts were selected and categorised as PBL and non-PBL. A diagnostic test was conducted to identify misconceptions. Multifaceted problems were crafted to relinquish these misconceptions in the whole unit. Teachers of PBL classes (3) were trained and guided to teach using PBL and the other teachers (3) were allowed to use their own method of teaching. Students of the PBL group were involved in a variety of activities using all sources of information. Both types of classes were observed and field notes were made. Interviews with teachers and students were conducted and photographs, videos, samples of student creations were also collected to gather more information. By triangulating data three assertions were formulated.

Students in PBL groups constructed their own knowledge by involving in various types of problem-solving activities by searching for information and engaging in different activities. Although they were dependent on their teachers at the beginning, they succeeded to direct themselves for self-learning. Contributions of each member in the groups were enormous in solving the problems. They were able to think beyond ‘bookish’ knowledge and developed critical thinking ability. They explicitly assessed the meaning and significance of information given to them. They were able to examine the problems with different points of view and used innovative steps to solve problems at some instances drawing out their inborn talents. Every student had an opportunity to exhibit their maximum capacities in this method of learning. Very good presenters were identified. Some unheard voices were brought-up in the class. Some students were able to deliver speeches similar to professionals. Some were well aware of their surroundings and environment. Leadership qualities and team spirit were also identified and developed among them. But in non-PBL classes students learned passively without having opportunities to engage themselves in doing Science and frustration among the students were also noticed. Successful guidance through PBL assisted the students to reach maximum in learning biology. Perfectly crafted problems and careful preparations were essential for the successful implementation of PBL. If teachers can be trained well for PBL approach, students will not only enjoy learning Science, but also develop a meaningful understanding of Science.
Difficulties in Teaching and Learning Chemical Equilibrium at G.C.E. Advanced Level

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A review of examination reports reveals that students have difficulties in solving problems about chemical equilibrium. Hence, the purpose of this study was to find out the difficulties in teaching and learning the sub-unit, “Chemical equilibrium” in advanced level Chemistry classes.

Seven hundred and seventy six students from the 2\textsuperscript{nd} year of G.C.E. advanced level classes (ages ranging from 18-19) were selected from thirty four 1AB urban schools (Schools with science advanced level classes) in the Central Province. At the end of the sub-unit, a concept-achievement test was administered to identify misconceptions and their possible sources. The test consisted of 20 open-ended items. Responses were marked and coded into four categories: no response, misunderstanding, partial understanding and sound understanding. In the second step, semi-structured interviews were carried out with sixty students according to their written responses, which reflected different perspectives. These interviews were conducted to obtain a more extensive source of data on their underlying beliefs, which affected learning. In order to understand teachers’ problems in teaching “chemical equilibrium”, 35 Chemistry teachers were interviewed. In addition, ten classrooms were observed to find out what was really happening during the process of teaching and learning. Data collected from multiple methods were analysed qualitatively and quantitatively.

Analysis of written responses showed that the students faced difficulty in understanding the concepts of chemical equilibrium. The results showed that many students exhibited misconceptions in all the content areas in chemical equilibrium. Many had misconceptions in areas such as changing equilibrium conditions, using Le Chatelier’s principle and rate vs extent. According to student responses, misconceptions emerged through student use of rote-learning, recall, algorithmic procedures, incorrect control of the variables involved, limited use of the chemical equilibrium law, a lack of mastery of chemical equilibrium principles and difficulty in transferring such principles to new situations. Analysis of classroom observations and interviews revealed that the way teachers taught was the main cause for these difficulties. Ninety percent used only lecture method and presented facts. Instruction was based on emphasizing correct concepts without highlighting common conceptual errors using students’ prior knowledge. The words used by the teachers in introducing and explaining the concepts of chemical equilibrium from everyday language also led to very different meanings. Students had no opportunity to think during learning, or to express or discuss their ideas with others. Assessments were based on recalling facts and not on applications or higher-order thinking. In order to bring meaningful understanding of these concepts in students, Chemistry teachers need to identify students’ difficulties in learning and the source of their misconceptions. Then their teaching could be improved to help in student learning. Hence, the teachers should use alternative approaches in teaching Chemistry and assessing student learning where students can express and discuss their ideas and clarify their doubts and misunderstandings.
Factors Affecting Decision Making and Achievements in Educational Pursuits of Students in Selecting Careers

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The success of educational endeavours of students is determined by many factors. Proper decision-making and social factors are very important for students to successfully complete education and achieve career goals. In Sri Lanka, education is very competitive and only students with higher intellectual capacity and ability to make right decisions are successful. The parents and family, teachers, peers and other important social groups such as clergy, celebrities and social organizations are also contributors to their success. Selection of suitable subjects in G.C.E. Advanced Level (A/L) is very important for acquiring better careers in the future. Upon successful completion of the A/L examination, only a handful of students obtain the chance to enter National Universities, where they could specialize for a certain profession or obtain a special or a general degree. After graduation, they go into professional careers depending on the available opportunities, overall qualifications and career interests.

Limited studies have been carried out to ascertain factors affecting educational pursuits of Sri Lankan students at critical points such as selection of A/L stream, selection of specialization stream in the University and achievement of professional careers. Therefore, the present study was conducted to assess the factors affecting the decision-making and achievements in educational pursuits of students in their advanced level and post-school careers by collecting information from A/L students, current university students and professionals. The survey was conducted in the Central Province, Sri Lanka from April to June 2011 by conducting a questionnaire guided interviews.

Seventy five percent of the professionals and current university students had at least one parent in a government job, which shows that there is a higher chance of success for the children of government servants. This implies that children of government servants had better guidance in education than children whose parents were not government servants. Sixty percent of the respondents had made their own decisions in selecting their A/L stream and the others had followed decisions made by their parents/family. The ability to make decisions is increased in university and postgraduate students indicating a lesser influence by parents/family. Eighty percent of school students preferred to be a socially high ranked professional. Primary people behind the career path and success of respondents were parents and teachers. Significant associations between preferred career and grades obtained for O/L Mathematics and between subject selection in A/L and grades for Mathematics and Science were observed (P=0.05). Thus, Mathematics and Science education is crucial in deciding the future careers of students, and must be strengthened at school-level. Thirty three percent of the respondents in all three categories had been motivated by successful role models in planning their life. Respondents were of the opinion that improving English language proficiency and career guidance programmes at A/L stage would be useful.

Decision-making and achievements of the students are decided primarily by self interests and social factors such as parents/family and teachers. Students mainly receive motivation through social groups such as peers. Therefore, parents/family, teachers and other important social groups must play a crucial role in supporting students to pursue education successfully.
Attitudes of Past Students towards the Complexity of Advanced Level Biology Curriculum

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The first detailed exposure in Biology for Sri Lankan students is through the Biology subject in the General Certificate of Education Advanced Level (A/L) curriculum. However, only a limited number of students are successful in getting selected to national universities through the highly competitive A/L examination. Students work hard to excel in this examination, which is an enormous stress for students. It is argued that increased stress and resulting problems are due to the complexity of the A/L Biology curriculum and that the content should be simplified. However, society has mixed feelings about simplifying the A/L Biology curriculum. Some believe simplification would alleviate the burden and stress on students while others think simplification would not allow students to develop the required competence in Biology and would make them unprepared for higher education and jobs, and not enable them to understand contemporary biological issues and biological problems in daily life. These diverse opinions on the current debate on simplification of A/L Biology curriculum has not been studied adequately. Therefore, the present study was conducted to assess the attitudes of past-students of A/L Biology, who sat for the A/L examination after the year 2000, towards the complexity of the A/L Biology curriculum. A survey was conducted by using-questionnaire guided interviews with 100 past A/L Biology students; current university students in Biology related fields, professionals with degrees and professionals without degrees.

The subject depth was considered adequate by majority of the respondents (80% or more) in all three categories. The extent of topics covered was also considered adequate by 75% of current university students, 63% of professionals with a degree and 67% of professionals without a degree. Around 70% of respondents in all three categories believed the complexity was at an optimum level. Thus, the general opinion of respondents was that they preferred the existing complexity of A/L Biology curriculum. More than 60% of the respondents were of the opinion that students face financial difficulties during their A/L studies. Ninety two percent of current university students felt stressed during A/L studies while only 47% of professionals with a degree and 55% of professionals without a degree felt stressed. More than 50% in each category enjoyed A/L Biology studies and around 40% had mixed feelings. Ninety percent of respondents in all three categories believed A/L Biology is helpful in their present careers and in daily life. Sixty percent of the respondents believed that there are job opportunities for people who have done A/L Biology. Ninety seven percent of professionals with a degree and all current university students were of the opinion that A/L Biology is very important for university education. Ninety nine percent of the past students used private tuition classes for A/L Biology studies and believed that extra support is essential to complete the syllabus and detailed learning. They were sarcastic about the role of government schools and teachers and suggested that the current system of teaching at schools should be improved.

Majority of the respondents believed that it is not necessary to change the depth, extent and current level of complexity of the A/L Biology curriculum but it is important to include more applied aspects of Biology and practical sessions.
ENGINEERING
GIS Model for Flood Risk Mapping
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Flood risk mapping is an important measure in mitigating impacts due to floods. A flood risk map over an area will enable inhabitants to take precautionary actions that will mitigate negative impacts due to floods. Among many methods used in the development of flood risk maps, use of GIS technology has received a wide interest due to its versatile capabilities. This paper presents the use of a GIS technology based model for the preparation of a flood risk map at Grama Niladari Division (GND) level for Nilwala river basin in Southern Sri Lanka.

Flood risk mainly depends on flood hazard and vulnerability. Inundation area and inundation depth are two criteria that determine flood hazard while factors such as population density, building types, road network, etc., determine vulnerability. Though GIS technology provides facilities to calculate flood risk at GND level, the process could be very tedious and time consuming, especially if the process is to be repeated. The model builder, which is a part of ArcGIS geo-processing framework can be used to automate GIS processes by linking data input, ArcGIS tools/functions, and data output and makes the task easier. A GIS model was built for mapping flood risk of the Nilwala river basin at different flood frequencies. GND based flood risk maps for two different floods frequencies are presented in Figure 1.

![Figure 1. GND based flood risk maps for 100 year and 10 year floods](image)

(a) 100 year flood  (b) 10 year flood

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Elastic Moduli Variation near the End-Capped Region of a Zigzag Type Single Walled Carbon Nanotube

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One end-capped zigzag type single walled carbon nanotubes (SWCNTs), which are considered in this study, have end-caps which are half C\(_{60}\) fullerenes (half buckyballs). In the \((9, 0)\) zigzag type SWCNT considered in this study, one end is capped and the other end is kept open. The variation of the anisotropic elastic moduli near the end-capped region of \((9, 0)\) zigzag type SWCNTs is reported in this paper.

The length of the nanotube section is considered to be much larger than the diameters of both buckyball and nanotube. The tube-to-ball transition region is taken to be one hexagonal unit cell length of the nanotube.

For an equilibrating loading system applied to the nanostructure, the bond forces are calculated and these bond forces are used to obtain the elastic moduli at the end-capped region. The anisotropic elastic moduli of different regions, obtained from this study are reported below.

**Table 1.** Anisotropic elastic moduli of different regions near the end-capped region of a \((9, 0)\) zigzag carbon nanotube (CNT)

<table>
<thead>
<tr>
<th>Region</th>
<th>Elastic Modulus/TPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tube axis-direction</td>
</tr>
<tr>
<td>((9,0)) zigzag carbon nanotube</td>
<td>1.411</td>
</tr>
<tr>
<td>Middle of tube-to-ball Transition</td>
<td>1.405</td>
</tr>
<tr>
<td>Half of C(_{60}) fullerene end-cap</td>
<td>0.870</td>
</tr>
</tbody>
</table>

It is important to know the elastic properties and the load transfer mechanisms near the end-capped regions of CNTs when such nanostructures are to be used in composites as reinforcing elements and also in medicine as drug delivery agents.
Chirality Dependence of Elastic Properties of Supercarbon Nanotubes

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Carbon nanomaterials are studied extensively among many nanoscale materials investigated during the last decade. Carbon nanotubes (CNT's) are linear fullerenes which can have aspect ratios as large as $10^3$ to $10^5$. After the discovery of Y branching of CNT’s, attention now is on the hierarchical structures (Supercarbon structures) which can be made of Single Walled Carbon Nanotubes (SWCNT’s). When SWCNT’s are arranged to form a higher order structure, it is called a supercarbon nanostructure. The present study focuses on the versatile elastic properties of Supercarbon nanotubes (SCNT’s) which can be mastered by changing various parameters such as geometry and chirality of constituent SWCNT’s and the chiral index of the SCNT. A simple mechanics model is used to estimate the stiffness of these supercarbon nanotubes and the results agree well with previous studies on these structures using molecular dynamics modelling. It was found that in super carbon nanotubes with Y junctions, the length of the constituent SWCNT and its chirality, influence the elastic modulus, stiffness and its ultimate tensile strength. Further the study shows that the higher the length of SWCNT the lesser the elastic modulus. It was also seen that for a given length, $L_0$, and diameter, $d$, of SWCNT, the elastic modulus of the super nanotube turns out to be the same for both armchair and zigzag SWCNTs.

By manipulating atoms to form different structures, it is possible to obtain different geometries of nano-structured materials. These new materials can be mastered to have desired material properties in any range. Therefore, these can be used to make bullet-proof clothes and vehicles, high-strength composite materials, nano electromechanical devices (NEMS) etc. At the same time, these low density, flexible materials can be used in light weight composite structures.
Low Cost Approaches to Reduce Speeding: Effectiveness of Optical Speed Bars

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Fatal crashes are more frequent in rural areas of the United States, even though the number of vehicle miles travelled and the total number of crashes remain low in such areas. Meanwhile, speeding is a major concern in small towns in rural areas, where high-speed highways pass right through. The situation requires considerable speed reductions and drivers seem to have a difficult time controlling their speeds at the reduced levels. Due to limited resources available and the difficulties in maintaining high levels of enforcement in such areas, it is necessary to identify low cost and effective countermeasures to properly manage speeding.

Accordingly, this study evaluated the effectiveness of optical speed bars in reducing speeds on five different approaches to small towns in Kansas in the United States. Each approach had one lane and speed drop was either from 65 mph to 45 mph (4 sites) or from 55 mph to 30 mph (1 site). Speed data were collected at the test sites before and after painting the transverse optical speed bars, using automatic traffic data recorders. The speed data were analysed for all vehicles, and also based on vehicle classification, time of day, and day of week. Before-after speed data were compared for statistically significant differences, using F- and t-tests. The analyses considered both the treatment direction where the optical speed bars were available and opposite direction, which was considered as the control direction. The results of the study showed significant reductions in speeds and speed variation at the end of the optical speed bar treatment at four of the five sites, with one site showing no statistically significant changes in speeds. Analysis of speeds in the opposite or control direction indicated reductions in speeds at some locations. Daytime speeds and speeds of two axle vehicles decreased the most at almost all test sites. However speeds analysed downstream of the treatments indicated that speed reductions were not maintained for a long distance.

This type of low cost countermeasures might have practical applications in developing countries like Sri Lanka. Once tested and evaluated, these simple pavement markings might help slow down Sri Lankan drivers under low traffic volume conditions.
Comparison of Characteristics and Contributory Factors for Fatal Truck and Non-Truck Crashes using Bayesian Statistical Analysis

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One-ninth of all traffic fatalities in the United States have involved large trucks in the past five years, although large trucks contributed to only 3% of registered vehicles and 7% of vehicle miles travelled. This contrasting proportion indicates that truck crashes in general tend to be more severe than other crashes, though they constitute a smaller sector of vehicles on the road. To study this issue, fatal crash data procured from the Fatality Analysis Reporting System (FARS) was used to analyse characteristics and factors contributing to truck-involved crashes. Driver, vehicle, and crash-related contributory factors were identified, and as an extension, the likelihood of occurrence of these factors in truck-involved crashes with respect to non-truck crashes was evaluated using a Bayesian statistical approach.

Likelihood ratios were calculated separately for crash-related factors, vehicle-related factors, and driver-related factors. Among the vehicle-related factors; being an emergency or utility vehicle, having a defective brake system, and other vehicular defects seem to have contributed to higher fatalities in truck crashes. Crash-related factors such as having a recent crash nearby, being struck by falling cargo, being in a construction/maintenance zone, inadequate warning signs etc. have greater probability of occurrence in fatal truck crashes than in non-truck crashes. Driver-related factors such as following improperly, starting or backing improperly, overloading or improper loading of the vehicle, making improper entry or exits, erratic lane changes, cellular phone usage, failure to yield right of way, inattentiveness, and failure to obey traffic rules also have a greater probability in fatal truck crashes. Inadequate warning signs and poor shoulder conditions were also found to have greater predominance in contributing to truck crashes than non-truck crashes.

Several other factors have been observed for a better understanding of characteristics and contributory factors for fatal truck crashes. By addressing these factors through the implementation of appropriate remedial measures, the overall truck crash rate can be reduced, which can help in improving overall safety of the transportation system.

Sri Lanka also seem to have a considerable number of fatalities involving larger vehicles such as trucks, buses, and other heavy vehicles and a similar methodology could be used in studying the factors contributing to such cases.
Optimality Considerations in Using Slender Cross Section for Steel Columns under Pure Compression

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Design for steel compression members can be made by either allowing or restricting the possible occurrence of the local buckling of component plates. Generally it is common practice to restrict the local buckling by specifying the maximum width-thickness ratios for component plates to keep the design process simple. Most hot rolled sectioned used in design of structures fall in to this category. However when built-up sections are used the designer may permit the local buckling by specifying the higher width-thickness ratio (b/t). In British Standard Structural use of steel work in building (BS 5950-1., 2000) specifications, widely used for design of steel buildings in Sri Lanka, classifies the steel cross sections as Class 1 plastic, Class 2 compact, Class 3 semi-compact and Class 4 slender. Only in Class 4 slender sections the load carrying capacity of the section is reduced due to local buckling.

An efficient design may be obtained by allowing the possible local buckling of component plates and thus enlarging the freedom for the determination of cross-sectional shapes with arbitrary selections of width-thickness ratio. The objective of this paper is to see that permitting the local buckling of component plates gives an efficient design for columns.

The design method of BS 5950-1., 2000 was initially compared with the limited experimental data from Usami T. et al. (1982), which includes the experiments of the built-up box shaped columns of the HT 80 steel grade.

Optimizations for steel compression members were performed, focusing mainly on whether allowing the local buckling of component plates will bring benefits for efficient design or not. Ultimate strengths were found for cross sections by varying width-thickness ratio (b/t) while having the same gross sectional area and member length to ensure constant weight of material for that particular member and plotted. This was repeated for different L^2/A ratios, where L is member length and A is gross sectional area. This study was limited to welded box sections under pure compression.

Comparison of design method with the test data available indicates that the design method has sufficient accuracy for the ultimate strength of the column. The optimization study indicates that there exists a range where allowing local buckling produce economical benefits for ultimate strength.
Retrospective Analysis of Victoria Dam

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Built across the river Mahaweli at Theldeniya during 1980-84, Victoria is a doubly-curved arch dam of 122 m height that impounds a reservoir of 722 million cubic meters capacity. It is the largest concrete dam in Sri Lanka. Equipped with three 70 MW generators for a total installed capacity of 210 MW, Victoria provides about 780 GWh of energy annually to the national grid. From the energy point of view alone, Victoria dam assumes great importance to the country’s economy.

During construction the dam was provided with extensive instrumentation to continuously monitor its behaviour. Among these instruments are, normal and inverted pendula, crest leveling studs, and survey targets on the downstream face. Over the past 27 years, they have yielded a great volume of data regarding the deformations of the dam, among other things. Such data can be used in two ways. First is that they can be compared with the expected behaviour to verify compliance with design assumptions, and in the case of any deviations, to understand the reasons for such deviations. Second is that they can be used to develop models to predict the future behaviour of the dam which will assist engineers in making operation, maintenance, and repair decisions. In fact these can be two phases of a single process. The present study attempts the first task: comparing observed deformations with those expected. A linear elastic, 3-d finite element analysis was performed to estimate the expected deformations. In view of the approximate symmetry, only one half of the dam was modeled. Even though there are some galleries inside the dam (the cross sectional area of which is about 2.35 % of that of the dam) and a set of openings for spillway gates near the top of the dam, they have been neglected in the model. Fixed boundary conditions are employed at the base and the abutments of the dam.

Comparison of deflections on the dam cross section at the centre line (Fig.1) shows reasonable agreement with respect to the deflection pattern between the finite element analysis and data obtained by means of the pendula soon after impounding. This indicates the validity of the adopted approach. However, it is noted that the finite elements consistently underestimate the observed values. This may be due to (a) possible variations in the Young’s modulus (b) non-inclusion of the dam galleries and the spillway gate openings in the finite element model, and (c) the assumption of fixed boundary conditions. It is believed that the rectification of these shortcomings could improve the co-relation between finite element estimates and actual observations.

Fig. 1

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Forecasting Extreme Rainfall in Kelani River Basin under Changing Climate

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Extreme precipitation events are becoming more frequent all over the world including tropical countries like Sri Lanka and are attributed to climate change. Frequent heavy precipitation brings frequent floods which severely affects lives, properties and the economic development of the country. The Kelani river catchment is one of the most vulnerable river basins for floods in Sri Lanka and the flood damages caused are high as the river flows through the commercial capital of the country. Therefore, it is a timely requirement to understand the occurrence of future extreme events to prepare for flood mitigation and necessary adaptive measures.

In this study, a Statistical Downscaling Model (SDSM) was utilized to downscale past and future General Circulation Model's (GCM) data available at a coarse resolution to the Kelani catchment. In this analysis the Kelani catchment was considered as two sub-catchments. Rainfall in the upper catchment was estimated by using seven rainfall gauging stations and the rainfall at the Colombo gauging station was used as the rainfall at the lower catchment. The observed data along with reanalysis data from National Centers for Environmental Predictions (NCEP) for the period from 1961 to 1975 and from 1976 to 1990 was used for calibration and validation of the model respectively for both upper and lower catchments. The GCM data from the Hadley Centre experiments under A2 (high emission scenario) and B2 (low emission scenario) scenarios published by Intergovernmental Panel on Climate Change (IPCC) was employed to forecast daily rainfall up to year 2099. An uncertainty analysis was carried out in order to have the assurance on the downscaled GCM outputs.

The forecasted rainfall was analysed for extreme value distributions for past, near future and far future according to Gumbel and Generalized Extreme Value (GEV) distributions, in order to compare the rainfall variation during these three periods and have estimates about the future condition of the Kelani river basin. Forecast of annual rainfall and annual maximum rainfall in both upper and lower catchments show an escalating trend of rainfall in future. This is an indication of increase in future rainfall extremes and highlights the necessity to prepare for adaptive measures.
Long Term Weather Forecasting for Planning Yala Season Paddy Cultivation in Kurunegala District

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Understanding future weather patterns is useful for planning paddy cultivation. The air temperature, as one of the governing forces for the growth of rice plants, would be a crucial factor since it is already reaching the threshold condition. In addition, the erratic patterns of rainfall increase the uncertainty over the water availability for paddy cultivation. Kurunegala district in the Northwestern Province which is one of the major paddy cultivating districts using 25 major irrigation schemes with over thousand small village tanks and diversions based storage irrigation systems was selected for the present study.

In this study, a Statistical Downscaling Model (SDSM 4.2) was used to downscale the General Circulation Models (GCMs) data for forecasting daily rainfall, daily maximum and minimum temperatures. Forty years of observed daily weather data from 1961 to 2000 were collected from the Department of Meteorology, Colombo and used for calibration and verification of SDSM with National Centre of Environmental Prediction (NCEP) reanalysis data. GCM data from the Hadley Centre experiments for the A2 (medium–high emissions) and B2 (medium–low emissions) scenarios projected by the Intergovernmental Panel on Climate Change (IPCC) were used for scenario generations of daily rainfall and daily maximum and minimum temperatures in the district up to year 2099.

The forecasted daily maximum temperature shows increasing trends of 0.049 °C and 0.031 °C per year under A2 and B2 scenarios respectively. The forecasted daily minimum temperature also shows increasing trends under both A2 and B2 scenarios while the rate of increasing is less than that of daily maximum temperature. The future rainfall in Kurunegala district shows an erratic pattern with a slightly increasing trend under the A2 scenario and a constant pattern under the B2 scenario. The cropping calendar could be prepared according to the predicted future weather conditions in order to minimise the risks of damages and losses that can occur due to the adverse impacts of climate change.
Lateral Deformation Characteristics of Coir Geomat Reinforced Vertical Embankments

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For the design of internally stabilised reinforced earth walls, lateral deformation is not considered as a design criterion and therefore, the designer would not know the performance of the wall with regard to its aesthetic appearance during its service life. Therefore, it is imperative that the designer limits the lateral deformation of reinforced earth walls under service loads. In addition to durability considerations, suitability of application of coir geomats as the reinforcing material in a vertical embankment requires an investigation of its lateral deformation characteristics as well. In this study, the lateral deformation characteristics of a model vertical embankment reinforced with coir geomats are compared with the lateral deformation characteristics of the same model embankment reinforced with non-woven type polymer geotextiles. For this purpose, a vertical embankment of height 500 mm and length 700 mm was formed by using either coir geomats or geotextiles of length 605 mm at a vertical spacing of 100 mm as reinforcement in a soil having shear strength parameters of $c'=5$ kPa and $\phi'=31^\circ$ compacted to 95% of standard Proctor density. The embankment was initially loaded at its natural moisture content up to a maximum surcharge pressure of 115 kPa through a rigid steel plate and was unloaded. It was then reloaded up to a maximum surcharge pressure of 244 kPa and was unloaded. The embankment was then soaked over a period of 48 hours ensuring no erosion of the soil took place during the process and again the embankment was loaded up to a maximum surcharge pressure of 244 kPa. During the above loading and unloading processes the lateral deformation along the central vertical axis was measured at the mid-height of each soil layer. The results show that the lateral deformation exhibited by the coir geomat reinforced embankment is comparatively less than that exhibited by the geotextile reinforced embankment corresponding to the same fraction of the design surcharge pressure applied, under the natural and soaked moisture conditions.

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Simulation Based Analysis of 16-QAM Constellations with Five Circular Shells in Long Haul Optical Links

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Nonlinear phase noise in optical fibers depends on the transmission power and has significant impact on the performance of long-haul transmission links. Many studies have been performed on sixteen quadrature amplitude modulation (16-QAM) constellations to overcome the effects of nonlinear phase noise. This work proposes three new constellations and analyses five different representations of 16-QAM. These representations use five circular shells with different placement of 16 symbols. The constellation diagrams consist of four circular shells with equally phased three symbols and a shell with equally phased four symbols. The shell with four symbols is different for each constellation diagrams.

The simulations were carried out using MATLAB software. A random bit stream was generated and by using the random bits 16-QAM symbols were formed by combining four bits. The symbols were modulated according to the constellations and a model nonlinear optical channel was used to transmit the bit over long distances. The nonlinear optical channel was approximated to a Gaussian distribution with a non-zero mean. Received patterns were rotated by mean nonlinear phase noise and recovered by using maximum likelihood detection techniques. The performances were compared in terms of bit error rate with different transmission powers at 3000 km and with different transmission distances at -2 dBm launch power.

The simulated results with different transmission powers show that the constellation diagrams with four symbol shell in the inner circle (4-3-3-3-3) and the outer circle (3-3-3-3-4) provide considerably high bit error rate compared to the other three constellation diagrams. However, the constellation diagram with four symbols in the outer shell (3-3-3-3-4) provides the performance of four symbols in the inner shell (4-3-3-3-3) with 4 dB reduction of power. Meanwhile, the constellation diagram with four symbols in the middle shell (3-3-4-3-3) provides the best performance for 3000 km link with the transmission power of -2 dBm. The constellation diagrams with four symbols in the second shell (3-4-3-3-3) and fourth shell (3-3-3-4-3) provide slightly increased bit error rates than four symbols in the middle (3-3-4-3-3). The simulation results with different transmission distances shows that the constellation with four symbols in the third shell (3-3-4-3-3) provides the best results over the analysed distances. The constellations with four symbols in the second shell (3-4-3-3-3) and fourth shell (3-3-3-4-3) provides slightly higher bit error rates and the constellation diagrams with four symbols in the inner shell (4-3-3-3-3)and outer shell (3-3-3-3-4) provides high bit error rates comparatively.

The simulated results suggest that the five shell circular constellation with four symbols in the middle shell (3-3-4-3-3) is the best option for a long-haul optical communication link within these five shell circular constellation diagrams. Meanwhile, constellation diagrams with four symbols in the second shell (3-4-3-3-3) and fourth shell (3-3-3-4-3) give slightly lower performances compared to the one with four symbols in the middle (3-3-4-3-3) and can be used according to the circumstances.
Efficient Redundant Picture Coding for Enhancement Layers of the Scalable Extension of H.264/AVC

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With the growth in the range of multimedia services being used for everyday activities such as teleconferencing, mobile television and peer-to-peer video sharing, the reception of video with high quality is of prime importance to users, as well as to service providers. However, providing video communication over wireless or wired networks creates many challenges due to fluctuations in the channel characteristics. In internet packet network scenarios the whole packet can be lost during the transmission due to congestion, faulty network connections and signal degradation. These errors create artefacts in the reconstructed video frames that propagate in both spatial and temporal domains due to the hierarchical prediction scheme employed in video compression stages. Hence, error resilience for video transmission has become a crucial area for research in the field of multimedia communication in the last decade. The methods used for this purpose vary from retransmission on request, embedding extra information in to the coded stream, to concealing the errors with already available data. However, the utilisation of error resilient tools in transmission networks is restricted by the channel bandwidth. Therefore, it is essential to maintain a flexible balance between the error resilient tools and the quality of the reconstructed video sequence. The overall objective of the research presented is to find a flexible error resilient mechanism which incorporates the redundant information transmission to recover from packet errors.

The proposed error resilience algorithm incorporates motion information generated by motion compensated prediction (MCP) to improve the robustness of the transmitted data. The MCP exploits the correlation between successive frames and identifies the movement of the objects within the current frame compared to the previous frame. This movement is described using motion information and can be used to predict an approximation for the current frame using the previous frame. Hence, the motion information of the video data plays a vital role in frame reconstruction. Therefore, the technique proposed in this research highlights the effect of providing extra protection for the motion information. The proposed system is implemented based on the existing redundant coding algorithm of the scalable extension of H.264/AVC and it encodes redundant data only for the motion information. The encoded scalable data stream consists of two layers: base layer with QCIF resolution and enhancement layer with CIF resolution. The paper analyses the effect of the proposed error resilience technique, redundant motion information coding, on enhancement layer picture quality. The performance of the algorithm is evaluated using objective quality measurements under both error free and error prone Internet Protocol (IP) packet network environments. The proposed algorithm increases bandwidth utilisation with slight degradation in the primary picture quality for error-free conditions, compared to the existing redundant coding method of H.264/AVC standard. Furthermore, the simulation results under packet loss environments show that the proposed algorithm outperforms the existing redundant picture coding technique of H.264/AVC standard.
Error Correction Technique for H.264 Compatible Video Stream Based on Turbo Codes

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When an encoded video bit stream is transmitted through an error prone environment, it is subjected to loss of packets. When a packet loss occurs, it will usually drop the whole frame. As a result, the video appears distorted and produce unacceptable video quality, making error control techniques highly desirable.

This paper presents an efficient error correction algorithm to further improve the reconstructed video quality during transmission over error-prone channels. There are many ways to accomplish forward error concealment. Essentially, they all add a controlled amount of redundancy at either the source encoder or the transport encoder. In the proposed method, H.264/AVC codec version Joint Model (JM) 17.0 is integrated with turbo coding which is a powerful forward error correction technique to improve the quality of a video.

Video transmission can be divided into three sectors; Transmission end, Channel and Receiving end. At the transmitter, a JM encoder compresses the input video signal and generates an information bit stream. At the same time, a turbo encoder generates a one parity bit sequence using information bit stream and another parity bit sequence using interleaved information sequence and transmits both parity streams with the information bit stream. Due to impairments of the transmission media, received information bit stream is distorted and different from the data that was transmitted. In the receiver, JM decoder detects this received information bit stream and turbo decoder detects two parity bit sequences. At entropy decoding, if the H.264 data stream is correctly decoded and identified as error free, it will be directly sent for inverse quantization. However, in the event of an erroneous data reception, the error-prone frame will be concealed to some extent using the inbuilt JM decoder error concealment algorithm, which is frame copy, where each pixel value of missing macro block is replaced by the corresponding pixel of the previous decoded reference frame. This is then sent to the turbo decoder for further correction using two parity bit sequences.

The proposed algorithm is tested using a simulated Gaussian channel environment. The experimental results show that the proposed method outperforms the existing method, which is frame copy, in terms of objective quality metrics. At the same time, it becomes more efficient for high-motion sequences because the frame copy algorithm fails to recover lost information from the previous frame due to their high motion. Thus, the proposed algorithm is capable of significantly improving the video quality that has been corrupted by transmission errors.
Comparison of MPPT Techniques with Regard to Speed of Convergence


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In order to extract maximum power available from a solar cell in a photovoltaic system, maximum power point tracking (MPPT) should be activated. Several MPPT techniques have been developed over the past years. In this paper, five Maximum Power Point (MPP) tracking techniques are compared with regard to their convergence speed and complexity of implementation. They are Perturb and Observe (P&O) method, Incremental Conductance method, Three Point method, Constant Voltage Method and Fractional Short Circuit Current Method. The results of the simulation study are shown for a clear sky situation assuming that there is no sudden irradiance or temperature variances. Finally, it has been proved from simulation studies that Constant Voltage method is simpler to implement and faster in MPP tracking compared to the other described methods.
Cross-Sectional Imaging of Dielectric Materials using Electrical Capacitance Tomography


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Cross-sectional imaging of objects is an important area in many applications, especially in medical and engineering fields. Computed Tomography is one such technique that refers to the cross-sectional imaging of an object by using either transmission or reflection of data over the object. This can be achieved using various fields, such as x-rays, ultrasonic waves, magnetic fields, electric fields, microwaves/RF etc. Since x-rays have properties of straight line propagation and better penetrating ability, x-rays can be considered as the best among them. However, it cannot be used for simple and low cost applications, because of its harmfulness and high cost of experimental equipment. Therefore, a requirement for finding alternative methods for x-rays emerged.

According to the analysis carried out, it was found that Electrical Capacitance Tomography (ECT) can be applied for cross-sectional imaging of dielectric materials. It was developed in the late 1980’s and it is a technique that can be used to obtain the spatial distribution of a mixture of dielectric materials inside a vessel.

In ECT, the object that is needed to be imaged is placed inside the vessel and the relative capacitances between electrodes are measured. Ultimately these capacitance measurements are converted into an image showing permittivity distribution as a pixel-based plot. Since the measured capacitance values depend on the permittivity values of the dielectric material inside the vessel, substances having different dielectric properties can be identified by using this technique.

The system used in ECT may vary depending on the number of electrodes and the sizes of the vessel and the electrodes. The sensor system discussed in this paper has eight electrodes placed along the periphery of the vessel. The permittivity distribution inside the vessel is obtained using Linear Back Projection Algorithm (LBPA). Also, it was shown that iterative and non-iterative reconstruction methods can be used to improve the results further. The Least Square method is used as an iterative method and the Tikhonov Transform is used as a non-iterative method.
Optimal Capacitor Placement to LV Distribution Network: A Simple Design Approach using Excel Sheet

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Shunt capacitors are usually installed in LV distribution networks to reduce power losses and system voltage drops. Recently, the Ceylon Electricity Board installed LV shunt capacitors in some of their selected 11/0.4 kV distribution substations in the Kandy region. This paper proposes a simple design approach in determining the optimal size and the location of such capacitors by using Microsoft Excel spreadsheet software. Two distribution substations namely Siyambalagastenna (SIY) and Mavilmada (MAV) were selected in Kandy city area. The SIY substation was selected for preliminary studies on capacitor placement whereas the MAV substation was used for investigating the proposed design approach.

The daily load patterns were obtained on both substations by using a Fluke 1735 data logger. The active, reactive, and apparent powers, power factor, voltages and current data were recorded for every minute continuously for 24 hours, with and without capacitors, at the transformer end. In the preliminary studies at SIY substation, the measured power values were compared with calculated values and it was found that the error was within 5% during peak hours and 10% during off-peak hours. In the design approach, the distribution network was built-up in Excel spreadsheets by line parameters (line resistance, reactance and distance) and customer loads connected to each pole. The customer loads were obtained first by calculating the average power consumption (from electricity bills during 6 month period) and then by normalising them by measured power at the transformer end. The pole voltages and the power losses were calculated using cumulative power in the distribution network. The line voltage drops were checked by random voltage measurements at the feeder end of the MAV distribution network. The optimal size and capacitor placement were determined while checking reduction of power losses and improvements of voltage drops. It was found that the proposed method provides useful information in designing capacitor size and location.
Control Algorithm to Optimize Power Balancing in Smart Grid with Voltage Constraints of Distribution Network

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Novel technologies are expected to be incorporated into today’s power grid to enhance its functional capabilities while providing increased customer satisfaction through a sustainable power network. Thus, future power networks are expected to incorporate large amount of Distributed Renewable Energy Resources (DRER) while maintaining power quality. Smart grid, which is based on microgrid, is expected to serve these requirements.

However, the intermittent and random nature of DREG, like wind and solar could destabilize the network as conventional power control systems cannot handle high frequency fluctuations. Hence, a high frequency power fluctuation has to be mitigated within the microgrid. Such power balancing algorithm-based diverse optimality criterion has been presented in many papers. However, voltage in the distribution feeder is affected due to variation in power flow. In order to guarantee the power quality, the voltage in the distribution feeder should be maintained within the standard tolerance level. When it comes to smart grid where multiple DREGs are pumping power into the grid at various nodes of the feeder, a fluctuating voltage profile results.

In this paper we have presented a way to incorporate voltage constraints into power balancing schemes with minimal changes to the conventional distribution network. In this study, a 33kV distribution feeder with four 33kV/400V transformers (node) is considered. The aggregated models of wind, solar PV, Combined Heat and Power (CHP), Electric Vehicles (EV), controllable loads and uncontrollable loads below 33kV/400V transformer are combined to represent a node. Voltage tolerance of ± 2% was included into an existing power balancing scheme and the simulation results are shown in Figure 1. It can be seen in the figure that voltage of the feeder was always maintained within the limits. It can also be noticed near t = 0 s, t = 183600 s and t = 194400 s, that the Load Tap Changer (LTC) is switched to maximise the solution space of the optimization algorithm.

![Voltage variation at node 1](image1)

![Voltage variation at node 2](image2)

![Voltage variation at node 3](image3)

![Voltage variation at node 4](image4)

Figure 1. Variation of voltage in each node
Text Message Service Based Home Care System


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In the modern world, house robbery has become a great issue. Relevant authorities face difficulties in giving reasonable solutions for this problem. In this paper we propose a cost-effective permanent solution for home security with some advanced features. The system is based on GSM network and a sensor and actuator network. The developed system can be used to control and monitor the user’s house through mobile phones.

There are four main parts of this system. They are: the controlling circuit on a microcontroller platform; the sensor and actuator network; GSM communication equipment; and the user’s mobile phone. The implemented sensor and actuator network has sensors such as proximity sensors, gas sensors and read switches. Further, in some actuators, relays to turn on/off any device and audible alarms are present. The control system utilises 5v regulator output which draws the maximum 100 mA without actuators.

The user is informed by a SMS when a security or other issue (for example, fire or gas leak) arises. The system will simultaneously send SMSs to relevant authorities like the police station or fire brigade. The user can always control the devices in the house by sending a SMS to the control unit and the user will receive an acknowledgement from the controller. As an example, the user can provide commands to switch on/off devices such as water pump, bulbs, TV etc. and receive acknowledgments. The system updates the user within a maximum of two seconds on each and every task. Furthermore, a J2ME user interface was developed to use in the mobile phone of the user.

Even though the concept has been developed for home automation, it is possible to use the same scenario for various applications. For example, in a control system, it is necessary to send references and get feedbacks. The developed system can be used to receive current status (feedbacks) of the control system and send control commands (references) to it. By combining the GSM section with a GPS receiver, a tracking system can easily be developed for fleet management, animals, stock maintainence etc. For these applications, a computer interface can be developed between the computer and the control circuit via serial port communication.

These research outcomes are especially useful for low-cost automation systems as all the GSM service providers provide GSM service at a very low cost. Considering all aspects, the Short Message Service Based Automation System is a low cost, reliable solution for many domestic and industrial applications.
Evaluation of Widely Used Wireless Technologies for AMI Applications in Smart Grids

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Smart Grid applications with appropriate communication technologies can bring about improved and efficient energy consumption. The objective of this study was to identify appropriate wireless communication technologies for Advanced Meter Infrastructure (AMI) in Smart Grid applications. Thus far, no technology has been developed specifically for AMI applications and as such, industry is compelled either to use existing technologies or to take necessary action to develop new technologies or to modify existing technologies to suit the needs of AMI. In this study, we have taken an effort to discuss characteristics of AMI applications and then to analyse and justify the suitability and shortcomings of selected wireless communication technologies for AMI Smart Grid applications.

Among many new Smart Grid applications envisaged, AMI applications operate in an environment where appliances in home or office environments connect to a smart meter and the meter concentrator collects data acquired by these smart meters (backhauling) and provide to the Meter Data Management System (MDMS) in the local distribution to monitor the energy consumption of the region.

Firstly, we consider its bandwidth, latency and reliability to identify technologies that have potential to support the communication needs of AMI applications. Then to classify them as Best, Good, Average and Bad communication technologies, we consider factors such as stability, spectral efficiency, energy consumption, security, mobility, availability, operating distance, supporting modulation techniques and operating and maintenance cost.

This study considered Long Term Evolution Advanced (LTE-A), Global System for Mobile communications (GSM), Ultra Wide Band (UWB), ZigBee, Bluetooth, Wi-Fi (802.11g), Wireless Mesh Networks (WMN)/ (802.11s), Digital Enhanced Cordless Telecommunications (DECT), Fixed Wi-Max, IEEE 802.16m, Wireless Broadband (Wi-Bro), High Speed Packet Access (HSPA), and IEEE 802.20 wireless communication technologies. Results are summarised in Figure 1.

![Figure 1. Classification of technologies according to their suitability](image-url)
Low Cost Telepresence Robot

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Telepresence robotics is an application in robotics which allows you to mark your presence in a location where you are not physically present. It not only allows you to present yourself, but also perform rudimentary activities (such as movement), on your behalf. Unfortunately, the use of telepresence robots is greatly limited due to the high cost of commercially available robots. This limitation is overcome in this project by producing telepresence robots which are appropriate for institutional or household use, at a lower cost.

Existing commercial telepresence robots use dedicated and specialised hardware components for their key activities. Although desirable, the major drawback of using these hardware components is their high cost and therefore, the unaffordable price of the robot. As a low cost alternative, use of special hardware components is avoided wherever possible and attempts are made to obtain the same functionalities through the use of general purpose hardware (such as a laptop motherboard) and software.

The structure of the robot consists of a power circuit, a motor circuit and a laptop. The laptop controls the movements of the robot through USB or parallel port interfacing and in addition the peripherals at the laptop such as Wireless Local Area Network (WLAN) card, microphone, speakers, webcam and display are used for the controls and activities of the robot. A remote user can interact with the robot via a Wi-Fi network connection maintaining video and audio streaming conversation to interact with the remote environment. In addition to the manual control, an automatic mode of operation uses image processing for controlling the robot.

Avoiding specialised hardware in this project adds a new challenge. That is, the way of implementing efficient and reliable functionalities on the software which were successfully implemented on hardware in the existing telepresence robots. In our software implementation, there are two main software programs, one for the controller of the robot and the other for the robot. Both software programs are implemented using Java and Java Media Framework (JMF) is used for handling audio and video streaming over Real-time Transfer Protocol (RTP). The software program at the robot differs from the other, since it includes computer interfacing to handle the motor-controlling circuit according to the signals sent by the controller over the WLAN network.

Our approach to the software implementation showed constant 2s to 4s RTP streaming delay but did not show any processing failure even with a low-performance processor (Intel Pentium III 1 GHz) in the robot. Reducing video resolution before transmission and increasing it after receiving did not help to improve the performance since the conversion process using JMF took a considerable amount of processing. Since the robot’s computer had a limited amount of physical memory, it did not show general performance gain of a multithreaded program. In addition, this implementation requires at least an IEEE 802.11g type WLAN.

This project allows implementing a telepresence robot with basic functionalities for the cost of around LKR 25000 (around USD 250; a commercial telepresence robot costs in the order of a few thousand USDs). Manufacturing cost is reduced by reducing the involvement of the hardware as much as possible. On the other hand, the overall functions are greatly limited with the processing power and the battery life of the laptop. However, the software of the robot system is highly extensible such as intergrading image processing techniques for sensing the environment.
Phonocardiography or heart sound signals acquired through an electronic stethoscope can be processed and analysed for the automatic diagnosis of heart related diseases, and thus used to provide a decision support system to assist medical professionals. Our aim is to develop an intelligent stethoscope, which is low cost and can be used in the same convenience of the normal stethoscope. This would provide an advanced device even for community level health care systems. At the core of this intelligent stethoscope is a set of algorithms. For the last two decades, a lot of work has been done to develop the automated electronic stethoscope. In addition to the investigation of heart sound signals using digital signal processing techniques, the available research has focused on segmentation of heart sound signals with or without using electrocardiography (ECG), and classification to diagnose heart diseases using the features extracted from the heart signals.

In this research, the focus is to detect heart abnormalities without ECG, as using it would make the device expensive and inconvenient, and to extract as much features as possible through signal processing and other computational methods for classification. The proposed procedure basically consists of segmentation of the heart signal to identify the first and second heart sounds, the systolic and diastolic phases, and to identify heart murmurs (due to heart valve problems), according to its phase, the temporal position and distribution (as early, late and pan). In addition, heart rate variation is also estimated to diagnose heart rate related diseases.

The segmentation algorithm is based on the Short Term Fourier Transform (STFT) or the spectrogram of the heart signal. Using the observations reported in the literature, that murmurs are of higher frequencies than heart sounds, the time-frequency spectrum is divided into two bands in the frequency domain, and the variation of energy in each of the bands with time is computed to obtain two functions: one to carry out segmentation and diastolic/ systolic phase identification; and the other to identify the temporal position and distribution of the murmurs within a phase. The algorithm was initially tested for a set of signals obtained from health-care training web sites, and has shown promising results for murmur detection. However, murmurs that overlap with the first and second heart sounds in the frequency domain posed a challenge for the proposed algorithm. As the algorithm is capable of computing the period of each heart cycle, heart rate variation can be estimated and diseases related to heart rate can also be diagnosed.

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Low Carbon Cooling Solutions for the Apparel Industry: Open Cycle Desiccant Cooling Systems

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Use of mechanical ventilation and air conditioning is becoming more prevalent in commercial and industrial sectors due to warm and humid outdoor conditions in most parts of the country. Such change in the use of energy for comfort is further supported by the requirements for clean air in working environments specified in relevant health and safety regulations. The common practice in maintaining required relatively comfortable indoor conditions is to use mechanical ventilation plus conditioning of air using conventional vapour compression refrigeration. Undesirable aspects of this technology are the use of environmentally harmful refrigerants and use of electricity that in many cases add a substantial running electricity bill. A more sustainable and low carbon alternative to vapour compression refrigeration based air conditioning would be to consider technologies that incorporate natural phenomena of cooling that use low-grade energy from industries or any other renewable source. Here, an evaporation and regeneration-based desiccant cooling system provide a satisfactory alternative for applications where indoor conditions are not very closely controlled.

This paper presents a study of a desiccant cooling system. The analysis is based on a software tool; TRNSYS, which enables detailed modelling of the heat and mass transfer process in a desiccant system, particularly the regeneration process and heat/mass transfer process in desiccant wheel. The performance of a cooling solution is parametrically studied, where the regeneration energy to drive the cooling cycle is determined by examining the humidity ratio and temperature profiles for a year on an hourly basis. The results of the simulations, at different conditions, in an air dehumidifier, are used to propose an optimum coefficient of performance (COP) of the cooling system for a selected case study.

Comfort indoor conditions specified in ASHRAE standards, i.e., of 25°C dry bulb temperature and 50% relative humidity were considered in the simulations as the desired indoor conditions. The results indicate that hot water storage at 100°C via a heat exchanger can produce the thermal energy required to heat up the return air at 70°C to regenerate the desiccant. The ventilation air flow rate is maintained at 20,000 kg/hr while the hot water flow rate required to produce the necessary energy of 250 kW is 1.2 kg/s. The cooling load met by the system is 120 kW and the calculated coefficient of performance of the desiccant cooling system is 0.48, which saves up to 40% in current electrical energy use of the application concerned.

This study makes it clear that use of low grade heat or renewable sources to drive the thermally activated component of a desiccant system have a number of benefits including reduction of peak demand and less energy consumption; i.e., a low carbon footprints. This work shows that a desiccant cooling concept could maintain satisfactory indoor conditions at a lower energy consumption level and presents a sustainable alternative to supplement industrial space cooling demands.
Study of Adsorption Isotherms for Methyl Red Removal using Activated Carbon Derived from *Ormosia amazonica* Seeds


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As an inexpensive alternative to charcoal-based activated carbon (CAC) in pollution control applications, several carbon-based materials have been studied. In this study, we researched the adsorption capacity of activated carbon derived from *Ormosia amazonica* (OA) seeds in the removal of an organic dye, methyl red (MR). OA seeds are found in the dry zone of Sri Lanka, almost free of cost.

OA seeds-based activated carbon (OASAC) was prepared in the laboratory using chemical methods. Batch equilibrium adsorption experiments were carried out using 0.7 g OASAC thoroughly mixed with 50 ml of synthetic MR solutions of initial MR concentrations varying in the range of 25 to 200 mg/L at pH 4.0. The adsorption equilibrium isotherm best fitting the equilibrium experimental data was chosen from among the most commonly used isotherms, namely, the Langmuir, Freundlich and the Tempkin isotherms. Another set of similar experiments were carried out with commercially available CAC. The results obtained with OASAC and CAC were compared in order to assess their relative adsorption capacities.

Batch equilibrium studies carried out with one sample showed that 100 min were adequate for equilibrium to be reached. A set of seven equilibrium liquid-phase and solid-phase concentrations were used to determine the isotherm parameters. Estimated correlation coefficients, given by adjusted $R^2$, provided evidence for the adsorption of MR onto OASAC/ CAC being best explained by the Langmuir isotherm,

$$q_e = \frac{Q_{\text{max}} K_L C_e}{1 + K_L C_e}$$

where $q_e$ (in mg/g) and $C_e$ (in mg/L) are the equilibrium concentrations of MR in solid-phase and liquid-phase, respectively. The Langmuir adsorption capacity reflecting the maximum capacity of a monolayer adsorption, given by $Q_{\text{max}}$, was estimated as 5.425 mg/g for OASAC and 5.667 mg/g for CAC. The Langmuir adsorption coefficient, given by $K_L$, was estimated as 0.142 L/mg for OASAC and 0.180 L/mg for CAC.

The similarities found among the parameters reported above as well as in the estimated parameters of the reasonably fitting Freundlich and the Tempkin isotherms in this study, therefore, bear strong evidence for the adsorption performance of OASAC being comparable with that of CAC when it comes to MR removal. Therefore, we recommend the use of OASAC as a low-cost alternative to the relatively expensive CAC for the removal of dyes or colour from industrial effluents.
Microbial Fuel Cells with Ceramic and Earthen Plate Membranes for Rice Mill Wastewater

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Microbial fuel cells (MFC) function as reactors, which can catalyse the conversion of organic matter found in wastewater into electricity using microorganisms. This catalytic activity is used to oxidise organic substrates in an anaerobic anode chamber to generate electrons and protons. Electrons are transferred from the anode to the cathode through an external circuit at the same time the protons are transferred towards the cathode through the membrane, which separates anodic and cathodic chambers. In the cathode chamber, electrons combine with protons and oxygen to form water. Nafion is the most commonly used membrane in MFCs. However, Nafion is quite expensive, which raises the production cost of MFCs. Therefore, some alternative membranes were used such as Salt Bridge, Ultrex, porcelain septum made from kaolin and earthen pot.

In this study, the efficiency of treatment of a rice mill wastewater in MFC was evaluated in terms of electricity harvesting and chemical oxygen demand (COD) removal using ceramic plate (MFC-1) and earthen plate (MFC-2) membranes. MFC-1 was made up of polymethylmethacrylate (Perspex sheet) with the anode chamber having a working volume of 500 ml and the cathode chamber having a working volume of 420ml. Both anode and cathode chambers were separated by a ceramic plate with the thickness of 4mm (having dimensions of 9 cm × 10 cm). The electrode arrangements consisted of a carbon rod with an affective area of 191cm² as the cathode and a stainless steel mesh with a surface area of 262.5 cm² as the anode. Distilled water was used as the cathodic electrolyte. Distilled water was aerated by an air pump but towards the end of the experiment, the air pump was removed and potassium permanganate was added as the cathodic electron acceptor. MFC-2 was identical to the MFC-1 except for the ceramic plate. In MFC-2, an earthen plate (thickness, 7 mm) was used. Electrodes were connected using copper wire through an external resistance of 100 Ω. MFCs were operated under batch mode. Reaction cycle time was 15 days for MFC-1 and 13 days for MFC-2.

Maximum chemical oxygen demand (COD) removal efficiencies of 57.5% and 48.75% were obtained in MFC-1 and MFC-2, respectively. A power density of 287.02 W/m² and volumetric power of 15 mW/m³ was generated by MFC-1 with 100 Ω external resistance at the influent COD concentration of 890 mg/L. MFC-2 generated a maximum power density and volumetric power of 146 W/m² and 7.7 mW/m³ respectively with 100 Ω external resistance, when the influent COD was 960 mg/L.

This study therefore, shows that MFCs were able to economically treat the rice mill wastewater with simultaneous generation of bio-electricity.
Experimental Study of Solar Heat Pipe Performance in Peradeniya

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Solar heat pipes are unique devices in the sense, that with absolutely no external power input or moving parts, they can transfer large quantities of heat obtained from solar energy over a long distance at a constant temperature. The objective of this study was to evaluate the thermal performance of solar heat pipes fabricated at the laboratory, working under different conditions to heat batches of water in Peradeniya. This is the first reported work carried out with heat pipes in Sri Lanka.

Two solar heat pipes of 1 m total length were made up of sealed copper tubes of 0.019 outer diameter and 0.002 m thickness. Inner surfaces were lined with a porous capillary wick made up of stainless steel of 50 mesh size. Methanol having a boiling point of 64.7°C was used as the working fluid, with 40 ml trapped inside each sealed tube. Methanol was vapourized by absorbing solar energy in the evaporator end of the pipe (0.75 m in length) which was exposed to sunlight. The vapour moved through the core of the pipe to the condenser end of the pipe, which was immersed in a bath of 0.1 kg water to be heated. At the condenser end, working fluid ejected the latent heat to water and became liquid. The liquid was absorbed by the porous capillary wick lining and it moved back to the evaporator end.

On the day of experiments, solar radiation measured at the location was in the range of 800 to 900 W/m² for about 50 min starting from 12.40 pm, and it dropped to about 450 W/m² in the next 30 min. Atmospheric temperature varied in a narrow range of 28.1 to 29.2°C. The batches of water being heated were at an initial temperature of 28.1°C. Temperatures of the same, measured at fixed time intervals, showed that in both cases studied, water temperatures were raised to 45°C in about 40 min. After that, the temperatures remained at a steady value of 45°C. Absence of further increase of water temperature in the latter part of the experiments may be explained by the solar radiation data which experienced a sharp drop during this period of time as reported above.

Cumulative thermal efficiency of the system, estimated as the ratio between the cumulative heat gain by water and cumulative solar energy input to the respective heat pipe, was as low as 8%. Even at this low efficiency, water could be heated from 28 to 45°C in about 40 minutes and the temperature could be maintained at that level despite the solar radiation dropping sharply to very low values. Both heat pipes, with and without a vacuum, prior to administrating methanol, exhibited similar results. When the experiments were repeated without a vacuum on a day in which the atmospheric temperature varied in the range of 29.2°C to 29.8°C and solar radiation varied in the range of 700 to 1000 W/m², water was heated from 29.2°C to 49.6°C in about 55 minutes at an efficiency of 7%.

Considering the simple construction of the heat pipes used in this experiment and the fact that no moving parts were involved, they could be recommended for water heating usage at homes in Peradeniya with appropriate modifications required to further enhance the efficiency.
FOOD, NUTRITION & LIVESTOCK
Comparison of Antioxidant Potential of Sri Lankan and Indian Pomegranate
\((Punica granatum \text{ L.})\) Cultivars

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Antioxidants, especially polyphenols, help to protect the body against oxidative stress by neutralising free radicals, reactive oxygen species (ROS) and reactive nitrogen species (RNS). The present study was carried out to determine the total phenolic content and antioxidant potential of extracts obtained from the aril of Sri Lankan pomegranate \((Punica granatum \text{ L.})\) varieties (Nayana, Daya, Nimali) and an Indian variety. Well-ripened pomegranate fruits were obtained in August 2010 from the Regional Research Station, Department of Agriculture, Mankandura. Pomegranate juice was extracted by pressing the arils manually and filtering through Whatman No. 1 filter papers to remove particulate matter. The clear liquid devoid of particulate matter was used for analysis. Total Phenolic Content (TPC) was determined using Folin Ciocalteu colorimetric method and expressed as milligram of gallic acid equivalents (GAE) per gram extract. Antioxidant potential of the fruit extracts was assessed using 2,2-diphenyl-1-picrylhydrazyl (DPPH). Total Antioxidant Capacity (TAC) was determined using 2,2’-azinobis 3-ethylbenzothiazoline-6 sulphonic acid (ABTS) radical. DPPH radical scavenging capacity was expressed as IC\(_{50}\) value while TAC was expressed as percentage inhibition after lapse of 1 min. of the reaction.

TPC of pomegranate varieties tested ranged from 0.015 to 0.164 mg GAE/g of extract. Daya variety possessed the highest TPC followed by Nayana, Nimali, and the Indian variety. The IC\(_{50}\) value of pomegranate extracts tested ranged from 0.182 mg/ml to 0.446 mg/ml with Nayana variety showing the highest antioxidant activity followed by the Indian variety, Nimali and Daya. Total Antioxidant Capacity (TAC) of pomegranate varieties tested varied from 72.73 - 93.1% with the highest being observed in Nayana variety. The TAC of varieties Nayana, Nimali, Indian, Daya were 93.1%, 91.2%, 89.7% and 72.73%, respectively, at the 0.1g/ml concentration. Despite the moderate TPC, Nayana variety showed the highest antioxidant activity as measured by DPPH scavenging activity (IC\(_{50}\) value 0.182 mg/ml) and the highest TAC (93.1% inhibition). On the other hand, Daya variety showed a relatively less antioxidant activity though it contained high level of TPC. The TPC and antioxidant activity as measured by TAC and IC\(_{50}\) value were not well correlated (\(R^2=\ 0.545\) and 0.465, respectively). The poor correlation may be attributable to differential behaviour of phenolic constituents.

Fruits with IC\(_{50}\) value of less than 1 mg/ ml are categorised as extremely high antioxidant potential fruits. Based on TAC and DPPH radical scavenging activity, pomegranate varieties tested can be categorised as fruits with high antioxidant potential.

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Quantification of Total Polyphenols and Flavonols in Sri Lankan Black Tea

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Tea produced in Sri Lanka, which has been well known as Ceylon Tea, is acclaimed as one of the best teas in the world. The unique characteristics of Ceylon tea, reputed for more than a century, are influenced by climatic conditions of plantations. Tea is the second most popular drink, which represents a major source of dietary polyphenols. The polyphenolic fraction in tea, which represents 30 to 40% (w/w) of solid compounds, serves as dietary antioxidants. Black tea contains significant amounts of flavonols, such as quercetin, myricetin and kaempferol, which are known to possess health promoting properties. However, there is very little work carried out to date to quantify flavonols in Sri Lankan black tea samples. The present study was carried out in this backdrop, with the objective of quantifying total polyphenols and flavonols present in upcountry, low country, mid country and Uva grown black tea.

Samples of (500 g) Broken Orange Peckoe (BOP) tea were obtained from 29 estates belonging to 10 different geographical locations of low country, midcountry, upcountry and Uva regions. Upcountry tea samples were collected from Dimbula, Nuwara Eliya, Bogawanthalawa, Udapusselawa and Agrapatana. Mid country was obtained from Kandy while low country tea was obtained from Ruhuna and Sabaragamuwa sub regions. Uva tea was obtained from Malwatte Valley and Bandarawela. All samples were collected during December 2010. The total polyphenolic content of tea samples was determined in quadruplicate using ISO 14502-1 method and expressed as percent gallic acid equivalent (GAE) on dry matter basis. Total flavonols and flavones were quantified using four different aluminum chloride methods and results were expressed as both rutin equivalents (RE) and quercetin equivalents (QE). Further, the conditions necessary for hydrolysing and analysing flavonols in tea infusions were optimised and the hydrolysed flavonols were quantified using HPLC.

Total polyphenolic content of black tea samples ranged from 11.66 ± 0.58 to 25.41 ± 0.58% GAE (w/w) on dry matter basis. Up country tea brew contained the highest quantity of total flavanols and flavones (18.82 mg RE/g), while the low country tea contained 11.46 mg RE/g. The flavonols and flavones of upcountry and Uva teas were significantly (P<0.05) different from those of mid and low country. The contents of myricetin, quercetin and kaempferol in black tea ranged from 0.25 ± 0.01 to 6.48 ± 0.39, 0.79 ± 0.06 to 20.60± 0.86, and 0.52 ± 0.02 to 7.42 ± 0.89 mg/g, respectively. These results indicate that tea from different regions, sub regions and estates were significantly (P<0.05) different suggesting that the geographical location and/ or the growing condition has an impact on these contents.
Optimization of Processing Conditions to Develop Salt Fermented Herring (Amblygaster sirm) by Preserving its Sensory Qualities

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Herring (Amblygaster sirm), an underutilised fatty fish, has good potential for developing new food products due to its high $\Omega-3$ fatty acid and vitamin D contents. Salting is a traditional preservation technique, which is practiced to ferment fish to develop different products. However, most such products are poor in sensory attributes compared to fresh fish. Therefore, this study was carried out to identify a new process to develop salt fermented herring while preserving its sensory qualities present in fresh fish. Initially, herrings were salted at three different fish to salt ratios (3:1, 4:1 and 5:1) and stored at 4±1°C or ambient temperature (28-30°C) up to 48 h under light proof conditions. At 24 h intervals samples were analysed for sensory attributes (colour, odour, texture, taste and overall acceptability) using a 9-point hedonic scale by employing 30 untrained panelists. Herrings treated with 4:1 ratio were significantly (p<0.05) different from the other two treatments with respect to all tested sensory attributes. Moreover, salted herrings (4:1) stored for 48 h had significantly (p<0.05) favourable sensory attributes compared to those salted fish stored for 24 h. Therefore, 4:1 fish to salt ratio was selected for further processing based on sensory attributes and analysed for physico-chemical properties. It was observed that, total volatile basic nitrogen (TVB-N), lipid oxidation and histamine levels were far below the recommended maximum levels. The salted herrings (4:1) were stored in two different brine solutions (75% or saturated) at 4 ±1°C or ambient temperature for the fermentation process. At weekly intervals, samples were tested for TVB-N content, histamine content, lipid oxidation and sensory attributes. There were no significant (p>0.05) differences observed in the above parameters under both storage conditions up to one month of storage. The levels of TVB-N, histamine and lipid oxidation gradually increased in salted fish stored in 75% brine solution and sensory attributes became gradually unacceptable, by the seventh week post-storage at both temperatures tested. However, in salted herrings (4:1) stored in saturated brine solution, the above parameters did not change significantly (p>0.05) and remained at acceptable levels. Therefore, results of this study confirm that the salt fermentation of herrings at 4:1 ratio for 48 h followed by storage in saturated brine solution can be used to preserve them at least for three months without affecting their sensory qualities.
Antioxidant Activity of Different Varieties of Bitter Gourds (Momordica spp.) Cultivated in Sri Lanka

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Bitter gourd is an important functional food crop grown in low lands of Sri Lanka. It has been well recognised that people consuming diets rich in plant food are at reduced risk of developing chronic diseases, such as coronary heart disease, diabetes mellitus, cancers and neurodegenerative diseases, among others. The bioactivities present in bitter gourd are partially attributable to the antioxygenic and free radical scavenging activities. The objective of this study was to assess the total phenolic content, total antioxidant capacity (TAC) and free radical scavenging efficacy of three varieties of bitter gourd (Momordica charantia): Palee, Matale Green and Thinnaweli White and Momordica dioica variety Visal commonly known as Thumba karawila grown in Sri Lanka.

Bitter gourd pods were obtained from registered farm fields in Wellawaya and Grain Legume and Oil Crop Research Station, Angunakolapelessa and cultivated in Yala season of the year 2011. The crops were cultivated under irrigation using recommended agronomic practices of the Department of Agriculture. Water extracts of each variety were prepared and total phenolic content of extracts was determined using Folin Ciocalteau colorimetry method and expressed as mg gallic acid equivalents per gram fruit weight on wet weight basis. Free radical scavenging activity of water extract of bitter gourds was evaluated using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and TAC was also assessed.

Total phenolic content of bitter gourd varieties tested ranged between 12.39 ± 0.79 and 27.66 ± 1.84 mg gallic acid equivalents per 100 g fresh fruit. The highest total phenolic content was observed in M. dioica variety Visal while the lowest was observed in Thinnaweli White. The total phenolic content of Palee and Matale Green was intermediate and not significantly different (p<0.05) from each other. The concentration of extract required to scavenge 50% of DPPH radical (IC₅₀ value) of bitter gourd extracts was calculated using data obtained from scavenging of DPPH radical. It was observed that the IC₅₀ values of different bitter gourd varieties tested ranged from 82.89±1.66 to 949.5±16.8 mg/ml. M. dioica showed the highest DPPH radical scavenging efficacy (IC₅₀= 82.89±1.66 mg/ml) while Thinnaweli White showed the lowest (IC₅₀=949.5±16.8 mg/ml). Total antioxidant capacity was determined by calculating the percentage inhibition after a lapse of 1 min. The TAC of bitter gourd varieties tested showed the following order: M. dioica variety Visal > Palee = Matale Green > Thinnaweli White. The total phenolic content and the IC50 value of all varieties tested were well correlated (R² = 0.933). Furthermore, total phenolic content and TAC also showed a strong correlation (R² = 0.8937).

This study showed that bitter gourd varieties tested possess strong antioxidant properties. Of the varieties tested, M. dioica variety Visal (Thumba karawila) possessed the highest total phenolic content and exhibited the highest DPPH radical scavenging efficacy and total antioxidant capacity while Thinnaweli White variety belonging to M. charantia showed the lowest total phenolic content, total antioxidant capacity and DPPH radical scavenging activity.
Effect of 1-Methylcyclopropene on Ripening-Related Changes in Dessert Type Banana Cultivar ‘Kolikuttu’

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Among the dessert type bananas, cultivar ‘Kolikuttu’ (AAB genome) is one of the highly prized fruits in Sri Lanka which has a high export potential. Early and rapid ripening, finger-shedding and the subsequent development of anthracnose spots on the peel limit the export potential of this cultivar. This cultivar can easily be introduced to the export market if the ripening process can be delayed. 1-methylcyclopropene (1-MCP) is a relatively new GRS chemical to the agriculture industry. Past studies have shown that 1-MCP can delay ripening of fruits including Cavendish banana (AAA genome) by blocking ethylene binding sites in membranes. This chemical has not been tested adequately on fruits in Sri Lanka. Thus, the present study was conducted to ascertain the possibilities of using 1-MCP to delay ripening in cultivar ‘Kolikuttu’.

Freshly harvested, physiologically matured ‘Kolikuttu’ bananas were kept in glass chambers and exposed to different concentrations of 1-MCP (0, 300, 500 and 1000 ppb) for 24 hours at 28 ± 2°C. After 24 hours of exposure, the glass chambers were emptied so that residues of 1-MCP do not remain. Thereafter, treated bananas were kept back in the chambers with the tops open and stored at 28 ± 2°C and at 65% RH. Pulp firmness, peel colour index, total soluble solids and weight loss were measured at three days intervals. Sensory evaluation using a descriptive testing approach was performed at the ready-to-eat stage.

Pulp firmness in bananas in the control (0 ppb) started to decrease by the third day after the treatment and reached the lowest values (0.23 kg) by 9th day. Treated samples maintained pulp firmness until the 9th day irrespective of the concentration of 1-MCP, and reached the lowest values (0.3 kg) by 15th day. Untreated bananas showed ca. 10% weight loss by day 9 of treatment and by the end of day 12, it was ca. 16%, whereas treated samples lost only about 8%. In the current study, peel colour index of control bananas significantly (P<0.05) increased by day 6 while in all treated groups it remained almost unchanged until day 9. Although the treated samples reached the ready-to-eat stage by day 15, they showed an uneven skin colouration when ripe, which could be due to random formation of new ethylene binding sites in the fruit peel. Moreover, results of sensory evaluation showed that the sweetness, aroma and flesh colour did not significantly differ (P>0.05) among treatments. Apparently, finger-drop was also not observed in 1-MCP treated bananas even at the table-ripe stage. In addition, the occurrence of spot anthracnose on the peel at table-ripe stage was considerably lower in 1-MCP treated bananas compared to the control group.

According to the above results, we can conclude that 1-MCP at a concentration of 300 ppb can be used to delay the ripening process in banana cultivar ‘Kolikuttu’ by at least 6-9 days. Further research is needed to clarify the effect of 1-MCP on peel colour development.
Association between Egg Production and Body Morphology of Some Village Chicken Ecotypes in Sri Lanka

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Village chickens, which are more adapted to local environment and management conditions, contribute 15% of the national egg production. Although they are poor egg producers, their potential in contributing to the rural poultry industry is yet to be determined. A study was conducted to evaluate the association between egg production and body morphology of different village chicken types, and to estimate the general egg quality and nutritional quality of eggs from different village chicken types in five selected villages in the Anuradhapura and Puttlam districts. A total of 138 birds representing four village chicken ecotypes, namely normal village chicken, naked neck, long leg and crown, were evaluated for body weight, pelvis width and breast width, body circumference, back length, wing length, keel length, comb type, body type, head type and egg production. Sixty eggs representing all ecotypes were investigated for egg weight, size, length and width of the albumin and shell thickness. Three eggs of each ecotype were taken for egg quality measurements at days 3, 5 and 10. The height of the thick albumin and yolk and area of albumin and yolk, yolk color, Haugh index, Albumin index, Albumin area index and Yolk index were calculated to determine internal quality of eggs. The external quality parameter, Shape index, was also calculated. Dry matter, crude fat, crude protein, and ash content were determined for nutrient quality analysis using three representative eggs from each ecotype. All egg quality parameters were also carried out with eggs from a commercial strain (ISA White) for comparison.

Four ecotypes of chicken showed varying degree of relationships between body parameters and egg production. Pelvis width showed a positive relationship with egg production. Egg quality parameters were similar in eggs from all ecotypes and the commercial strain except for ash and fat contents. The ash contents of eggs from the four village chicken types were significantly high (P<0.05) compared to that of commercial strain, whereas fat content of egg yolk of normal village chicken was significantly higher (P<0.05) than that of commercial chicken egg yolk. Eggs from all village chicken ecotypes had a higher fat content than the commercial chicken egg. The internal egg quality declined with storage in both village and commercial egg while commercial egg showed a drastic decline during storage compared to village chicken eggs. The external egg quality remained unchanged in all egg types.

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Effect of Ante-Mortem Factors and Slaughtering Conditions on Physical Quality of Commercial Broiler Chicken Carcasses

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The ante-mortem handling and slaughtering conditions influence the final carcass quality of the broiler chicken. Many problems may occur at these stages that potentially increase the rate of carcass downgrading and meat quality. The determination of factors affecting poultry meat quality is a very important issue for the poultry industry to eliminate their possible negative effect on broiler meat quality in order to maximise the profit. The present study was carried out to determine the effect of carcass weight, transportation distance to processing plant and the main machinery used at the processing line on the possible defects of the chicken carcasses.

The current study was carried out at a commercial broiler processing plant at Gampola using Cobb 500 broiler strain. The first experiment was done to investigate the relationships between weight categories and possible carcass quality defects. Two hundred broiler carcasses were selected randomly, weighed, categorised into five distinct weight categories and quality defects recorded. In the second experiment, 40 birds were selected from open type poultry houses located at Gampola, Pupuressa, Galewela and Kajuwatta, separately. Quality defects were recorded considering the transportation distance. The severity of the quality defects was ranked (Acceptable quality: 1, Slightly damaged: 2, Damaged: 3, Severely damaged: 4 and Rejected: 5) by visual observation. Ranked data obtained from experiment I and II were subjected to one way Kruskal-Wallis test. Median values were analysed using Mann-Whitney test. In the third experiment, carcass quality defects were recorded at machinery level of the processing line. The data obtained from each machine were analysed using linear logistic models and the variability was assessed by Proc (PROBIT) in SAS software package.

The carcass weight had a significant effect on the severity of the defects. Lowest carcass weight category (600-1049 g) showed significantly higher severity of wing dislocation, bruises on the breast area and presence of pin feathers. Furthermore, carcass quality defects increased with distance of transportation. The highest percentage of bruises on both wing and breast were showed when transportation distance exceeded 35 km. According to severity evaluation of the damage, the highest transportation distance showed a significantly higher effect on presence of bruises on breast and wing. Considering defects of the machinery at the processing line, the de-feathering process had a significant effect on wing dislocation. Pre-slaughter handling conditions and processing conditions are very essential factors which contribute to carcass and meat quality defects; therefore, these factors should not be overlooked.
The Effect of Pre -Harvest Application of Potassium on Fruit Quality of “TEJC” Mango (Mangifera indica L.) Selected for Processing

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‘TEJC’ is a vegetatively propagated, heavy bearing Sri Lankan mango (Mangifera indica L.) cultivar, currently cultivated in a few areas including Galkiriyagama and Dambulla areas. Having a high demand, especially for the export markets, there is a need to increase post-harvest quality of fruits, with regard to external appearance, colour and internal eating quality, targeting higher quality of processed products such as ready to serve drinks and dehydrated slices of the fruit. Therefore, the objective of this research was to evaluate the effect of pre-harvest application of potassium sulphate spray on the postharvest qualities of fruits relevant to selected processed products of ‘TomEJC’ mango. Concentrations of 2%, 4% and 6% w/v of potassium sulphate spray applications on fruits were applied while on the tree and postharvest quality of mango at table ripen stage were evaluated two months after the treatment.

The relevant physical properties; peel and flesh colour, the colour of ready to serve drinks and dehydrated products were measured using a Minolta colourimeter (L*a*b* colour space). Hue angle (H*) and Chroma (C*) were calculated using the above colour data. Further, fruit circumference, length, weight loss, peel percentage, flesh percentage, total soluble solids, titrable acidity and pH were also measured to assess the quality of the fruit required for processing. Severity of the anthracnose development was studied on daily basis after harvesting. A completely randomised design was used as the experimental design and the results were analysed using SAS 9.1 software. Analysis of the data exhibited that L* was significantly (p < 0.05) increased in both flesh and peel with increasing potassium sulphate concentration and a* of flesh and dehydrated mango was significantly higher in fruits treated with 2% w/v potassium sulphate. Peel thickness and titrable acidity significantly increased (p<0.05) while the pH decreased significantly with increasing concentration of potassium sulphate. Anthracnose disease severity decreased significantly up to ripen stage with increasing potassium sulfate concentration within the limit of use. These results provide evidence that pre-harvest potassium sulphate spray application onto fruits can be used to improve postharvest quality of ‘TEJC’ mango which then provides better quality in processed products. However, the economic feasibility of application needs to be investigated before making recommendations as potassium is a relatively expensive nutrient.
A Prospective Evaluation of Nutritional Care Given to Patients Admitted to Intensive Care Units

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Nutrition is an important adjunct therapy in overall management of critically ill patients and often it is an overlooked area in busy Intensive Care Unit (ICU) settings. Therefore, identification of individual nutritional requirements and timely supplementation is of utmost importance. The objectives of this study was to compare the individual calorie and protein requirements with the actual amounts of calories and proteins received by the ICU patients and to identify the discrepancies and deficiencies, if any, in the nutritional care with the aim of formulating guidelines on nutritional management of ICU patients in Sri Lanka.

This was a prospective cross sectional study conducted in five ICUs in the central province over a period of three months. Consecutive sampling method was applied. Patients between 20-70 years of age were included and those who were not given enteral feeds and patients who were haemodynamically unstable were excluded. Protein and calorie requirements were calculated using the Harris Benedict equation, adjusted according to stress factor and sex, and compared with the food received. Independent sample t test was performed to find out any significant difference between the recommended requirement and the received amounts.

Out of 85 patients, 64% were males and 36% were females. The average daily calorie amount received by male patients was 889.81 kcal ± 439.93 and for females 711.64 kcal ± 410.25. The average daily protein amount received by males and females were 45.36 g (± 25.93) and 33.15 g (± 22.31) respectively. Out of the study sample, 77.2% did not receive the recommended calorie requirement while 92.4% did not receive the recommended protein requirement. Further, the average calorie and protein amount received by patients was significantly lower than the respective recommended values.

In conclusion, the daily average calorie and protein intake was found to be significantly low among adult patients when compared to recommended requirements. Further improvement in calorie and protein provision is required depending on the clinical condition of individual patients. Therefore, more studies directed at individual clinical conditions and diseases and their nutritional intake is necessary.
In-Vitro Bioavailability of Metal Nutrients and Oxalic Acid in *Averrhoa bilimbi*

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Several acidic fruits found in Sri Lanka, utilised either as culinary or acidulants in human diets, are believed to increase bioavailability of certain mineral nutrients. However, the presence of inherent antinutritional components in addition to nutrition enhancers in acidic fruits may affect the bioavailability of nutrients. Diets may be monotonous, particularly in poverty stricken populations, and any physiological effects caused by antinutrients may exacerbate existing problems of malnutrition and chronic diseases such as urolithiasis associated with high levels of oxalate in the diet. For instance, the presence of phytic acid (PA) could inhibit bioavailability of metal nutrients while ascorbic acid (AA) could enhance bioavailability of minerals such as iron (Fe). There may be a mixture of metal nutrients, as well as antinutrients and nutrition enhancers in a composite meal. The current study was an investigation to determine the relative bioavailability of selected substances using a simulated gastrointestinal digestion system.

Before embarking on the main experiment, a preliminary experiment was carried out by selecting six popular acidic fruits, namely *Averrhoa bilimbi* (Billing), *Averrhoa carambola* (Kamaranga), *Citrus aurantifolia* (lime), *Garcinia quaesita* (Goraka), *Lycopersicon esculentum* (tomato), and *Tamarindus indica* (tamarind). They were analysed for acid (citric, malic, tartaric and oxalic) contents using a gravimetric precipitation technique. From the above findings *A. bilimbi* was chosen for the main experiment, which had an oxalic acid (OA) content of about 87%. Therefore, the objective of the present investigation was to analyse the relative influence of OA, PA and AA on in vitro bioavailability of three metal nutrients (Ca, Fe and Zn) and additionally, the bioavailability of OA in *A. bilimbi*.

Standard methods were used for analyses. The levels of Ca, Fe and Zn were analysed by atomic absorption spectrophotometry. The levels of OA were analysed by precipitating as calcium oxalate and reacting with indole reagent followed by colourimetry. The levels of PA were analysed by precipitating as ferric phytate and reacting with a chromogenic solution. The levels of AA were analysed by preparation of a test solution which was titrated with standard 2,6-dichlorophenol indophenol reagent. For the determination of bioavailability of Ca, Fe, Zn and OA in vitro gastrointestinal digestion was carried out by simulating oral, gastric and intestinal digestions using relevant enzymes and equilibrium dialysis where appropriate.

The bioavailabilities of the three metal nutrients were: Ca 4.2%, Fe 15.0% and Zn 26.2%. Linear regression analysis revealed that OA accounted for 83% ($r^2 = 0.83$) and 80% ($r^2 = 0.80$) inhibition of Ca and Zn absorption respectively. PA accounted for 66% ($r^2 = 0.66$) inhibition of Fe absorption. Furthermore AA accounted for 81% ($r^2 = 0.81$) and 76% ($r^2 = 0.76$) enhancement of Ca and Zn absorptions respectively. The OA bioavailability was 52.8%.

These findings infer that bioavailability of Ca, Fe and Zn are influenced by the acidic constituents present in *A. bilimbi*. The high bioavailability of OA in *A. bilimbi* is of concern due to its ability to cause urolithiasis.
Can the Use of Genotype Probabilities with Selective Genotyping Reduce Bias in Genetic Marker Estimates?

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Incorporation of genetic marker information in animal breeding programs is useful in improving traits with low heritabilities, traits that are hard to measure, expressed in only one sex or later in life, rare alleles etc. The marker genotype information of such traits is used in estimation of breeding values of animals, in order to select the best animals for breeding purposes. However, obtaining good estimates for the markers are necessary for this to be more effective. Genotyping of the entire population is usually not practicable to obtain a good estimate for the markers. Therefore, most of the time, only a proportion from a population is genotyped. If the pedigree information is available, the utility of the genotype information can be improved with the use of genotype probabilities of the non-genotyped individuals.

Due to the comparisons of individuals in two phenotypic extremities of a trait, selective genotyping has shown more power over random selection in detecting quantitative trait loci (QTL) effects. However, when a smaller proportion is genotyped from the population, the estimates are expected to be biased upwards, and the assumptions of the formula for correction of this bias tend to deviate. Use of genotype probabilities reduces this estimation bias due to the inclusion of additional genotype information in the analysis. Since the correction formula available in the literature tends to over correct the “less biased” estimates obtained, a modification was required to accommodate the additional information from animals with genotype probabilities in the formula.

This study attempts to fill this gap and compares the use of genotype probabilities with selective genotyping in order to estimate a bi-allelic single nucleotide polymorphism (SNP) marker segregating in a population, with an allele frequency of 0.5 and allele substitution effect ($\alpha$) = 6. A random mating population [phenotypic mean ($\mu$) =100, standard deviation ($\sigma$) =30, heritability ($h^2$) =0.25] was simulated for this purpose. The marker genotype or the probability was fitted as a fixed effect in Best Linear Unbiased Prediction (BLUP). Marker estimates obtained from BLUP was compared when 50% or 35% of the population was genotyped, with and without using genotype probabilities under selective genotyping and random selection. Each experiment was replicated 20 times.

Results show that the corrected estimates for bias under selective genotyping with 50% or 35% genotyped were more accurate (smaller standard error, $p<0.05$), compared to random selection under similar proportion genotyped. At 35% genotyping, there was a significant deviation of the marker estimate ($P<0.05$) from the true value (6) under selective genotyping, when the individuals with genotype probabilities were not used in the analysis. This suggests that inclusion of individuals with genotype probabilities can increase the utility of genotype data, and facilitate obtaining accurate and unbiased estimates with selective genotyping at extreme levels of genotyping.
Establishing the Baseline Total Bacterial Count for Cows’ Milk in Sri Lanka and its Application in Determining Bulk Milk Contamination

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The Total Bacterial Count (TBC) or the standard plate count refers to the number of viable bacteria present in a milk sample. TBC is used as the official regulatory test to determine bacterial population in milk and the acceptable TBC for raw cow milk is <30,000/ml. It is a criterion that determines the purchase price of milk, a crucial factor to increase consumer confidence and a valuable measure for keeping quality and shelf life. However, this standardisation is not applicable to developing countries where codes of hygienic practices are different compared to developed countries. Therefore, it is important to establish a local standard for the benefit of both farmer and consumer. Bacterial contamination is possible due to shedding of organisms within the udder and via environment. Cows with mastitis contribute to high TBC and often shed more than 10,000,000/ml. Milk from subclinical (SM) and chronic mastitic (CM) cows accidentally gets mixed with bulk milk and causes milk to be rejected imposing reduced profit to dairymen. The present study was designed to determine TBC of milk from healthy cows and to determine the contribution made to high TBC by mastitic milk.

A total of 386 cattle farms were evaluated covering 29 veterinary ranges from Kandy (15), Nuwara Eliya (8) and Matale (6) districts. A cross sectional study was carried out to investigate the randomly selected farms where 696 cows were screened for SM and CM using California Mastitis Test (CMT). Systematic sampling was done to collect milk initially from CMT negative healthy cows ($n_1 = 80$). All CMT positive cows were sampled to obtain TBC ($n_2 = 206$).

The estimated mean TBC of CMT negative milk was 11,946 cfu/ml, with the 95% confidence interval (CI) being 9271 - 14,627 cfu/ml. Mean TBCs of SM and CM milk were $1.419 \times 10^8$ cfu/ml (95% CI: $1.411 \times 10^8 \pm 0.99 \times 10^5$) and $1.651 \times 10^8$ cfu/ml (95% CI: $1.654 \times 10^8 \pm 1.26 \times 10^5$), respectively. To compare the effect of adding CMT positive milk, TBCs were calculated as the average of natural logarithm. 95% CI for CMT-negative milk, SM and CM were 3.75±0.14, 6.72±0.36 and 7.02±0.54, correspondingly. Hence, there is a considerable effect of mixing mastitic milk with bulk milk in terms of keeping quality, shelf life and public health. In conclusion, to minimise the above quality and safety issues, farmers should be educated on early detection tests of SM and CM, thereby preventing rejection of their milk at collecting centres.

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Effect of Weather Patterns on Bovine Clinical Mastitis in Nuwara Eliya District of Sri Lanka

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Mastitis is a complex multi-factorial disease, which affects the quality and quantity of milk. Among several factors, climatic conditions have a serious influence on the prevalence and incidence of clinical mastitis (CM). Studies have shown that the temperature-humidity index has a direct effect on the occurrence of CM. This is mainly due to moisture which facilitates the growth of environmental bacteria on organic substrates. Bacteria gain access through the teat canal resulting in udder infection when cows rest on humid and soiled bedding and wade through mud. Detailed information on patterns of mastitis in relation to climatic conditions in Sri Lanka is limited. Therefore, this pilot study was aimed to determine the relationship between climatic conditions (temperature, rainfall and humidity) and incidence of mastitis in Nuwara Eliya district of Sri Lanka.

Weekly climate summaries [relative humidity (X₁), cumulative rainfall (X₂) and ambient temperature (X₃)] from 2008 to 2010 were collected and data on occurrence of CM were obtained from eight veterinary ranges (VR) in Nuwara Eliya district. Weekly incidence of CM (Y) in these VR was calculated. Correlation coefficients (CC) of variables were determined and multiple linear regressions with backward elimination (MLR) were performed. General ‘drift’ of scatter diagrams illustrated a linear relationship between variables. The CC indicated that X₁ and X₃ positively correlated with Y (rX₁Y=0.452, rX₃Y=0.363), while X₂ has a weak correlation (rX₂Y=-0.092). After removing the non-significant term (X₂), the reduced model was Y=-8.17 +0.029X₁ +0.82X₃. Even though the model is significant (P<0.0001), the adjusted R-sq is substandard (0.33). Parameter estimates of the variables X₁ and X₃ were significant (P<0.0001, 0.0006) and no significant multicolinearity was observed between variables.

According to this study, X₁ and X₃ were significant factors in occurrence of CM. Similar studies have shown both temperature and humidity are associated with the occurrence of CM while no trend was evident with cumulative rainfall. But the low R-sq might be due to less variability observed in the explanatory variables within the study area. Even though the observation in this study concurs with the literature, the predicted model might be improved if different climatic zones were studied. It is recommended to carry out further investigations covering all climatic zones (wet, intermediate and dry) to predict a better regression model and to identify the most significant weather factors that correlate with the occurrence of CM in Sri Lanka.

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PCR-SSCP Polymorphism of BMP4 Gene (Intron II) in Goats in Damana and Thirukkovil Veterinary Service Divisions in the Ampara District of Sri Lanka

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Application of molecular genetic approaches for screening of economically important quantitative traits (i.e. growth and reproduction) in goats is an effective way of increasing their productivity through improved selection based on genetic markers. Single Strand Confirmation Polymorphism (SSCP) analysis is one such powerful genetic screening method to identify the sequence variation in Polymerase Chain Reaction (PCR) amplified DNA. In the present preliminary study, we investigated genetic variation in the second intron of bone morphogenetic protein 4 (BMP4) gene, by PCR-SSCP, in local indigenous (LI) and Jamnapari crossbred (JC) goats in Damana and Thirukkovil Veterinary Service (VS) divisions in the Ampara district.

Genomic DNA was extracted from a total of 103 samples (49 LI and 54 JC) collected from 15 farms located in the two VS divisions and subjected to PCR-SSCP analysis. Polymorphism was detected in both LI and JC goats of the study area and five different conformational patterns were identified (A through E). Three conformational patterns (A, B and C) were found in both LI and JC animals. Patterns D and E were unique to LI animals, indicating the benefit of searching for more genetic markers. Calculated total frequencies of patterns A, B, C, D and E as revealed by PCR-SSCP were 58.25%, 14.56%, 5.83%, 11.65% and 9.71% respectively. In general, pattern A was predominantly found in both LI (40.43%) and JC (73.21%) whereas pattern C was found to be at lowest frequency in both groups. Pattern D observed in LI goats may have some association with phenotype and growth of the animals as we observed similar external characters in all the animals possessing pattern D. Gene sequencing of the five conformational patterns observed are being pursued to identify the genotypes and the alleles present.

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Topography, Macroscopic and Microscopic Anatomy of Kidney of *Oreochromis niloticus*

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Tilapia nilotica (*Oreochromus niloticus*) is a very successfully established fresh water fish species in Sri Lanka and an understanding of its biology is very important in maintaining the species in optimum health and production. A study was undertaken on the morphology of its organ systems and this paper describes the topography and macroscopic and microscopic structure of the kidney.

Nine adults were dissected from the left flank. All organs were removed to observe the topography and gross anatomy of the kidney. For histology, whole fish were fixed in 10% formal saline and decalcified in EDTA. Selected samples were processed, sectioned and stained with Hematoxylin and Eosin for light microscopy. As with other fish, two sets of paired kidneys, the head kidney (HK) and posterior or trunk kidney (PK) were identified. The dark brown HK was located in the pharyngeal region and each had two lobes. One lobe was directed caudally along the body wall while the other extended cranially within the hypaxial muscles. The dark red PK was located retroperitoneally ventral to vertebral column and ran along the entire length of the body cavity. The two PKs although separate in the cranial half, were fused caudally. Microscopically, the HK showed a thin connective tissue capsule and mainly consisted of islands of red blood cells outside the sinusoidal spaces and epithelial-lined tubular structures similar to mesonephric tubules. Degenarating mesonephric tubules in the HK have been reported to be replaced by hemopoetic tissue in other species of fish. Numerous large irregular cells with yellow-brown cytoplasm with eccentric nuclei were identified as melano-macrophages. The parenchyma of the PK consisted mainly of renal corpuscles, renal tubules and collecting ducts. Four distinct regions based on epithelial structure are identified in other studies - neck segment, proximal segments 1 and 2 and a distal segment - were also identified in the present study. The neck segment had a non-ciliated low columnar epithelium. Proximal segment 1 showed a tall columnar epithelium with central nuclei and densely packed brush border. Proximal segment 2 showed basal nuclei and a low brush border of reduced density resulting in a larger lumen. The distal segment which opens to the collecting duct was characterized by low columnar cells with central nuclei without an apical brush border. The collecting duct had a taller epithelium surrounded by a thin layer of smooth muscle followed by connective tissue. A few melano-macrophage centers and corpuscles of Stannius comprising concentric basophilic cellular laminae surrounded by a fibrous capsule were also present. There were large irregular eosinophilic inter-renal cells with round central nuclei. From the present observations it may be concluded that the PK is the functional kidney in the adult.
Influence of Age of Hen and Storage Time of Eggs on Embryonic Mortality in Broiler Grandparent Breeders

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The poultry industry is the only well-established commercial livestock sector in Sri Lanka and it contributes around 70% to the Sri Lankan livestock production. There is a scarcity in the availability of breeder stocks in the country. Fluctuations in the market demand for chicks lead to storage of eggs. Viability of fertile eggs can be affected by the age of hen and storage time. The objective of this study was to assess how the hen’s age and storage length affect the embryonic death as this information is very valuable for broiler breeder farms.

The study was carried out using broiler breeder grandparent flocks of Cobb 500. Eggs of hens of different ages were used: 30-39, 40-49 and 50-59 weeks. Collected eggs were stored for 1-8, 9-16 and 17-24 days in a cool room at 16 ºC with 75% Relative Humidity (RH). Fertile eggs were incubated at 37.5 ºC and 53% RH. The hatching performances were assessed by candling eggs at the 18th day of incubation. Incubation was completed on day 21 and all chicks were removed from the hatcher.

In all age groups of hens, embryonic mortality was significantly higher in storage period 17-24 days than storage period 1-8 days (8.37% and 3.8% respectively). Early-embryonic deaths were significantly associated with storage period (P<0.01) but not with flock age (P=0.8). Mid-embryonic deaths were not significantly different among any storage or age group. There was a significant association of late-embryonic deaths with flock age and storage period (P<0.01). The results of the study suggest that the best performance was evident with eggs from younger hens which were stored for less than 9 days.
Bacterial Isolates and *In Vitro* Biogram of Milk Collected from Cows with Chronic Mastitis in the Central Province of Sri Lanka

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Bovine chronic mastitis (CM) has been a common problem in dairy herds with serious and frustrating consequences. This exists in unnoticeable subclinical form for months, persisting from one lactation to another, with high tendency of being nonresponsive to therapy, resulting in intermittent flare-ups and ending up in sub-acute or acute form. Chronically infected cows act as carriers and they impose a severe economic burden. The present study was aimed at revealing the organisms involved in CM and disclosing their antimicrobial susceptibility.

Two hundred and twelve cattle farms were selected through multistage sampling and 379 milking cows from these farms were screened by California Mastitis Test. Based on their history, 23 CM cows were identified and milk samples of these cows were cultured to obtain pure isolates. The bacterial isolates were identified on the basis of their cultural, morphological and biochemical characteristics. Susceptibility levels were determined by the disc diffusion method for seven commonly used antimicrobials in intra-mammary infusions.

Prevalence of CM in cows was 6%. Bacterial growths were yielded from 20/23 samples (87%). Only two of them showed a single isolate of bacteria and the remaining were mixed cultures. Twenty four coagulase positive *Staphylococci* (CPS), nine coagulase negative *Staphylococci* (CNS), nine Gram negative rods, six *Streptococcus* spp, ten *Bacillus* spp and five *Corynebacterium* spp were obtained out of 63 different isolates. An *in vitro* biogram revealed that 11/24 were resistant to at least one of the antibiotics used. Moreover, 7/24 isolates exhibited multi-drug resistance for minimum of three antibiotics and four isolates were resistant to chloramphenicol. Cephalothin was the most effective antibiotic (96%) for CPS. Only one CNS isolate showed multi-drug resistance and others were susceptible for all chemotherapeutic agents tested. Ampicillin was the drug of choice for *Streptococci* (with 100% susceptibility). Six out of nine (67%) Gram negatives were either resistant or intermediate to neomycin whereas all were susceptible to gentamicin. As there appears to be an increasing tendency of developing resistance to commonly used antimicrobials, indiscriminate and frequent use of antibiotics should be restricted to control emergence and spread of resistance. Moreover, identification of causative agents and testing their susceptibility to antibiotics is recommended prior to selecting a treatment for CM as the causative agent and the type of antimicrobial to be used cannot be generalised.
HEALTH & HYGIENE
Incidence of Renal Calculi and Quality of Drinking Water in Kurunegala District

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There is an increasing prevalence of renal calculi in certain districts in Sri Lanka such as Anuradhapura and Kurunegala. Renal calculi are inorganic crystalline aggregates that develop in kidneys and urinary tract. High concentrations of chemical constituents such as calcium oxalate, calcium phosphate and uric acid and low pH of the urine are some of the factors that contribute to formation of renal calculi. However, the calculi formation process in the body is not properly understood. Presence of mineral salts in drinking water is commonly known as water hardness. There are two types of water hardness: temporary and permanent. Temporary hardness can be removed through boiling while permanent hardness cannot be eliminated through boiling. The present study was carried out to: (i) investigate whether there is a relationship between the incidence of renal calculi and temporary hardness of drinking water in selected areas of Kurunegala district. (ii) determine whether the use of boiled water has an impact on formation of renal calculi.

A sample of 200 patients diagnosed with renal calculi attending the teaching Hospital Kurunegala was surveyed using a self–administered questionnaire. Drinking water samples from each area where the patients resided were collected for analysis. Temporary hardness of water samples was determined titrimetrically.

Temporary hardness of water in Kurunegala ranged from 90 – 270 mg/L of water. The study revealed that there was a weak relationship ($r^2 = 0.164$) between the incidence of renal calculi and temporary hardness of drinking water in the Kurunegala district. It was also revealed that 83% of males and 74% of females do not use boiled water for drinking.
Modification of Methaemoglobin Reduction Test/ Brewer’s Test for Rapid Diagnosis of G6PD Deficiency for Screening

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Methaemoglobin reduction test (Brewer’s test) is the most commonly used technique to screen the G6PD deficiency, which is the most common human enzyme deficiency in the world. The standard test procedure requires a large volume of blood (2 ml) and includes a longer incubation period of three hours at 37°C which makes it difficult to use in the field.

The objective of this study was to develop a rapid diagnostic method by changing different parameters of methaemoglobin reduction test procedure, enabling it to be used in the field.

Minimum incubation period, minimum blood volume and minimum reagent volumes needed for the reaction were tested. Dry tubes were prepared with the reagents necessary for the lowest volume of blood. A new enzyme activator was introduced to minimize the incubation time.

The study results showed that minimum incubation time required for the standard test was 135 minutes, minimum blood volume needed was 0.100 ml, minimum NaNO₂ and glucose reagent volume required was 0.01 ml at 0.0864 mol/l. The minimum methylene blue volume was 0.01 ml at 0.2 X 10⁻⁵ mol/l. Results revealed that MgCl₂ can be used as an enzyme activator and the incubation time needed for the test reduced up to 105 minutes. Development of strip method failed due to instability of the negative control.

The standard methaemoglobin reduction test can be modified to reduce the incubation time. The development of the strip method needs improvement for the negative control.
Evaluation of Awareness about Physiotherapy and Identification of the Most Vulnerable Region to Injury among School Level Male Hockey Players in Kandy Educational Zone

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Physiotherapy is a therapeutic health profession that assists people with injuries, pain, stiffness, weakness, and other movement problems. Physiotherapists are hospital-based trained personnel and are experts in diagnosis, treatment and prevention of injuries, exercise prescription, rehabilitation and many other areas of sport concerning musculoskeletal health and fitness.

A cross-sectional study was conducted among 69 school level male hockey players in Kandy educational zone to evaluate their awareness on physiotherapy. Eight schools were taken into the study and one school was selected for the pre-test prior to the survey. The study was carried out as a whole population study. Ethical clearance was taken from the ethical clearance committee of the Faculty of Allied Health Sciences. Written consent was taken individually from the participants. A self-administered questionnaire consisting of 50 questions was administered to all male hockey players under 19 age group who have participated in hockey tournaments for the last 12 months. A screening examination was done to identify the most vulnerable region to injury. The data was analysed by using Minitab computer software.

According to the responses obtained from self-administered questionnaire, 2.89% had inadequate awareness, 81.15% had moderate awareness and only 15.94% had an adequate awareness about physiotherapy. The screening examination revealed the knee joint (19.29%) followed by the ankle joint (15.78%). According to literature, ankle injuries were the commonest among hockey players. We assume that the playing surfaces and practice techniques may have an impact on this result among Sri Lankan hockey players.
The Cut-Off Value of Mean Corpuscular Volume for Screening Thalassaemia Carrier State

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Thalassaemia is a fairly common haematological disease in Sri Lanka and screening programmes on the general population are done to detect thalassaemia carrier state as a preventive measure. In these screening programmes, the Mean Corpuscular Volume (MCV) is currently used as the screening test and the value of 80 femtolitres (fl) is taken as the cut-off. Blood specimens with MCV < 80 fl is directed for confirmatory tests, such as, High Performance Liquid Chromatography (HPLC) technique.

The objective of the present study was to evaluate a new cut-off value for MCV which is most compatible for screening thalassaemia carrier state in the Sri Lankan population as the current value has a high false positive detection.

A retrospective analysis was conducted on 1287 individuals attending the thalassaemia screening programme at the General hospital, Kurunegala from 1st May, 2010 to 31st July, 2010. Both male and female subjects above 6 months of age were included in the study. Routine data from automated haematology analyser and haemoglobin values from HPLC technique were collected. Data were analysed to detect the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of each MCV value below 80 fl, up to 70 fl for screening thalassaemia carrier state.

Based on the statistical analysis, the sensitivity, specificity, PPV and NPV of 80 fl cut off MCV value were 100%, 6.12%, 62.81% and 100%, respectively. The sensitivity and the NPV for MCV value between 80 fl and 75.3 fl were the same (100%). The specificity and the PPV increased to 13.87% and 64.80%, respectively at MCV of 75.3 fl.

Therefore, the cut off MCV of 75.3 fl is the most suitable for screening of Sri Lankan population for thalassaemia carrier state.
Root and Canal Morphology of Permanent Maxillary First Molars in a Sri Lankan Population

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The study of root and canal anatomy of teeth has clinical and anthropological significance. A number of studies have shown different trends in the shape and number of roots and canals of teeth among different populations. It has been reported that the mesiobuccal root of the maxillary first molar contains a double root canal system more often than a single canal. However, prevalence of such morphological variations for South Asian people has rarely been reported. The aim of this study was to determine the root and canal morphology of permanent maxillary first molars in a Sri Lankan population with special concern to the presence of a second canal in the mesiobuccal root.

One hundred and fourteen permanent maxillary first molars were washed immediately after extraction and stored in 10% formalin until the collection was completed. The teeth were boiled in 5% NaOH for five minutes and then cleaned with 10% NaOCl to remove organic debris on the surface. Any further deposits such as calculus and bone fragments were removed by scaling and polishing. Each specimen was examined visually under a quartz-halogen light with the aid of a hand lens. The root numbers of the molars were recorded. Vacuum injection protocol was used to inject the ink into the root canal system and make the tooth transparent in order to visualize the canal system. The cleared specimens were examined under a dissecting microscope at ×10 magnification. Vertucci’s classification was taken as the main reference during the evaluation of the samples. JMP (SAS Institute, Ver. 3) software was used for statistical analysis.

The commonest canal type in the mesiobuccal root was type IV (42.11%), followed by type II (24.56%) and type I (22.81%). The prevalence of the second canal in the mesiobuccal root was 77.20% and that in distobuccal root was 3.51%. Palatal root had only a single canal in 99.12% of the teeth. These findings signify that due consideration should be given by clinicians to find the second canal in the mesiobuccal root of upper first molar for successful root canal treatment of the permanent maxillary first molar tooth.
Effect of Root Extracts of *Pongamia pinnata* on Cell Surface Hydrophobicity of *Candida* spp.

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*Candida* is a dimorphic fungus that causes opportunistic infections. Cell surface hydrophobicity (CSH) of *Candida* plays an important role in the pathogenicity of the organism as it is a key factor for the adhesion of the candidal cell to the host tissue. Our previous findings revealed a significant anti-candidal activity of the root extract of plant *Pongamia pinnata* ("karanda"/ "pongam") which is popular in Sri Lankan traditional medicine. Hence, this study aimed to evaluate the effect of root extracts of *P. pinnata* on CSH of *Candida* spp.

Root extract of *P. pinnata* was prepared using 75% ethanol and the extract was evaporated and freeze dried. CSH of five different candidal isolates (MIC were previously determined) were evaluated under five different concentrations (Minimum Inhibitory Concentrations (MIC), 1/2 x MIC, 1/4 x MIC and 1/8 x MIC) of the freeze dried extract. Data were analysed using analysis of variance (ANOVA) and means were separated by Tukey test at P<0.05.

Among the five isolates subjected to the assay, *Candida dubliniensis* was the most hydrophobic followed by *Candida guilliermondii*. The hydrophobic affinity of *Candida albicans* (ATTC 90028 and the wild type strain) and *Candida parapsilosis* was relatively low. The effect of *P. pinnata* on the CSH was concentration dependent. *C. albicans* (ATCC 90028), *C. albicans* (wild type) and *C. dubliniensis*, showed a significant reduction (P<0.05) in their CSH when treated with 1/8 MIC, which was the lowest concentration used in the study. Negative CSH were observed for *C. guilliermondii* at 1/4 MIC, while a negative CSH was observed for the other isolates when they were treated with 1/8 MIC. Negative CSH may be an indication of the hydrophilic behavior of the organism which makes the organism less virulent.

Capability of root extract of *P. pinnata* to influence CSH could be due to its potential in altering the surface characteristics of the organism. Its ability to make a significant reduction in the CSH at concentrations even below the MIC will assist the control of the pathogen instead of its complete inhibition. Since *Candida* is a commensal fungus, usage of sub-inhibitory concentrations will help maintain the balance of the host microflora while controlling pathogenicity of the organism. However, purification of the active compound of the root extract and evaluation of its effect on CSH of *Candida* spp. is needed.

The results suggest that root extract of *P. pinnata*, has a potential in reducing CSH of *Candida* spp, even below their MICs. This will result a reduction in the hydrophobic binding capacity of the organism when treated with the extract.
Association between Plasma Lipid Levels and Periodontitis: A Preliminary Analysis

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Hyperlipidaemia and periodontitis are both highly prevalent chronic diseases in the world population, with periodontal disease being the most prevalent adult oral health problem in Sri Lanka. Literature reveals a bidirectional relationship between periodontitis and some systemic illnesses including atherosclerotic cardiovascular diseases, metabolic diseases such as diabetes mellitus and dyslipidaemia. Dyslipidaemia is an established causative factor for atherosclerosis and cardiovascular diseases. Periodontitis could alter blood lipid metabolism, however treating periodontal infections improves the dyslipideamic status in patients. The objective of this study was to evaluate any possible relationship between presence of periodontitis and blood lipid levels.

This is an ongoing study in the Division of Periodontology, Faculty of Dental Sciences, University of Peradeniya. The study consisted of a ‘Test’ group of patients (n = 47) diagnosed with periodontitis according to the established diagnostic criteria, and an age and sex matched ‘Control’ group (n = 22) with individuals free of periodontitis who attended the clinic for dental consultations. Full mouth periodontal assessments were done by a well trained practitioner, following intra-examiner calibration. Their lipid profiles were assessed within three days following recruiting subjects and prior to commencing periodontal treatment or oral prophylaxis.

Results of the preliminary analysis showed that, there were significant increases in levels of Total-Cholesterol and Low-Density Lipoprotein Cholesterol in the test group compared to the control group (p < 0.013 and p < 0.007, respectively; Students t-test). This preliminary finding supports the already reported trend by similar research studies outside Sri Lanka to describe the association of hyperlipidaemia and periodontitis.

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A Descriptive Study of Amelogenesis Imperfecta including Syndromic Forms

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Amelogenesis Imperfecta (AI) is a developmental disorder of genomic origin, associated with abnormal enamel formation. The aim of the present study was to identify different clinical presentations and inheritance patterns observed in Sri Lankan children affected with AI.

Children, who presented to the Division of Paedodontics, Faculty of Dental Sciences, University of Peradeniya over a period of two years from 2008 to 2010, were screened to identify the patients suffering from AI.

The study sample obtained during this period included twenty children with AI, belonging to 16 families with four families each contributing two children with AI. The mean age of the present study sample was 12 years (range: 3-17 years). Female predilection (12/20) with a male to female ratio of 2:3 was also noted. With reference to racial distribution, majority of the affected children were Sinhalese 65% (13/20) followed by 15% (3/20) Tamils and 20% (4/20) Muslims. Out of the twenty patients with AI, 45 % (9/20) had hypoplastic form (Type I) while 30% (6/20), 15% (3/20), 10% (2/20) had hypomaturation (Type II), hypocalcification (Type III), hypoplastic/hypomaturation form (Type IV) of the disease, respectively. A positive family history could be identified in 50% (8/16) of the families having children with AI. With pedigree plotting, a positive identification of patterns of inheritance as either autosomal dominant or X-linked pattern was possible in eight families. Eight children were considered to show autosomal recessive pattern of inheritance as these children had parents in consanguineous marriages. The remaining three children, without identifiable pattern of inheritance, were considered as sporadic cases of AI. Children who may have Kohlschutter syndrome, Cone-rod dystrophy and Tricho-dento-osseous syndrome were identified, and are currently undergoing further investigations to confirm the diagnoses.

In the absence of previous published studies, our study reports the first descriptive analysis of subtypes of AI in Sri Lankan context and our findings shed light into lesser-known aspects of this complicated group of conditions. This baseline data could be used to improve the awareness among dental surgeons and to highlight the importance of early accurate diagnosis leading to improved quality of life among patients affected by AI.

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Relative Frequency of Odontogenic Tumours in Sri Lanka: An Analysis of 1674 Cases

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Odontogenic tumours (OT) are lesions derived from epithelial, ectomesenchymal and or mesenchymal elements of the tooth forming apparatus. It constitutes a heterogeneous group of lesions with diverse histopathologic features and clinical manifestations. The spectrum of biologic behaviour of these lesions ranges from hamartomatous or non neoplastic tissue proliferations to malignant neoplasms.

The objective of this study was to determine the frequency of odontogenic tumours (OTs) in Sri Lankan population. A total of 1674 cases of OTs retrieved from the archives of the Department of Oral Pathology, Faculty of Dental Sciences, University of Peradeniya, Sri Lanka were analysed for age, gender and primary site of the tumours. Cases were re-classified according to the new W.H.O. OT classification (2005). Relative frequency of different types were also analysed and compared with the literature.

Odontogenic tumours represented 3.75% of all cases received during the period of 30 years (1980 - 2010). Ninety eight percent of these tumours were benign and the rest was malignant. Mandible (73.9%) to maxilla (26.1%) ratio was 2.8:1. Posterior part, the molar region was the most frequently affected site for the mandible whilst it was the anterior region for the maxilla. The age ranged from 1-80 years with a mean age of 30.6 years. Ameloblastoma of solid/multicystic (S/MA) and unicystic (UA) types showed high preponderance for the mandible (>90%) with a ratio of 12.9:1 and 10.8:1, respectively. In accordance with the literature, adenomatoid odontogenic tumours (AOT) and odontomas showed higher maxillary predilection with the ratio of 2.3:1 and 6.6:1, respectively. Desmoplastic ameloblastomas tend to occur commonly in anterior maxilla. Tumours that involved more than two areas such as premolar-molar area or incisor-premolar area or half of the mandible were mainly ameloblastomas (S/MA & UA) and keratocystic odontogenic tumours (KCOT). Out of 1674 cases, 48.7% were ameloblastomas, and other tumours such as KCOT, odontomas, AOT were 25.7%, 10.1% and 4.6%, respectively. The cases that involved more than one zone in mandible were 478 (45.5%) and 118 (31.2%) in maxilla. In conclusion, although odontomas are said to be the commonest in western countries, our results showed ameloblastoma as the commonest, followed by KCOT.
Analysis of the Relationship between Status of Nodal Metastasis, Clinical Stage and Histological Parameters of Oral Squamous Cell Carcinoma

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More than 50% of patients with squamous cell carcinoma of the oral cavity have lymph node metastases and histological confirmation of metastatic disease is considered the most important prognostic factor. Among the patients with a clinically negative neck, the incidence of occult metastases varies with the site, size and thickness of the primary tumour. The TNM (Tumour/Node/Metastasis) staging system allows clinicians to categorise tumours of the head and neck region to assist with the assessment of disease status, management and prognosis. Management of clinically negative neck is debatable in patients with oral squamous cell carcinoma (OSCC). Although various therapeutic approaches are available, the data supporting any particular strategy do not appear to be consistent.

The stage of oral cancer is one of the main prognostic indicators. The main aim of this study was to evaluate the relationship between stage of tumour and the level of nodal metastasis and to analyse the relationship between primary site, pattern of invasion and extra capsular spread with the stage of tumour.

During the study period of 1999-2008, 292 patients of OSCC with neck dissections were included in the study. Clinical details including the clinical stage of the tumour and histopathological features such as level of differentiation, nodal status and pattern of invasion were assessed. The M: F ratio was 2.8:1. The age ranged from 24 to 86 years (mean age of 57.8±9.98 SD years). The commonest primary site was buccal mucosa followed by tongue. There were 123, 144 and 25 cases of well differentiated, moderately differentiated and poorly differentiated cancers, respectively. Of the 292 patients, 110 cases showed microscopically positive nodes and 80 of them showed extracapsular invasion. Almost all stage 1 and 2 tumours showed negative nodes and all cases of stage 3 and stage 4 tumours showed lymph node metastasis and this association was statistically significant for each site (P < 0.001; chi-square test). There was a significant association between the stage of the tumour and extracapsular invasion (P < 0.001; chi-square test). Pattern of invasion was another reproducible prognostic marker which showed a significant relationship with metastasis and extracapsular invasion (P < 0.001, chi-square test).

In conclusion, the present study provides valuable information with regard to treatment plan for patients with clinical stage 1 and 2 tumours (T1N0, T2N0). Tumours with stage 3 and 4 with pattern of invasion III or IV appears to be reliable predictors of metastasis and can be used as a tool to decide management of neck nodes. Therefore, clinical stage of the tumour should be regarded as a key factor in deciding the treatment of neck nodes in OSCC.
Oro-Facial Features, Related Medical Problems and the Level of Dental Caries in a Group of Children with Down Syndrome

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Down Syndrome (DS) is a genetic disorder with severe growth and intellectual impairment, which results from the presence of an extra chromosome 21. Although genetic disorders are rare, DS is relatively common with an incidence of 1:700 to 1:1000. Among the range of clinical manifestations, which depend on the variable expression of the genetic mutation, some features are characteristic to DS. A majority of these appear in the oro-facial region either extra-orally such as narrow palpebral fissures or intra-orally such as macroglossia.

Children with DS belong to a large group of patients who need special dental care. This is not only due to their apparent inability to comprehend, but also due to other complications such as cardiac pathologies and impaired immunity, which have serious implications to the choice and execution of treatment. Dental caries incidence was earlier reported to be less in children with DS compared to that of healthy children. This has been attributed to the spacing between teeth and increased salivary Immunoglobulin A levels. Contrary findings have been reported in a more recent study that discovered the level of dental caries of DS children to be higher compared to that of normal children.

The main objectives of this study were to assess the level of dental caries and other intra-oral features, and the common medical problems of DS children and to assess the association of three of the known risk factors for development of DS, i.e., advanced maternal age, having a sibling with DS and consanguinely married parents. This study group consisted of all children with DS, from two special schools in the Kandy district, who met specific selection criteria. The data were collected using cross calibrated examiners after acquiring written proxy consents from parents. Subsequently, results were presented using descriptive statistics.

From the sample, 88% of children had at least one tooth with caries. This is in agreement with current trends in caries patterns that had been observed in DS children. DMFT and dmft indices were 3.25 and 6.7, respectively and were clearly high, compared to those of normal children which were 0.9 and 3.5, respectively (National Oral Health survey 2003). High percentage of children with untreated caries also indicates less attention to dental care of this group of children. Congenital cardiac or thyroid problems were observed in approximately 50% of the sample and all the participating children demonstrated macroglossia or ‘relative macroglossia’. Seventy percent of DS children in this sample were born to mothers who were over 35 years of age, and only 8% were from consanguinely married parents.

Higher DMFT and dmft values and high occurrence of medical problems in DS children demand early intervention for prevention of dental caries and special precautions in management procedures.
A Survey on Tobacco Use and Awareness on Tobacco Related Health Hazards among Teenage Students

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According to the World Health Organization (WHO), tobacco use is one of the major preventable causes of premature deaths and disease in the world. In Sri Lanka, tobacco is consumed in two forms: smoking and chewing. Chewing tobacco is used mainly as a complement to betel chewing. Smoking is mainly practiced in the form of cigarettes, beedi, and cigars. The aim of this study was to identify the tobacco habits and awareness on tobacco related health hazards in school children of 15-18 years of age.

A group of 763 students (290 males and 473 females), aged between 15-18 years, studying in randomly selected schools from the Theldeniya education zone participated in the study. Data was collected using a self administered questionnaire with both open ended and multiple choice type questions.

Among the sample, 20.8% (159 students) had used tobacco products at least once which included 40% male (116) and 9.1% females (43) students. The gender difference was statistically significant (p < 0.001). Among the male students who use tobacco products, 56.9% chewed tobacco with betel leaves while 24.1% were smokers. Another 16.1% were using both forms of tobacco and all the female users were tobacco chewers. Accordingly, when the total sample was considered, 16.8% chewed tobacco leaves while 6.2% were smokers. All smokers were males. The relationship between the gender and the type of tobacco products used, was statistically significant (p < 0.001). Elders in the family who use tobacco were the main influence for the children to start using them (56%). Friends also had strong impact on the boys (41%) but not much on the girls. Boys were almost equally interested in pleasure (48%) and experimenting (47%) while using tobacco products, whereas girls were mostly experimenting (84%). Stress relief and/or peer pressure did not seem to be an important factor among the current study sample. All students were able to name at least one tobacco related health problems.

When the total sample was considered 52.9% did not have any family members using tobacco products. However, when only the tobacco users were considered, it was 81.1%. This relationship was statistically highly significant (p < 0.001). The type of tobacco products consumed by the family members appears to have an impact on the tobacco use by the children. When the tobacco using family members were considered, 87.2% chews it with the betel quid. Since betel chewing is considered as a habit associated with the Sri Lankan culture, it is not categorised as a bad or hazardous habit like smoking by many people. Instead, it may be even encouraged by some adults. It is also freely available in most of the households and there are no legal or social restrictions even for minors to acquire them. Therefore, these findings may be useful in implementing tobacco control policies in Sri Lanka.
Prevalence, Severity, Pattern of Dental Caries and Care Index of Six Year Old Primary School Children in a Semi Urban Area in Kandy, Sri Lanka

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Dental caries is a significant health problem among Sri Lankan children and fluoride is the most important agent that can be used to control dental caries. The School based Fluoride Mouth Rinsing (SFMR) program is a world recognized economical dental caries preventive measure. The aim of the present study is to evaluate the prevalence, severity, and patterns of dental caries and care index of 6 year-old primary school children in a semi urban area in Kandy in order to implement a SFMR program.

This study group consisted of 410 children from six selected schools in Denuwara Educational Zonal, Kandy. The clinical oral examinations were carried out and the numbers of decayed, missing or filled teeth (DMFT/dmft index) or affected tooth surfaces (DMFS/dmfs index) were recorded. Care Index was adapted to assess the oral health care level of the population.

According to the study group, 32% children were caries-free, while the mean dmft was 3.5 (±0.36), mean dmfs was 6.78 (± 0.79) and mean DMFT was 0.02 (± 0.01) for the total sample. There was no statistically significant difference between males and females on the prevalence of caries. The decayed component of the dmft was 76.26% and the filled component was 10.74%. The Care Index which reflects the contribution made to the dmft by filled teeth (ft), of the present study was very low (10.61%) when compared to that of the British population (86.4%). Further, 11.8% of total sample showed Molar Incisor Hypomineralization (MIH). This suggests a high risk for demineralization of teeth in these children. In 1981, WHO and FDI (International Dental Federation) formulated an oral health goal for 5-6 year old children by year 2000, by which 50% of children would be caries free. However, our results indicate that we are far behind this goal even in 2010. Therefore, the necessity to develop preventive strategies such as SFMR program or water fluoridation or fluoride varnishing program is significant.
Denture Induced Stomatitis and Associated Factors in Patients Attending the Dental Hospital, Peradeniya, Sri Lanka

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Denture induced stomatitis (DIS) is a common oral medical problem in the elderly denture wearers. Clinically, DIS is characterized by erythematous patches on the denture bearing mucosa in both jaws with a high predilection for maxilla. However, there is no consensus on the aetiological factors of DIS at present. Therefore, objectives of this study were to determine the factors associated with DIS, assess the feasibility of using the presence of hyphae in palatal smears and denture surfaces to diagnose Candida associated DIS and assess the oral and hand carriage of Candida by DIS patients.

Complete or Partial denture wearers (n=47) presented to the clinic with DIS from April to September 2011 were included in the study. An interviewer administered questionnaire was used to obtain socio-demographic data, medical and dental history, status of receiving post delivery instructions and denture and oral hygiene habits. Denture hygiene was assessed using modified Hoad-Reddic classification. Clinical type of DIS was recorded in Newton’s classification. A scraping from the palatal mucosa and a swab from the denture surface were obtained from each patient and stained with Periodic Acid Schiff stain to determine the presence of candidal hyphae. Concentrated oral rinse technique using 10 ml of sterile phosphate buffered saline was done in order to assess the oral yeast colonisation. Candidal hand carriage was assessed using fingerprints on a plate of Sabourad’s agar. Identification of Candida was done using colony characteristics and Gram’s stain.

There were 87.2% (n=41) Sinhalese, 6.4% (n=3) Tamils and 6.3% (n=3) Moors, out of which 89.4% (n=42) were female and 10.6% (n=5) were males. Their ages ranged from 31-80 years (mean = 56.91; SD = 10.07). Eighty three percent had received post delivery instructions. Unsatisfactory denture hygiene was observed in 70.2% of the upper dentures. Majority (66.0%) used dentures during sleep. Age of the current denture set varied from 1-41 years (Median = 10; Interquartile Range = 5-17). Most frequent clinical pattern of DIS was Newton type II (70.2%). Majority (57.7%) showed candidal hyphae on both palatal mucosa and denture. There were 55.3% (n=26) patients carrying Candida in oral cavity and in hands. The odds ratio for carrying Candida in hand by oral candidal carriers was 9.5.

Our observations are in agreement with a previous finding. The likelihood of carrying Candida in hand by an oral candidal carrier was very high. Factors such as denture hygiene, increased denture age and use during sleep may be associated with DIS. Denture hygiene was generally not satisfactory in majority in spite of high rate of receiving post delivery instructions.
Dental Practitioners’ Views on Adequacy of Undergraduate Training in Dental Laboratory Technology

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The undergraduate curricula in dental schools worldwide are undergoing frequent and constant revisions. Decreasing edentulism and advances in technology have led to changes in patient management and treatment options available for general dental practitioners in Sri Lanka as well. Yet, the present undergraduate training program in removable prosthodontics of the Faculty of Dental Sciences, University of Peradeniya has seen little change in the past few years. As benchmark specifications are not available for teaching prosthodontics in Sri Lanka, the aim of the present study was to investigate the views of dental practitioners in Sri Lanka on the relevance of undergraduate training in dental laboratory technology in their practice.

A pretested questionnaire was posted to 750 dental practitioners in Sri Lanka exploring their socio-demographic information, professional qualifications and clinical experiences and their views on undergraduate laboratory technology training.

Hundred and seventy three dental practitioners with a mean experience of 19.2 ± 12.24 (SD) years responded. Eighty four per cent of them were from urban areas and 67% were males with 58.4% having no postgraduate training. Fifty two per cent of the respondents indicated that the program needs improvements. From the respondents 39.9% - 60.7% reported that there is no training on techniques such as fixed prosthetics, maxillofacial prosthetics and ceramic techniques. Of the respondents, 8.1% to 68.8% indicated that the exposures to different laboratory technical procedures are inadequate. Sixty nine percent to 80% of respondents reported that fixed prosthodontics, ceramic techniques, metal removable partial dentures and indirect restorations are among the techniques useful in practice but still not included in the training program.

In general, the practicing dental surgeons are of the opinion that the extent of the current training in laboratory techniques in commonly used treatment modalities is less relevant and insufficient for catering to the treatment demands of patients. These findings highlight the need for updating the content of available curriculum of prosthodontics to equip future dental surgeons to meet the demands in their practice.
Sanitary Issues of Plantation Sector Workers – A Case Study in Pussellawa, Sri Lanka

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Health and sanitary condition of people in Sri Lanka have been developed remarkably over the past two decades. However, poor sanitary conditions are still prevailing in some communities in the country, especially within plantation sector worker communities probably due to the lower education levels and/or traditional habits. Their residences are overcrowded with less space, and lack of proper sanitary facilities.

This study was carried out in a tea estate community in the Melfort Estate, Pussellawa, Sri Lanka to identify the socio economic factors and the health and sanitary issues leading to stream pollution. A questionnaire survey and site investigations were carried out in a densely populated stretch closer to a drainage stream at the Melfort Estate, to find out the type of households, population data, available sanitary facilities including excreta disposal mechanisms, gray water disposal mechanisms and water consumption patterns etc.

The results indicate that even though majority of households in this community (95%) comprises with a pit latrine for disposal of excreta properly, still few people (3% of total population) uses improper ways of excreta disposal methods like open defecation in bare lands. In addition, excreta of 14 infants and 2 elderly people with walking difficulties out of 325 populations (ie. 5% of total population) are disposing directly in to the drainage stream or on bare land contributing to the stream pollution. Moreover, 26% of pit latrines are with close proximity to the stream which allows leaching of toilet waste into the stream. Further, people dispose their gray water and garbage improperly, creating aesthetically unpleasant and environmentally damaged sites. Therefore, to prevent further deterioration, these communities should be made aware of the prevailing sanitary issues together with suitable remedial measures.
Cardiac Sounds Monitoring by Resonant Frequency of the Heart Sound

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This paper describes cardiac sounds monitoring techniques using advanced signal analysing algorithms. Cardiac sounds contain very important information about activities in the heart. In general, doctors analyse cardiac signals by listening to patient’s heart sounds using acoustic stethoscopes. However, this technique is one of the oldest and primary ways of observing audio cardiac signals. The resonant frequency of the heart is highly correlated with the structure of the heart. Therefore, this paper investigates the probability of using resonant frequency of the heart for diagnosis of diseases. The cavity of the heart can be modelled using all poles acoustic filter as shown below in formula (1).

\[
H(z) = \frac{1}{1 - 2\cos(\omega_0 z^{-1})}
\]  

(1)

Cavity Filter coefficients were predicted by using linear predictive coding (LPC) method. With the use of conjugate pole pairs in cavity filter it is possible to generate formants frequency components in a heart signal. Formants are the resonant frequencies of the heart signal which is produced due to propagation through the human chest cavity.

There are four different types of cardiac signals that are used for analyses. These are normal cardiac signals and the three different heart murmur sounds. Patent ductus arteriosus (PDA), pulmonic stenosis (PS) and mitral regurgitation (MR) are the murmurs which are been used for this research. Three sample signals from each case were analysed.

According to the frequency spectrum graphs, it was revealed that analysed cardiac signal characteristics are different from each other. When spectrum results of each cardiac signal are closely observed, some sudden peaks were noticed. These peaks occurred at the resonating frequencies of the cardiac signals. To further differentiate normal cardiac signals from murmurs, each signal’s first two resonating frequencies were plotted in F1-F2 plane as shown in figure 2. By plotting multiple realisations of healthy cardiac signal outputs in the F1-F2 domain, it is possible to define a ‘general subspace’ for healthy cardiac signals. Proper identification of this subspace enables the diagnostician to distinguish between normal and murmurs conditions without much ambiguity.
Prevalence of Diarrhoea and Intestinal Parasites and Possible Factors Affecting Transmission in Children Admitted to Kattankudy Base Hospital

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Kattankudy, with a population comprising of 7.7% of the total population of Batticaloa district is one of the major towns in this district. This study was done to assess the prevalence of intestinal parasites and diarrhea among children who were admitted to Kattankudy Base Hospital.

Children less than twelve years of age who were admitted to the Paediatric ward from April to June 2010 were included in this study. Faecal samples were fixed with 10% formalin and transported in screw capped bottles to the Department of Parasitology, Faculty of Medicine, University of Peradeniya. Samples were processed using the formol-ether concentration technique and modified Ziehl-Neelson stain. Socio-demographic data were collected via an interviewer-administered questionnaire.

A total sample of 96 children with mean age 4.84 years (SD = 2.7) which included 59 males (61.45%), had a prevalence of diarrhoea of 22.9%. Of these, 77% were under six years of age. The prevalence of intestinal parasites was 4.54% (1/22) in diarrhoeal samples and 10.81% (8/74) in solid stools.

One child had cysts of 	extit{Entamoeba histolytica} / 	extit{Entamoeba dispar} (1.04%), two had 	extit{Entamoeba coli} cysts (2.08%), and two had 	extit{Giardia duodenalis} cysts (2.08%). Among those with helminth ova three had 	extit{Ascaris lumbricoides} (3.125%) and two had hookworms (2.08%). 	extit{Cryptosporidium} species were not found. Of the 60.41% (n=58) who obtained water from wells 24.13% (n=14) had diarrhoea. Incidence of diarrhoea was less among those who used tube wells rather than shallow wells. Of the 83.34% who used a toilet for defecation, 17.5% (n=14) had diarrhoea. However 50% of those who did not use toilets also had diarrhoea. Anthelminthic treatment had been given to 47.29%.

Prevalence of intestinal parasites in Kattankudy was 9.37% (n=9). One fifth of admissions were due to diarrhea. Use of toilets and tube wells was associated with reduced numbers of diarrhoea cases.
Seroprevalence of Toxoplasmosis and Diagnosis of Acute Toxoplasma Infection among Pregnant Women

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Toxoplasma gondii is an obligatory intracellular protozoan parasite of both humans and warm blooded animals with worldwide distribution. This parasite is transmitted to humans mainly by ingesting food or water contaminated with oocysts shed by cats, or by eating raw or undercooked meat containing tissue cysts. In healthy humans, T. gondii infection is generally subclinical or mild. However, disease can occur in-utero or when the host is immunocompromised. Transplacental transmission from mother to foetus may have serious consequences for the foetus when acute infection occurs during pregnancy. In Sri Lanka, although several studies have been done to determine the prevalence of this infection, the majority of the studies have been carried out in Colombo area. Therefore the present study was carried out to determine the prevalence of toxoplasmosis in pregnant mothers, to determine the incidence of acute toxoplasmosis in pregnancy and to identify exposure related risk factors influencing transmission of toxoplasmosis.

Blood samples were collected from 281 pregnant women attending antenatal clinic, Teaching Hospital, Peradeniya. Each serum sample was subjected to IgG ELISA, followed by IgM ELISA on IgG positive samples. PCR was done on 30 IgG positive samples. Personal details and data regarding known risk factors for the infection were obtained using an interviewer-administered questionnaire.

The age of pregnant women varied between 16 – 56 years (mean = 28) and 55.5% of them were primigravidae. The majority (79.8%) were housewives and only 4.2 % (13) had a past history of miscarriages. Seroprevalence of anti-Toxoplasma IgG was 35.3% and of these, one was IgM positive while 3 were PCR positive indicating acute infection. There were no significant associations between known risk factors (cat ownership, miscarriages, eating raw or under cooked meat, poor hand hygiene, raw meat tasting while cooking) and seropositivity. This study indicates high seroprevalence of toxoplasmosis among pregnant women and emphasizes the importance of adopting preventive measures to reduce the transmission of toxoplasmosis in sero-negatives. Current study further stresses the importance of performing PCR along with serology in the diagnosis of acute toxoplasmosis.

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Can We Use ASGE Guidelines for Sri Lankan Patients Presenting with Dyspeptic Symptoms?

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Upper gastrointestinal endoscopy (UGIE) is a widely used diagnostic tool which is used to detect structural lesions in the upper gastrointestinal system. The American Society of Gastrointestinal Endoscopy (ASGE) prepares guidelines for their population based on their statistics, as such guidelines are not available for Sri Lankan population it is worth verifying whether ASGE guidelines are appropriate for our population, at least for common referral indications.

This was a retrospective observational study carried out at the Endoscopy unit, Teaching Hospital Peradeniya from January 2010 to May 2011, in 305 patients with recently diagnosed dyspepsia without alarming symptoms who were referred for UGIE. Data were analysed using SPSS 16.0 in relation to the cut off age limits and gender of the patients.

The sample consisted of 50.16 % males (153) and 49.84% (152) females with a male to female ratio of 1:1. In the age group < 50 years, 45.5% (71) patients had positive findings, while in the age group > 50 years, 59.7% (89) had positive endoscopic findings with these differences being statistically significant ($\chi^2 = 6.178; p = 0.013$). In female patients 46.7% (71) had positive findings while in male patients 58.2% (89) had positive findings with statistical significance ($\chi^2 = 4.015; p = 0.045$). In the < 50 year group, 62.16% (23) males and 50% (17) females had antral gastritis whereas in the > 50 year group, 55.77% (29) males and 56.76% (21) females had antral gastritis. Therefore, all age groups had antral gastritis as the commonest structural lesion.

Therefore, ASGE guidelines with a cut-off age of 50 years for recently diagnosed dyspeptic symptoms without any alarming signs are applicable for Sri Lankan population. In addition, there was a significant association between males and presence of structural lesions in UGIE. It is advisable to reconsider the implication of endoscopic findings in relation to gender and management of < 50 year old patients with dyspeptic symptoms. On the other hand, it is worthwhile to study the causative factors for high prevalence of antral gastritis in our population and to use appropriate treatment on them and refer only the treatment failures for UGIE. Older patients presented with dyspepsia even without alarming symptoms can be offered early UGIE compared to younger patients.
A Preliminary Study on Characteristics of Patients with Primary Osteoarthritis of the Knee Undergoing Joint Replacement

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Osteoarthritis (OA) is a disease of the synovial joints and the knee is most commonly affected. OA causes pain and immobility of the patient. When other treatments fail, replacement of the joint becomes the only treatment option. It was the aim of this study to analyse the age, gender, body mass index (BMI) and the type of mal-alignment of the knee in patients undergoing knee replacements for primary OA at THP.

The Orthopaedic Unit of the Teaching Hospital Peradeniya (THP) undertakes one knee joint replacement a week and the sample consisted of 102 patients with primary OA from December 2008 to December 2010. The age, gender weight and height of the patients were recorded. Clinical examination and a weight-bearing radiograph of the knee was used to decide whether the patients' knees were varus, valgus or neutrally aligned.

There were 96 females (94.1%) and 6 males in the sample and the age ranged from 46 to 80 years with a mean of 64.2 ± 8.3. Studies elsewhere have reported a higher mean age of over 70 years. The mean BMI of the sample was 26.59 (±4.3) and 23 patients (22.5 %) had a normal BMI (18.5-22.9), 41 patients (40.1%) were in the overweight group (23-27.5) and 38 patients (37.2%) were found to be in the obese group (27.6-40). Sri Lankan patients have a BMI less than that recorded in OA patients in India (30) and Australia (29.7) due to the fact that the Sri Lankan population as a whole has a low BMI. However, the question whether Sri Lankan primary OA patients have a lower BMI compared to the primary OA patients elsewhere needs to be addressed.

In the study patients, 84.3% (86) had varus mal-aligned knees, 5.8% (6) were valgus mal-aligned and 9.8% (10) were neutrally aligned. It appears that varus mal-alignment is much commoner in the Sri Lankan patient compared to patients in U.S.A., U.K. and Netherlands (58 -74%).

The Sri Lankan patients appear to need knee replacement at an earlier age. Predominantly females undergo knee replacements in Sri Lanka. The BMI in the Sri Lankan patients appear to be lower than that of values for other countries. Since this is a preliminary study, further studies are necessary to prove or disprove the above observations and to find the reasons for them.
Injuries Related to Falls: An Audit on Trauma Victims Admitted to Teaching Hospital, Peradeniya

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Falls are a leading cause of injury-related morbidity and mortality in Sri Lanka. However, only little is known about the details on context and characteristics of such falls. The aim of this study was to describe the characteristics of fall related injuries in patients admitted to Teaching hospital, Peradeniya.

Recording of trauma data is done using a questionnaire developed based on WHO injury surveillance guidelines and constitutes part of the prospective data base maintained by the surgical unit. Data is entered into a Microsoft Excel spreadsheet and analysed using Minitab.

Out of a total of 870 patients admitted to the surgical unit during May 2010 to August 2011, due to trauma, falls were the leading cause (382, 43%) and 56% of falls were in males. More than one third (38.2%) of the injuries due to falls were reported in the age group of 0-14 years and of them two thirds were boys. Females were the majority (63%) in the > 55 year age group.

Falls from the same level of the standing position were more common (67.2%) than falls from a height (21.4%). The home environment (84%) was the commonest place where the injury took place. In the age group above 18 years, 12 (5.6%) patients were under the influence of alcohol. All of these patients were males. With regard to the pattern of injuries, most patients 347 (89.7%) had injuries to a single area of the body. Majority of the patients (85.7%) had minor or moderate injuries based on Abbreviated Injury Scale. According the Glasgow Outcome Scale, predicted outcome at discharge was good in most patients (95%).

This study describes the context and characteristics of fall related injuries presenting to a tertiary care hospital of Sri Lanka. It also demonstrates some epidemiological factors such as extremes of age and the use of alcohol which are causative associations. This epidemiological as well as clinical information provides us with insight to plan the management of such injuries and will also guide future funding of public health programs, particularly to develop preventive strategies.
Partial Purification of Anthelmintic Compounds from *Solanum indicum*

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The increase in helminth infections and their growing resistance to most broad spectrum chemotherapeutics is a major problem of medical and economic significance in the tropical and subtropical regions of the world. An effort is now being directed to discover new anthelmintics of plant origin. Previously we have reported that *Solanum indicum* (SI) fruits exhibit strong anthelmintic activity. Objective of the present study was to partially purify the anthelmintic compound/s from SI fruits using solvent extraction and anion exchange chromatography.

Methanol extract of SI fruits was partitioned using butanol and water. Anthelmintic compounds were partially purified from the butanol extract using DEAE Cellulose-52 at pH 7.0. Bound compounds were eluted from the column with a linear gradient of 0-1 M NaCl at pH 7.0. All fractions were screened using *Caenorhabditis elegans* bioassay and their light absorbance was measured at 214 nm. The *C. elegans* Bristol strain N2 was cultured aseptically and bioassay was carried out in triplicate using 96-well plates. Percentage of dead nematodes was counted under light microscope after 24 h incubation with the fractions at 21°C. Mebendazole was used as the positive control and an appropriate negative control was also used.

*Caenorhabditis elegans* is considered the most suitable test organism for preliminary high-throughput *in vitro* screening for broad spectrum anthelmintic activity. Fractions eluted from DEAE cellulose showed anthelmintic activity in four separate peaks based on *C. elegans* assay. Those peaks were eluted at 0.1, 0.28, 0.48 and 0.85 M NaCl. Highest mean death percentages observed at each peak were 53, 59, 37 and 61, respectively compared to the negative control. Fractions showed detectable absorbance only at 214 nm. Total recoveries of compounds showing anthelmintic activity in the four peaks were 13.2% in peak 1, 32% in peak 2, 12.6% in peak 3 and 34.6% in peak 4. The active compounds could not be proteins as the extraction methods used would denature the proteins and may be secondary metabolites which absorb light at 214 nm.

In conclusion, compounds showing anthelmintic activity were partially purified from *Solanum indicum* fruit extracts. It seems that SI fruit contains at least four different anthelmintic compounds. Further studies are necessary to purify and identify these compounds and to find their efficacy against parasitic nematodes.
In-Vitro Inhibition of Pancreatic Lipase by the Polyherbal Formula “Lekhaneeya Dashakaya”

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Hyperlipidaemia and obesity are two important modifiable risk factors of cardiovascular diseases which have become the number one cause of death, globally. “Lekhaneeya Dhashakaya” (LD) has been described in classical ayurvedic text, Charaka Samhitha as the ten most effective herbs that could be used to treat ailments related to hyperlipidemia. LD is used as a decoction or tea in ayurvedic practice to treat hyperlipidaemia. A clinical study conducted previously on patients with ischaemic heart disease and obesity, has shown significant antihyperlipidaemic effects of LD. Pancreatic lipase is being used as a target in modulation of blood lipid concentrations. The objective of this study was to determine the potential of LD to inhibit pancreatic lipase in-vitro and to compare the effect of different processing methods (herbal tea and decoction) of LD on lipase inhibitory activity.

Polyherbal formula LD was prepared as a powder of dried plant materials (DP) which was used either as herbal tea or decoctions. Aliquots of the decoction were collected at 6/8, 4/8, 2/8 and 1/8 of the initial volume. In vitro pancreatic lipase inhibitory activities of the extracts were evaluated using optimum conditions. All experiments were conducted in triplicate on three occasions and percent inhibitions were expressed as mean ± standard deviation.

Lipase inhibition was observed in all the tested extracts with mean percent inhibitions 35.64 ± 0.87 with herbal tea, 25.21 ± 0.9, 30.01 ± 1.11, 45.79 ± 1.23 and 47.95 ± 0.91 with 6/8, 4/8, 2/8 and 1/8 volume extracts of the decoction respectively. It was observed that lipase inhibition increased with the increase of processing time of decoction. However, herbal tea showed a relatively higher inhibition, compared to that of the decoction with similar processing time. This observation may possibly be an indication of a heat labile nature of lipase inhibitor/s present in the LD. Inhibition of pancreatic lipase may be one of the mechanisms which could have contributed to the antihyperlipidaemic effects of LD seen in the clinical study conducted by another group. However, the nature of the inhibitor/s is yet to be studied.

In conclusion, this study shows scientific evidence for in-vitro inhibition of pancreatic lipase by LD and that this lipase inhibitory effect depends on the processing method used. However, both processing methods used have shown promising inhibitory potential. Further studies are necessary to identify in-vivo effect of LD on lipase activity.
Analysis of Blood Parameters and RT-PCR Results in Dengue Suspected Patients from Kandy and Padaviya

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Dengue Fever is currently considered the most important mosquito-borne viral infection in Sri Lanka with thousands of patients affected each year with a significant social, economic and political impact. Early diagnosis of dengue infection can reduce the numbers of cases of dengue haemorrhagic fever and dengue shock syndrome. Primary diagnosis of dengue is usually based on clinical signs, symptoms and haematological testing. Single-step reverse transcriptase polymerase chain reaction (RT-PCR) offers a sensitive and specific diagnostic procedure for detection and serotyping of dengue virus. Objective of this study was to analyse the blood parameters and RT-PCR results in clinically suspected Dengue patients.

Blood samples were obtained during the first 5 days of the febrile phase, from ninety eight (98) clinically suspected dengue patients who were admitted to Kandy (68) and Padaviya (30) hospitals. Following investigations were carried out at the Department of Biochemistry: RNA extracted from serum samples was subjected to single tube multiplex RT-PCR; haematological parameters included total white cell count (WBC), differential count, platelet count, haemoglobin concentration (Hb), pack cell volume (PCV); clinical chemistry parameters included aspartate transferase (AST) and alanine transferase (ALT) concentrations. Recommended quality control methods were used in all procedures. Data were analysed using Student’s t-test.

Out of the 98 blood samples analysed, 42 (43 %) showed positive results with RT-PCR and all positive samples were of DEN-2 serotype (119 bp PCR product). Blood parameters, namely, WBC, platelet count, Hb, PCV, AST and ALT, showed significant differences (p< 0.05) between RT-PCR positive and negative samples. Among the parameters ALT level was the most significantly affected in relation to RT-PCR positivity. More than 50 IU/ L of ALT level was observed in 90% of the RT-PCR positive patients. Similar increase of ALT was seen only in 3.6% of the RT-PCR negative patients.

In conclusion, 43% of the samples tested were RT-PCR positive and all positive samples were of DEN-2 serotype. Positive correlation between elevated levels of ALT and RT-PCR positivity would be useful in identifying patients infected with dengue virus and to manage them accordingly.
Assessment of Nutritional Status of Elderly Hospitalised Patients According to Their Co-Morbid Conditions and Educational Levels Using Mini Nutrition Assessment Tool


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Elderly patients suffering from various age specific and other diseases and vulnerability to those diseases increase with a higher risk of them being nutritionally deprived. Mini nutrition assessment tool (MNA) has been developed for rapid assessment of the nutritional status of geriatric patients. Data on prevalence of malnutrition in various disease conditions is not available in Sri Lanka. This present study applied the MNA tool to find the prevalence of malnutrition in hospitalised elderly patients according to their co-morbid conditions and educational level. A cross-sectional hospital based study was conducted at the Medical wards 07 and 08, Teaching Hospital, Peradeniya in August to September 2011 using an interviewer administered questionnaire. All patients > 65 years old were included in the study. Maximum circumference of the left calf was measured. A total score of 0-7 points was considered ‘malnourished’, 8-11 ‘at risk of malnutrition’ and 12-14 ‘normal nutritional’ status.

A total of 175 patients were included in the study. Thirty three patients had chronic obstructive pulmonary disease (COPD) and two of them (6%) had normal nutritional status, nine (27.27%) were at risk of malnutrition and 22 (66.66%) were malnourished. Numbers of hypertensive patients were 82 and 12 (14.63%) had normal nutritional status, 37 (45.12%) were at risk of malnutrition and 33 (40.24%) were malnourished. Diabetes mellitus group included 36 patients and six (16.66%) had normal nutritional status, 19 (52.77%) were at risk malnutrition and 11 (30.55%) had malnutrition. Twenty two patients had ischemic heart disease and three (13.63%) had normal nutritional status, ten (45.45%) were at risk of malnutrition, nine (40.90%) were malnourished. Fourteen patients had bronchial asthma and one (7.14%) had normal nutritional status, ten (71.4%) were at risk of malnutrition, three (21.4%) had malnutrition. Twenty seven patients had no identified co-morbid conditions and three (7.8%) had normal nutritional status, 17 (44.73%) were at risk of malnutrition, 18 (47.36%) were malnourished. In the study population, 27 patients have not gone to school and none of them had normal nutritional status. Of them, 13 (48.14%) were at risk of malnutrition and 14 (51.85%) were malnourished. Out of 55 patients who were educated from grade 1-5, two (3.63%) had normal nutritional status, 18 (32.72%) were at risk of malnutrition, 35 (63.63%) were malnourished. Of 67 patients educated up to grade 6-11, 11 (16.41%) were at normal nutritional status, 31 (46.26%) were at risk of malnutrition, 25 (37.31%) were malnourished. Out of 26 patients with educational level at grade 12, seven (26.92%) had normal nutritional status, 12 (46.15%) were at risk of malnutrition, seven (26.92%) were malnourished.

This study shows different co-morbid conditions affect nutritional status in different ways. COPD patients had the highest prevalence of malnutrition (66.66%). COPD leads to the development of malnutrition and vice versa. Bronchial asthma patients were at highest risk of malnourishment (71.4%). Diabetes and hypertension affect nutritional status in a more complex way because almost all were type 2 diabetes patients and a significant percentage of them were obese. As the educational level of patients increase, the prevalence of malnutrition decreased and normal nutritional status increased. Therefore, planning of nutritional intervention of patients should differ according to different disease conditions and educational levels.
Assessment of Nutritional Status of Medical Ward Patients Aged More Than 65 Years Using Mini Nutrition Assessment Tool


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Mini nutrition assessment tool (MNA) was developed to rapidly assess the nutritional status of elderly people which can be used as part of a standard evaluation of such patients in the wards. This is a validated tool, already in practice in western countries which show the prevalence of malnutrition among hospitalised patients to be 20.5%-21.5%. Currently MNA tool is not used for this purpose in Sri Lanka and data on prevalence of malnutrition in hospital settings is also not available. Early detection of patients who are at risk of malnutrition helps health care workers to take necessary preventive actions. This present study applies MNA tool to find the prevalence of malnutrition in hospitalised geriatric patients and also according to their age and gender.

A cross-sectional hospital based study was conducted at the Medical wards 07 and 08 in Teaching Hospital, Peradeniya in August and September 2011 using an interviewer administered questionnaire. All the patients > 65 years were included in the study. Left calf circumference was measured instead of body mass index (BMI). Responses to the questions and the calf circumference were given different scores and finally the total score was calculated. If the total score fell between the range of 0-7 points patient was categorised as malnourished, 8-11 at risk of malnutrition and 12-14 normal nutritional status.

Of the total 175 patients (99 male, 76 female) included in the study, 20 (11.4%) were in the normal nutritional status, 74 (42.3%) were at risk of malnutrition and 81 (46.3%) in the malnutrition categories. Out of 99 males, 15 (15.15%) had normal nutritional status, 46 (46.46%) were at risk of malnutrition and 38 (38.38%) were malnourished. Out of 76 females, five (6.57%) had normal nutritional status, 28 (36.84%) were in at risk malnutrition category and 43 (56.57%) had malnutrition. Out of 95 patients in the 66y-75y age group, 14 (14.73%) had normal nutritional status, 46 (48.42%) were at risk of malnutrition, 35 (36.84%) had malnutrition. Out of 70 patients in the 76y-85y age group, 6 (8.57%) had normal nutritional status, 25 (35.71%) were at risk of malnutrition, 39 (55.71%) had malnutrition. In the age group of > 86y, none had normal nutritional status, 3 (30%) were at risk of malnutrition, 7 (70%) were malnourished.

This study shows 46.3% of hospitalised patients were malnourished and 42.3% were at risk of malnutrition. These figures are much higher than the western figures. Female malnourished group contain more patients than their male counterparts, but male patients were at a higher risk of malnutrition than females. As the age increases, the number with malnutrition and risk of malnutrition increased. As admissions of malnourished elderly patients into medical wards are high in Teaching Hospital Peradeniya, it is a major health care problem. Health care workers should pay more attention to identify patients who are malnourished and at risk of malnutrition patients and take action to improve their nutritional status, which will lead to rapid recovery of patients.
A Preliminary Study on the Hypoglycaemic Effect of *Averrhoa carambola* (Star Fruit) in Rats

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Diabetes mellitus (DM) is one of the five leading causes of death in the world. As estimated in 2008, around 24% of the Sri Lankan population suffer from this deadly disease. Maintenance of normoglycaemia is the key issue in managing these patients, and this is achieved by administering exogenous insulin or other hypoglycaemic agents. *Averrhoa carambola* (star fruit) leaves have been a part of traditional medicine used in Ayurvedic preparations to treat DM in Sri Lanka. Researchers have investigated the hypoglycaemic effects of several insoluble fiber-rich fractions (FRFs) including insoluble dietary fiber, alcohol-insoluble solid and water insoluble solid from the pomace of *A. carambola*. The objective of the study was to investigate the effect of *A. carambola* fruit pulp on blood glucose level of healthy rats.

Thirty male Sprague Dawley rats weighing between 150-350 g and ten healthy female Sprague Dawley rats of the same age and weight were used in the study. The animals were caged individually at the Animal House, Faculty of Medicine and were provided with 25 g of broiler starter feed per day with *ad libitum* water. They were allowed to get accustomed to the experimental set up for a period of two weeks and were divided equally into the test groups (male and female), and control groups (male and female). *A. carambola* fruit pulp was prepared by homogenising ripe fruit with a little added water in a warring blender and the resultant pulp was stored at -20°C. The animals in the test groups were then fed with the *A. carambola* fruit pulp at a rate of 1600 mg/kg body weight for 63 days and the fasting blood glucose levels were measured each week, using an enzymatic assay method using glucose oxidase enzyme. Results were compared between *A. carambola* fruit pulp treated group (1600 mg/kg BW) and control group which received only the basal diet using analyses of variance and Dunnet’s t-test.

Treatment with *A. carambola* fruit pulp significantly (*p = 0.033*) decreased blood glucose levels (mean 131.0 ± 10.2 mg/dl) after a treatment period of 8 weeks and elevated body weight in healthy male Sprague Dawley rats compared to that of normal rats (blood glucose levels mean 153.4 ± 11.2 mg/dl). However, although there was a decrease in blood glucose level of the test group after three weeks of treatment the difference was not statistically significant up to 7 weeks. Treatment with *A. carambola* fruit pulp non-significantly decreased the blood glucose levels in healthy female rats after treating for 8 weeks, compared to that of control rats which could be due to hormonal changes in the female animals. This study demonstrates that the *A. carambola* fruit pulp has a hypoglycaemic effect on mammalian systems, which need to be investigated further.
A Cross Sectional Study on Nutritional Care Given to In-Ward Medical and Surgical Patients in Teaching Hospital, Peradeniya


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Ensuring optimum nutritional conditions during an illness is of utmost importance to have a satisfactory patient outcome. Poor nutritional conditions are invariably associated with bad patient outcome resulting in poor wound healing, delayed physical recovery and other complications, finally leading to increased morbidity and mortality. Therefore, the aim of this study was to identify the discrepancies and deficiencies if any in the nutritional intake compared to the individual patient requirement during hospital stay of medical and surgical patients.

The study was carried out in medical, surgical and orthopedic wards in Teaching Hospital Peradeniya, from June to September 2011 and a consecutive sampling method was used. Data was obtained to calculate the calorie requirement using the Harris Benedict equation and protein requirement and both adjusted according to stress factor and sex and compared with what the patient received. Results were expressed as percentages and mean ± (SD), depending on the variable type. Independent sample t test was performed to find out any significant difference between the recommended calorie and protein intake and the amount received.

Of 96 subjects 38.8% was dependant on the hospital meal service while 57.1% depended on home food. The average daily calorie amount received by male patients was 1214.78 kcal ± 849.93 and for females was 1206.21 kcal ± 519.77. The average daily protein amount received by males and females were 47.82 g ± 36.49 and 49.58 g± 27.20 respectively. Sixty one percent of the study sample did not receive recommended nutritional needs. Further, the average daily calorie and protein amount received by patients was significantly lower than the respective recommended values.

In conclusion, a majority of the study sample did not receive recommended nutritional needs during hospital stay. Therefore, further improvement in adequacy and quality of food intake during hospital stay should be encouraged. Further studies are necessary to find out reasons for underfeeding during hospital stay.
An Evaluation of Patients’ Attitudes on Hospital Meal Service


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The aim of provision of hospital meal service is to provide proper nutrition to inward patients, ensuring their health and quick recovery. Therefore, a proper hospital meal service will improve the nutritional care and also minimize the wastage of food. Since the food is prepared in large quantity, improving the quality of food provision in hospital setting remains a difficult challenge.

The objectives of this study were to identify and describe the problems, if any, associated with diet received during hospital stay among inward patients in Teaching hospital, Peradeniya and to evaluate patients’ attitudes on hospital meal service.

This was a cross sectional study carried out in medical, surgical and orthopedic wards of Teaching Hospital Peradeniya over one month based on a pretested structured questionnaire. The questions were designed to focus on patients’ satisfaction regarding nutritive value of hospital meals, meal preparation, and food presentation and to reflect their suggestions to improve the quality of hospital diet from patients’ point of view. Consecutive sampling method was applied and results were expressed as mean ± standard deviation or percentages depending on the variable type.

Out of forty one patients, 51% were medical patients and the rest was surgical. Mean age of study group was 53 ± 16 years and 56% of subjects were males. The mean BMI was 20.5 kg/m² ± 3.8. Majority of patients (58.5%, n = 24) were satisfied with the nutritive value of the food provided and the way of food presentation (78%, n = 32). However 56% of the respondents did not consume the whole portion provided. The main reasons for not consuming the whole portion or for refusal of certain food items were inadequate taste (24.4%, n = 10) and inadequate cooking (19.5%, n = 8). There was a significant relationship between positive attitude towards the hospital diet and the consumption of whole portion (p<0.01). Proper cooking, providing more choices, increasing the amount were few suggestions made by patients to improve the quality of hospital diet.

In conclusion, the patients’ attitude towards current hospital meal service is satisfactory. However food preparation should be improved in relation to providing more choices, maintaining proper temperature and timing of serving.
Can the Spread of Spinal Anaesthesia be changed with Serum and Cerebrospinal Fluid Sodium Concentrations?

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In spinal anaesthesia, the cerebrospinal fluid (CSF) density has a direct relationship with the spread of anaesthetic agent. The CSF density is determined by the CSF sodium (Na\textsuperscript{+}) concentration. Therefore, the changes of CSF Na\textsuperscript{+} may have an effect on spread of spinal anaesthesia.

This study was designed to detect the relationship between CSF Na\textsuperscript{+} and the spread of spinal anaesthesia, and to detect any relationship between serum Na\textsuperscript{+} and CSF Na\textsuperscript{+}.

In this cross sectional study, women (n = 60) with a singleton pregnancy of at least 36 weeks gestation who were scheduled to undergo elective Caesarean delivery under spinal anaesthesia were randomly selected. When spinal anaesthesia was performed, CSF and venous blood were collected to determine the Na\textsuperscript{+} levels using atomic absorption spectrophotometry. The time taken to achieve the maximum sensory level, the quality motor block, and the changes of blood pressure and heart rate were recorded. Results were expressed as mean ± standard deviation depending on the variable type. Pearson correlation coefficient was used for statistical analyses (alpha = 0.05).

There was a weak positive correlation between serum Na\textsuperscript{+} concentration and CSF Na\textsuperscript{+} concentration ($r = 0.308; p = 0.028$). Further, there was a weak negative correlation between CSF Na\textsuperscript{+} concentration and time taken to achieve maximum sensory level ($r = -0.305; p = 0.03$). There were weak negative correlations between CSF Na\textsuperscript{+} concentration and time taken to achieve a maximum systolic blood pressure drop ($r = -0.327; p = 0.037$) and diastolic blood pressure drop ($r = -0.376; p = 0.014$).

In conclusion the findings indicate that there is a significant relationship between serum Na\textsuperscript{+} and CSF Na\textsuperscript{+} concentration. Further, the increase in CSF Na\textsuperscript{+} concentration will facilitate in achieving a quick sensory block.
A Preliminary Study of Distribution of Somatotypes among Sri Lankan Male Elite Runners

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Physical performance is correlated with the body shape and is also associated with the success in sports performance. The genetic makeup dictates our unique body shape and physiological tendencies. Most successful athlete should have a physical structure best suited for it. Studies of high level performances have clearly indicated the association between somatotype and performance.

An individual’s somatotype can be defined by three components namely endomorphy, mesomorphy and ectomorphy. The Heath - Carter method of somatotyping is the most commonly used method to assess somatotype at present. The purpose of this study was to describe the body somatotypes of elite male Sri Lankan short distance runners (SD), middle distance runners (MD), long distance runners (LD) and to compare the three event groups in terms of somatotypes.

The subjects included 16 male athletes who attended the Sports Medicine clinic at Teaching hospital Peradeniya during the period from July 2011 to September 2011. Ten morphological body measurements were taken on a sample of 02 SD (100 m and 200 m), 07 MD (800 m, 1500 m and 3000 m) and 07 LD (5000 m, 10000 m and Marathon) with a mean age of 23.5 years. Somatotypes were calculated according to the standard Carter and Heath (2002) method.

Mean somatotypes were 2-3.6-3, 1.8-3-3.6, and 1.8-3-3.4 in SD, MD and LD respectively. Mesomorphic-ectomorph body type (50.0%) was found to be dominant among all runners followed by Balanced-mesomorphic body type (18.75%), whereas the endomorphic component was the least marked. Commonest somatotype among LD was mesomorphic-ectomorph (71.43%) body type. Distribution of somatotype among MD runners showed a mixed pattern with Mesomorphic-ectomorph, Balanced-mesomorphic and Balanced-ectomorph body types (28.57% each). Adequate sample size is necessary to comment on the distribution of somatotype among SD.
Comparison of Diagnostic Efficacy of Rapid Diagnostic Assays Used for the Detection of Hepatitis B Virus Surface Antigen

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There are different tests available for the detection of hepatitis B surface antigen (HBsAg), which is the main viral marker in hepatitis B diagnosis. Enzyme immunoassaays (EIA) and polymerase chain reaction (PCR) are the most sensitive methods in detecting HBsAg. However, rapid tests are intended for qualitative detection of HBsAg in human serum, plasma or whole blood wherever EIA methods are impractical or cannot be sustained. Several rapid diagnostic tests were developed for screening HBsAg and the majority are based on immuno-chromatographic principle. Immunochromatographic assays (ICA) are cheaper, faster and are easy to perform when compared with EIA, but reliability of these assays varies. The reliability of the test is very important because HBV infection is a serious and silent infection in some patients. The current study was planned to compare two rapid diagnostic test kits, CORTEZ’S HBsAg one step detection kit (Cortez Diagnostics Inc, USA.) and CTK Biotech’s Onsite HBsAg rapid test (CTK Biotech Inc, USA) in detecting HBsAg in serum using the SURASE B-96 (TMB) enzyme immunoassay (General Biologicals Corp, Taiwan) as the gold standard method.

Fifty blood samples received by the Department of Microbiology, Faculty of Medicine, University of Peradeniya for detecting HBsAg between April and August 2010 were tested using the above two tests. Moreover, the SURASE B-96 (TMB) EIA was also performed on these samples.

The gold standard SURASE B-96 ELISA detected 45 samples as HBsAg negative and 5 samples as HBsAg positive. Four samples were HBsAg positive with CTK Biotech’s Onsite HBsAg rapid test and 46 samples were HBsAg negative. Hence, the specificity and positive predictive value (PPV) were 100% but sensitivity and negative predictive value (NPV) were 80% and 97.82%, respectively. CORTEZ’S HBsAg one step detection kit detected 3 samples as HBsAg positive and 47 samples as HBsAg negative, giving specificity and PPV as 100% and sensitivity and NPV as 60% and 95.74%, respectively.

Both ICAs showed less sensitivity and NPV than the EIA. Sensitivity and NPV were higher in Onsite HBsAg kit than the CORTEZ’S HBsAg kit making the former slightly better than the latter for detecting serum HBsAg. Many studies have noted that the specificity and the PPV of the ICAs to be high but sensitivity and the NPV to be low as observed in our study. In conclusion, the accuracy of ICA can vary when compared to EIA. Hence, assessing and validating ICA at regular intervals routinely and/or when changing to a new ICA, will give an idea on the accuracy rate of the ICA used by a particular laboratory in countries where ICA are commonly used.
Viral Aetiology in Children Diagnosed with Acute Bronchiolitis

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Acute respiratory viral infections (ARVI) leading to bronchiolitis are a leading cause of death in children < 5 y of age. Paediatric hospitalisation due to respiratory syncytial virus (RSV) infections is very common in many parts of the world. In the UK, RSV-attributed death rate was 8.4 per 100,000 and viral aetiology for ARVI in Sri Lanka has not been studied.

Objectives of the current study were to screen nasopharyngeal aspirate (NPA) from children diagnosed with bronchiolitis using a mixture of antibodies to detect 7 viruses and characterise the positive NPAs to individual viruses (RSV, Influenza A, B, Parainfluenza 1, 2, 3 and adenoviruses). The NPAs in children between the age of 1 month to 3 years presented to the paediatric ward, Kegalle Teaching Hospital (July to September 2011) with bronchiolitis suspected to be due to ARVI were tested for viral aetiology using immunofluorescence (IF) antigen tests.

Out of the 99 NPAs tested 32 (32%) gave positive results for IF indicating one of seven viruses tested were present in those children suspected having a viral aetiology for the bronchiolitis. When Imagen typing for individual viruses is considered, of the 32 NPAs typed, 29 (29%) gave positive IF for RSV (n=29), para influenza type 2 (n=2) and influenza A (n=1) viruses in the children suspected having a viral aetiology for the bronchiolitis.

Although bronchiolitis suspected to be due to ARVI have been clinically diagnosed in children by paediatricians and general practiceners in Sri Lanka, the aetiologies were not identified. In a recent preliminary study, out of the 70 NPAs from ARVI suspected children tested for influenza A and B during the H1N1 epidemic (June to December 2010), only 5 NPAs were positive for influenza A and B antigens and 65 without the suspected aetiology. The current study has found three different types of viruses including RSV in predominance, parainfluenza 2 and influenza A in children suspected of ARVI, suggesting the prevalence of diverse viral aetiologies in the study population. However, NPAs of 67 children that were clinically diagnosed with ARVI did not show positivity to the common respiratory screening, indicating one of the seven viruses tested were absent. Those children would have had ARVI due to other viral causes such as human metapneumovirus, rhinoviruses and enteroviruses that we have not tested. Large scale studies spread out throughout the year will help us to understand the diversity of these viruses in children with ARVI in Sri Lanka.

Prof J.S.M. Peiris, University of Hong Kong is acknowledged for providing guidance and Respiratory Screening Reagents (DAKO IMAGEN™) for the study.
Assessment of Task Specific Kinetic Finger Tremor while Playing Carrom Using Surface Electromyography


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A tremor has been observed in the middle finger in one fourth of carrom players just before striking. The aim of this study is to describe the characteristics of the above tremor and to determine its effect on the performance of the carrom players using surface electromyography and spectral analysis.

The details regarding carrom play, tremor and any conditions that could precipitate tremor in 150 otherwise normal young adults, who are carrom players, were obtained using a questionnaire. The real-time recording of surface Electromyography (EMG) activity of the Extensor Digitorum Cominis (EDC) muscle of the dominant hand was obtained in a study group of 20 subjects who developed tremor and in a non-tremor control group of 20 subjects. The tremor group and the non-tremor controls were compared at 95% confidence on the frequency, power and performance.

Out of the 150 subjects, 23.3% believed to have a tremor, of whom, 60% believed that the tremor was adversely affecting their performance. The mean frequency of the EMG activity of EDC while playing carrom were 8.310Hz and 8.605Hz for the tremor and non-tremor control groups respectively, showing no statistically significant difference ($p=0.505$). The power of the EMG power spectra of the tremor group was significantly superior to that of the control group ($p=0.001$). The comparison of the performance tested with a chi-square test of independence revealed that there is no significant difference in the performance of the tremor group and the control group.

The power spectra of all the subjects were demonstrating 3 clear peaks at the ranges of 2-5 Hz, 6-11 Hz and 18-24 Hz. Similar peaks had been shown to occur in the power spectra of all subjects while pointing a laser beam into a circle in a previous study. The second peak was consistent with physiological tremor in both studies proving that carrom is an activity which enhances physiological tremor. The higher power of the tremor waves in the subjects observed to develop tremor, allowed the visualization of the tremor waves as opposed to the controls.

This study therefore concludes that a tremor develops while playing carrom in approximately one fourth of carrom players. The frequency of the tremor was found to be within the range of physiological tremor, suggesting that this is an enhanced physiological tremor. Tremor was not found to affect the performance.
Agricultural Risk Index for Chronic Kidney Disease of Unknown Origin

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Chronic Kidney Disease due to unknown aetiology (CKD-U) is one of the growing health problems in Sri Lanka. About eight thousand diagnosed CKD-U patients are enduring treatment, largely in the North Central Region (NCR) 90% of the patients are farmers. The study is designed to estimate an agricultural risk index for an individual who lives in high risk areas of the country. The study is a case control study and 315 CKD-U patients and 321 normal healthy individuals were randomly selected from NCR. The age, sex and agriculture related risk factors were collected from both patients and controls. Multiple linear logistic models were used to calculate the risk index.

The gender of the individual (male, female), age category (<45, 45-60, 60> years), extent of land cultivated (>1, <1 hectares), exchange of labour (hiring labour, high or low), usage of agrochemicals (yes or no) protective measures against agrochemicals (low or high) were considered for the calculation of the index using the following formula:

\[ \ln \left( \frac{\pi}{1-\pi} \right) = \beta_0 + \beta_1 \times \text{age} + \beta_2 \times \text{gender} + \beta_3 \times (\text{cultivated area} \times \text{exchange of labour}) + \beta_4 \times (\text{usage of agrochemicals} \times \text{protective measures against agrochemicals}) \]

\( \pi = \) probability of the disease occurrence, \( \beta_0 = \) regression constant, \( \beta_i = \) Regression coefficient of the \( i^{th} \) variable.

According to the multiple linear regression logistic models, the maximum and minimum risks were calculated as 1.0 and 0.0 respectively. The male individual > 60 years of age, low exchange of labour and poor protective measures against agrochemicals had the highest risk of getting CKD-U irrespective of the cultivated land extent (p =0.87). Females < 45 years of age with high labour exchange and using good protective measures had the lowest risk (p= 0.14) irrespective of the cultivated land area. The calculated risk index will be useful to identify individuals at risk of developing CKD-U and to implement preventive strategies for the disease in the high-prevalence area. The individuals > 60 years of age with poor agricultural practices had the maximum possibility of getting CKD-U probably due to long term exposure to the aetiological agents and risk factors in this area.

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Agricultural Risk Factors of Chronic Kidney Disease of Unknown Aetiology in North Central Region of Sri Lanka

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Health professionals in Sri Lanka have noticed a high incidence of a new form of chronic kidney disease of unknown aetiology (CKD-U) in farmers of North Central Region (NCR).

The aim of the study was to identify the risk factors related to farming in order to implement preventive strategies. Potential agricultural risk factors and other information were collected through interviewer-administered questionnaires given to 315 CKD-U patients and 321 healthy controls that were randomly selected. The relative risk of each factor was compared in terms of Odds ratios (ORs) and 95% confidence interval (CI) by applying the linear logistic model.

Involvement in paddy farming activities (OR = 1.945, 95% CI; 1.256-3.010), usage of agro-chemicals (OR = 2.034, 95% CI; 1.297-3.190), poor preventive measures when using agro-chemicals (OR = 2.845, 95% CI; 1.788-4.527), high operated paddy extent without exchange of labour (OR = 4.734, 95% CI; 2.586-8.665) were identified as significant contributory risk factors for CKD-U (p < 0.005). Cultivating a large land extent without hiring labour was a significant risk factor for the disease (p < 0.05). Furthermore, cultivating smaller land extent without hired labour (OR = 1.558, 95% CI; 0.47-1.56) had higher risk than cultivating larger land extent with hired labour (OR = 1.40, 95% CI; 0.42-1.42). In addition to the agricultural activities, being a male, age > 60 years, smoking, alcoholism, family history of CKD-U, history of malaria and snake bites (p < 0.05) were identified as other contributory factors.

There is a strong occupational risk factor in the pathogenesis of the disease where the male farmers of > 60 of age were at a high risk probably due to long term exposure to the aetiological agents (risk factors). Agricultural activities involving intense physical activity were related to CKD-U. Further studies are indicated to identify the effect of dehydration and physical exertion on the renal functions of these individuals. Poor preventive measures in agrochemical usage related to the disease indicate the need to educate the farmers on safe agrochemical usage.

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Estimation of 24-Hour Protein Excretion in Chronic Kidney Disease Patients by Analysing the Protein to Creatinine Ratio of Four Timely Urine Samples

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Measurement of protein excretion in a 24-hour urinary collection is the gold standard method for the quantification of proteinuria in kidney disease patients with various aetiologies. The aim of this study was to evaluate which spot urine protein to creatinine ratio (UPCR) could be a reliable alternative to 24-hour urinary total protein (24UTP) estimation by analysing four daytime urine samples of patients with chronic kidney disease (CKD).

Forty eight CKD patients (28 males and 20 females) with nephritis and high proteinuria (>1g/L for 24 hours and GFR> 45 ml/min/1.73m²) attending the Nephrology Unit were selected for the study. Four daytime urine samples namely early morning, 7am - 10 am, 10 am-4 pm and before parting to bed were collected along with the 24 hours urine sample. Urine protein and creatinine levels were measured by using turbidimetry and modified Jaffe methods. The best correlation between UPCR and 24UTP was calculated. The linear regression, central tendency and dispersion were also established and the Friedman test was used to evaluate significant difference among UPCR levels of 4 daytime urine samples.

The correlation coefficient (r) between 24UTP and spot UPCR in the study population were: early morning 0.81 (P < 0.001); 7am - 10 am 0.64 (p < 0.001); 10am-4pm 0.66 (p < 0.001); and before parting to bed 0.792 (p < 0.001). Early morning spot urine sample showed the highest linear association whereas the 7am-10 am and 10 am-4 pm show lower associations compared to other two spot urine samples. Highest and lowest median of UPCR were 7 am -10 am and before the bed respectively. Highest dispersion of UPCR reported in 10 am-4 pm and the distribution of before bed is somewhat skewed to right.

This study concludes that the protein to creatinine ratio in early morning urine sample is an accurate, convenient, and reliable method to estimate the 24 hours total protein in urine in study population. The other three urine samples, namely, 7am - 10 am, 10 am-4 pm and before departing to bed, can also be used for the estimation of 24-hour protein (p<0.001).

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Effect of Concentrated Water from Reservoirs of High Prevalence Area for Chronic Kidney Disease of Unknown Origin in Sri Lanka on Mice

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There is threateningly high prevalence of chronic kidney disease due to tubulointerstitial disease ending as chronic renal failure in the North Central Region of Sri Lanka. The epidemiology of the disease shows distribution of these patients around some water reservoirs and most of them are farmers. The low prevalence of the disease among the in villagers who use water from the natural springs was observed. The aim of the study was to find the potential effects of concentrated water of the reservoirs in the high-prevalence area by mouse bioassay.

Water of Padaviya reservoir supplying water to a high disease prevalent area was concentrated fifteen times by evaporation, exposing to sunlight from the month of May to July. The test group of mice (n=20) and control group (n=15) were fed with concentrated reservoir water and water from non-prevalence area (Kandy) respectively, for a period of 6 months and the kidneys were examined histopathologically for evidence of renal disease. Water samples were analyzed for Fluoride, Na\textsuperscript{+}, K\textsuperscript{+}, heavy metals and for cyanobacterial toxins microcystin and cylindrospermopsin.

The analysis of concentrated water samples from Padaviya reservoir from May to July showed a significantly higher content of fluoride (2.25±0.7 mg/L) and sodium (225±62 mg/L) (p<0.05) than control samples. However, no increased levels of heavy metals were detected. The analysis of water samples from Padaviya reservoir showed the presence of Deoxycylindrospermopsin (1.28 ug/L; DCYN) as the predominant isomer present over cylindrospermospin (CYN), which is unusual. At the end of 6 months, interstitial nephritis was detected in 45% of test mice and only 6.5% of control group (p < 0.001).

The results show the ability of the water of this reservoir to induce interstitial nephritis that could be due to the high salinity, fluoride or due to DCYN. Although present in low levels, the possibility DCYN to induce interstitial nephritis needs to be investigated further as the epidemiological evidence is in favor of a cyanobacterial toxin. The long term effects and safe levels for DCYN in drinking water and the effect of salinity and high fluoride content of water need to be studied.

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The Short Term Effect of Cyanobacterial Toxin Extracts on Mice Kidney

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Chronic kidney disease of unknown origin (CKD-U) in Sri Lanka shows clustering of patients around water reservoirs, and similarities in incidence over time in CKD-U and alcoholic liver disease in the North Central Region, which indicates the possibility of a common aetiological agent. The aim of this study was to find the short term effects of extracts of cyanobacteria isolated from the reservoirs and canals of the high prevalence area of CKD-U on mice kidney.

Diluted extracts of *Microcystis*, *Cylindrospermopsis* and *Lyngbia* blooms were fed to groups of 5, 7 and 10 mice respectively for a week. Another 5 mice were fed for one week with diluted extracts of microcystis bloom, followed by 2 weeks of normal water. The control group of mice (n= 10) was given normal water for a week. Cyanobacterial extracts were analyzed for microcystin, deoxy-cylindrospermopsin (DCYN) and cylindropspermopsin (CYN).

Acute tubular necrosis (ATN) was detected in 5/5 mice fed with extracts of *Microcystis* bloom that contained microcystin (65µg/l), DCYN (2.1 µg/l) and CYN while 2/5 mice had ATN when this extract was followed with normal water for 2 weeks. One out of seven mice fed with *Cylindrospermopsis* bloom that contained DCYN (29.5 µg/l) and CYN (0.7 µg/l) and 6/10 mice fed on *Lyngbia* bloom containing CYN (1.7 µg/l) and DCYN (0.5 µg/l) had ATN. All control mice had normal tubules.

The results show the ability of the cyanobacterial extracts to induce ATN in mice in the given concentrations. The ability of the kidneys to recover is suggested by the less frequent abnormalities seen after normal water has been supplied for 2 weeks post-*Microcystis* poisoning. As DCYN was available in all 3 extracts causing ATN, the ability of DCYN on its own to induce tubular necrosis even at low concentrations need to be investigated.
A Study on Geographical Distribution of Chronic Kidney Disease of Unknown Origin in Sri Lanka Using GIS and GPS Mapping

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An alarmingly high incidence of an apparently new form of chronic kidney disease of unknown aetiology (CKD-U) was noticed in some parts of Sri Lanka in the early nineties and a steady increase has been observed within the last twenty years. Histopathological studies have revealed a tubulo interstitial nephritis at early stage of the disease which is suggestive of a toxic aetiology. Researchers who investigated the disease proposed a number of risk factors including high level of fluoride in ground water, leaching of heavy metals such as cadmium from agrochemicals into water sources, exposure to inorganic pesticides and usage of aluminium containers for cooking. However, the lack of sufficient epidemiological studies made the identification of the aetiological agent difficult.

The aim of the present study was to investigate the geographical distribution of CKD-U using modern GPS and GIS mapping. Information of 11630 patients were used for GIS mapping using ARC 9.2 software and GPS mapping.

GIS mapping indicated five high prevalent areas in the region, namely, Medawachchiya (identified 20 yrs ago), Padaviya (identified 18 years ago), Girandurukotte (identified 12 years ago), Medirigiriya (identified 8 years ago) and Nikawewa (identified five years ago). Low prevalence of the disease was noted in communities who consume water from natural springs for drinking. All the high prevalent areas are clustered around reservoirs of the irrigation system. In all five areas, the distribution is related to stagnant irrigated water. GPS mapping showed most of the cases were located below the level of some reservoirs and some were related to the irrigation canals.

The epidemiological data on geographical distribution infers that while older foci of CKD-U are persisting, there is an emergence of new foci of CKD-U with time. The presence of the affected villages located below the level of the reservoirs and canals indicated the possibility of irrigated water draining to the shallow wells of households which is the source of drinking water. A similar pattern of distribution of endemic nephropathy was described in Balkan region along the Danube river in low altitude areas where water stagnates.
Descriptive Psychopathology of Obsessions and Compulsions of a Clinic Population of Patients with Obsessive Compulsive Disorder

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Obsessive-compulsive disorder (OCD) affects approximately 2-3% of the adult population and is considered a debilitating and costly disorder, with associated impairments spanning the social, occupational, and familial domains. OCD is characterised by obsessional symptoms and compulsive behaviour. The obsessional symptoms include thoughts, images, ruminations and impulses. Compulsive behaviour ranges from overt acts to covert ritual or a mental manipulation.

Objectives of the present study were to describe the frequency of the type of obsessions and the compulsions in a clinic population. The study also attempts to describe the contents of the obsessions and compulsions of the study population.

All patients with OCD who were registered as outpatients from 1997 to 2003 were included in the study. Patients were traced back from the clinic register where the final diagnosis of OCD was made by the consultant psychiatrist at their first visit. The relevant clinic notes were traced back and data on epidemiology as well as details of the particular obsessions and compulsions were recorded from the clinic notes. The study population consisted of 23 males and 17 females, and their average age was 27.7 years.

The main type of obsession in this study was obsessive thoughts (70%) followed by ruminations (25%). The main theme of the obsession was to do with cleanliness (45%). Therefore, as observed in the study, washing behaviour is a commonly practiced (25%) ritual.
Pilot Study of Clozapine Treatment in Patients Suffering from Resistant Schizophrenia

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Clozapine is currently the only proven effective drug intervention in patients with resistant schizophrenia, or intolerant to extra pyramidal side effects. It is therefore recommended to all the patients who do not respond to or cannot tolerate at least two other antipsychotics. The main factor limiting its use is the risk of potentially fatal agranulocytosis, which occurs in 1 - 2% of treated patients.

The objectives of the present study were to describe the basic demographic data of patients suffering from resistant schizophrenia who are on long term clozapine and to establish a correlation between the dose and the duration of clozapine with the mean neutrophil count of the patients.

The study was designed as a descriptive cross sectional study. All patients in the clozapine clinic in the Teaching Hospital, Peradeniya were selected. Information on age, sex, date of commencement of clozapine, duration of the treatment, initial clozapine dose, current clozapine dose and the six recent neutrophil counts were taken from the patients' clinic records. The data were analysed using SPSS software.

In the study population 67% were males, and the mean age was 32.5 years; ranging from 16-72 years. Mean duration of treatment was 49.35 months (SD=36.03). Mean clozapine dose of the sample population was 310 mg (SD=112.42). Mean neutrophil count was 61% (SD=8.42). During the course of treatment clozapine was withheld in 3% of the study population due to very low neutrophil counts. Other 97 patients were responding well to the treatment and were in remission during the course of treatment with clozapine. There was a significant negative relationship between clozapine dose and neutrophil count (F = 9.174, p = 0.003), suggesting a possible impact of high clozapine dose on neutrophil count, one of the most feared complications of clozapine. There was no relationship between duration of treatment and neutrophil count (F = 0.168, p = 0.683)

Vigilant monitoring of the patient while on clozapine treatment is very important due to a fatal complication of agranulocytosis. The fact that dose of clozapine is positively correlated with the risk of neutropaenia should be kept in mind when titrating clozapine to higher doses in patients. Duration of clozapine treatment showed no association with neutropaenia. This is supported by the fact that most of the episodes of agranulocytosis occurs in the first 6 months of initiation of therapy and then the risk declines steadily.
A Descriptive Study of Offending Species and Epidemiology of Snake Bites of Two Areas in the Dry Zone of Sri Lanka: Anuradhapura and Jaffna

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Snake envenomation is a major health problem in dry zone of Sri Lanka. The aim of this research was to study the offending species and the epidemiology of snake bites in two areas in the dry zone of Sri Lanka; Anuradhapura in the central dry zone and Jaffna in the northern top end. This was a prospective, observational, hospital based study carried out at General Hospital Anuradhapura, from January to December 2010, and Teaching Hospital Jaffna, from February 2009 to January 2010. Epidemiological and clinical data were recorded from patients admitted with snake bites.

There were 304 and 1018 snake bites reported in Jaffna and Anuradhapura respectively. Of 189 (62%) identified bites in Jaffna, 99 (52%) were saw-scaled viper bites. Out of 398 (39%) identified bites in Anuradhapura, 209 (53%) were Russell’s viper (\textit{Daboia russelii}) bites and 88 (22%) Merrem’s hump-nosed viper bites (\textit{Hypnale hypnale}). Eight species of non-venomous snakes were identified from each area, and a majority of bites were caused by the flowery wolf snake (\textit{Lycodon osmanhilli}) and by \textit{Lycodon aulicus} in Anuradhapura. Monthly distribution of snake bites showed a similar pattern in both areas: 196 (64%) and 798 (78%) were envenomed in Jaffna and Anuradhapura, respectively. Similar monthly distribution of cases could be related to similar rainfall pattern in both areas. Nine deaths were reported from Anuradhapura and four from Jaffna.

The total number of snake bites reported in Anuradhapura was approximately thrice that of Jaffna. Majority of snake bites were saw-scaled viper bites in Jaffna, and Russell’s viper in Anuradhapura. The number of Russell’s viper bites reported from Anuradhapura was about five times that of Jaffna. There were no hump-nosed viper bites reported in Jaffna, whilst 88 were found in Anuradhapura. The proportion of envenomed snake bites was higher in Anuradhapura than Jaffna. There were more deaths due to snake bites in Anuradhapura than Jaffna.

In conclusion, differences were observed with regard to offending species of snakes and epidemiological parameters among snake bites victims in Anuradhapura and Jaffna.
Clinical and Laboratory Features of Spotted Fever Rickettsioses in Patients Presented to Teaching Hospital, Peradeniya


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Spotted fever group rickettsioses (SFG) are predominantly seen in the central hills of Sri Lanka. Unfortunately, routine laboratory diagnostic facilities are not available in the hospitals. Therefore, logical use of the clinical features may help to arrive at a clinical diagnosis and to institute treatment, or otherwise delay in treatment could be detrimental. The aim of this study was to describe clinical and laboratory features of SFG from a prospective case series.

Those patients who were presented to Medical Unit, General Hospital, Peradeniya from 2008-2010 with an IgG titer > 1/256 were included in the study. The confirmation of the diagnosis was made with Immunofluorescence antibody assays (IFA) which detected specific rickettsial IgM and IgG antibodies for Rickettsia conorii antigen. Ethical clearance for the study was obtained from ethical review committee, Faculty of medicine, Peradeniya.

A total of 247 patients were confirmed to have either primary (19%) or secondary SFG (81%). Of them, 130 (53%) were males and 117 (47%) were females and the mean age of the group was 43 years (12 to 87 years). Patients were presented to the hospital after an average of six days (SD = 4) of fever. A maculopapular skin rash was observed in 78% and a rash with skin necrosis was seen in 6% of patients. Fever (98%), headache (95%), skin rash, arthralgia (70%), myalgia (84%), nausea (51%), vomiting (47%), cough (28%) and conjunctival injections (66%) were the predominant clinical findings. Leucopaenia, thrombocytopaenia and anaemia were seen in 17%, 74% and 19% of patients respectively. Both transaminases, (AST and ALT) were elevated in 66% of cases and ESR was elevated in 25 of 37 patients. Rapid response was noted with prompt administration of anti-rickettsial therapy including doxycycline or chloramphenicol.

A wider clinical spectrum was noted among SFG patients. Cardinal clinical features such as skin rash, arthritis and response to anti-rickettsial antibiotics would help to arrive at a diagnosis. However, PCR and sero-diagnostic facilities must be available in the hospitals for confirmation of diagnosis.
Epidemiological Factors Associated with Spotted Fever Rickettsioses in the Central Province, Sri Lanka

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The spotted fever group (SFG) rickettsioses are common throughout the rural and suburban areas in central hills of Sri Lanka. The aim of this study is to describe the risk factors and epidemiological factors associated with SFG in the region.

Confirmation of diagnosis was made with Immunofluorescence antibody assays (IFA) by detecting specific rickettsial IgM and IgG serum antibodies for Rickettsia conorii antigen. The patients presented to the General Hospital, Peradeniya from 2008-2010 were interviewed and examined on admission and basic demographic data such as age, gender, residence, history of contacts with animals and arthropod bites were recorded.

During the three years under study, 247 patients residing in the Kandy district in rural and suburban areas had SFG infection. Of them, 130 (53%) were males and 117 (47%) were females. The mean age was 43 years (range 12 to 87 years) and they were. A majority of, 204 (82%) patients were living in solidly constructed asbestos or tile roofed houses, 211 (85%) had cemented floors. One hundred and seventy (70%) patients had less than 3 rooms in their houses. Two hundred and twenty eight (92%) patients had contact with one or more animals, and the exposure status was: wild boar 194 (78 %), dogs 160, (65 %), cats 97(39%) and cows 25 (10 %). History of arthropod bites (mainly tick bites) was 76(30%) and 84 (34%) patients had a recent contact history of febrile illness. The occupational status of the study group was: office workers 105 (42 %), field workers 54 (22%), house wives 64 (26%) and unemployed 22 (9%). The seasonal distribution showed occurrence of cases throughout the year with peaks in June 29 (12%), July 36 (15%) and December 26 (11%).

The SFG caused infection throughout the year and all age groups irrespective of gender were affected. High rate of contact with animals, predominantly wild boars, history of tick bites and occupational status of patients may give clues to possible mode of transmission of the infection.
Serodiagnosis of Clinically Suspected Cases of Rickettsial Infections Presented at Teaching Hospital, Peradeniya

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Rickettsial infections are well established in Sri Lanka and the number of patients with rickettsial infections from central hills of the island has been increasing every year. This study was planned to describe positive indirect fluorescent antibody (IFA) titers against several rickettsia serotypes in patients presented to the Teaching Hospital, Peradeniya.

All patients clinically diagnosed with rickettsial infections who were admitted to the Medical Unit, General Hospital, Peradeniya from 2008-2010 were included in the study. Blood samples were collected at the acute phase of the disease and IFA tests were performed for disease confirmation by detecting specific rickettsial IgM and IgG antibodies. Fluorescein-conjugated anti human heavy chain immunoglobulins were used in IFA and Eriochrome Black was used to counterstain. Ethical clearance for the study was obtained from ethical review committee, Faculty of Medicine, Peradeniya.

A total of 220 patients were confirmed by IFA to have secondary rickettsial infections within the study period. Out of this group 111 (50.45%) were males and 109 (49.54%) were females. Mean age of the group was 45 years (SD-18) ranging from 13 to 87 years. Seropositivity was detected for all three rickettsial antigens tested (Rickettsia conorii, Orientia tsutsugamushi and Rickettsia typhi). Of the 220 confirmed cases, 200(91%) cases were positive only for Rickettsia conorii, 3 (1.4%) cases were positive only for Orientia tsutsugamushi and a single case (0.45%) was positive for Rickettsia typhi. Mixed infections were seen among 17 (8%) patients. Spotted fever group infection was detected among all the mixed infections. Commonest co-infection was seen with Rickettsia conorii, and Orientia tsutsugamushi in 14 (6.4%) cases. Antibodies to all three species were detected in a single patient.

Spotted fever rickettsioses predominated during the three year period. Males and females were equally affected and the disease was detected in a wider age range with the majority in the middle aged. The occurrence of mixed infections can be either due to co-infections in the same disease episode or due to re-infection following a previous infection.
Risk Factors Associated with Two Viperid Snake Bites among Patients Presented to General Hospital, Kurunegala: A Case Control Study

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Two viperid snakes, namely Russell’s viper (Daboia russelii) and hump-nosed viper (Hypnale spp.) are responsible for most of the venomous snake bites in Sri Lanka. These two snakes share similar habitats and behaviour. Prevention of viperid snake bite would certainly reduce the burden on hospitals and as such, identification of related risk factors is of paramount importance. The aim of this study was to assess the environmental and the behavioural risk factors of victims that promoted the attacks by these two snakes.

This case control study was based on Kurunegala district. Sample size was calculated considering the anticipated odds ratio as two, with the level of significance as 95% and the power of the test as 80%. The cases were recruited from consecutive admissions to the General Hospital, Kurunegala with proven viperid bites. Age and gender matched controls, with no history of snake bites, were selected from relatives and neighbours of patients at a ratio of 1 case: 2 controls. Patients and controls were interviewed and the relevant data were collected in an interviewer administered questionnaire.

There were 56 cases and 112 controls with mean age 44 years (SD 15) and 45 years (SD 22) respectively. Of the 14 risk factors assessed, 8 risk factors showed a significant association with viperid bites. Among these, the risk factors at the time of bite were:

1. (p < 0.001, OR, 95% CI= 6.6 (3.25-13.4), being in an ill lit place
2. (p < 0.001, OR, 95% CI= 148.8 (43.7-506), being in outdoor places
3. (p < 0.001, OR, 95% CI= 175 (31.4 – 976), working in a field

The general risk factors that showed significant associations were:

1. (p < 0.001, OR, 95% CI= 5.3 (2.3-12 ), Occupation as a field worker
2. (p < 0.001, OR, 95% CI=(p < 0.001,OR, 95% CI=9.9 (2.75- 35.5), low level of financial status
3. (p < 0.001, OR, 95% CI= 7.38 (2.15- 25.3), lack of attached toilet
4. (p < 0.001, OR, 95% CI= 11 (4.88-24.9), presence of rats in the compounds

Identifying easily remediable risk factors such as use of protective foot wear, avoiding ill lit places, having attached toilets and getting rid of house rats would help in preventing viperid snake bites.
Effects of Long Term Lithium Treatment on Renal Function

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Lithium Carbonate is used as the first line therapy for bipolar disorders; however, some studies have suggested an association between progressive renal impairment and long term Lithium treatment.

The aim of the present study is to assess the renal function of psychiatric patients, who were on long term lithium treatment and to determine an association, if any, between these two factors. Glomerular filtration rate (GFR) is an important index that reflects the functional status of the kidney; therefore, creatinine clearance (CL) was calculated to assess GFR of these patients.

Thirty seven patients of the psychiatry clinic (21 females and 16 males), Teaching Hospital, Peradeniya who were on Lithium for more than one year were included in the study. Written consent was obtained from the patient or caretakers (when patient was incapable of giving valid consent). Information on age, sex, dose and duration of Lithium treatment and serum Lithium concentration was collected from the patients’ record books. Height, weight, skinfold thickness and serum creatinine concentration were measured. The standard Cockcroft-Gault formula was applied to determine CL. Standard reference values were taken from the National Kidney Foundation, USA.

Table 1. Degree of renal impairment according to creatinine clearance values

<table>
<thead>
<tr>
<th>Degree of renal impairment</th>
<th>No. of patients</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1- Normal kidney function (GFR 90-130ml/min)</td>
<td>4</td>
<td>10.8</td>
</tr>
<tr>
<td>Stage 2- Mild reduction in kidney function (GFR 60-90 ml/min)</td>
<td>14</td>
<td>37.83</td>
</tr>
<tr>
<td>Stage 3- Moderate reduction in kidney function (GFR 30-60 ml/min)</td>
<td>19</td>
<td>51.35</td>
</tr>
<tr>
<td>Stage 4- Severe reduction in renal function (GFR 15-30 ml/min)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Stage 5- Kidney failure (GFR 0-15 ml/min)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>37</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

A mild (37.83\%) to moderate (51.35\%) decline in the renal function observed in the study population (Table 1) may be attributed to their Lithium usage. Significant negative correlation of 0.509 between serum Lithium levels and GFR (p = 0.0013) suggests the possible impact of high serum Lithium levels on renal function. There was a significant effect of serum Lithium on creatinine clearance (ANOVA, F = 7.14, p = 0.012). Thus, regular monitoring of renal function of patients on long term lithium treatment is recommended. The use of mood stabilisers such as carbamazepine in patients who have already developed renal impairment or those with impending renal impairment due to long term use of lithium, should be considered.
Chronic Prostatitis: Symptomatology and the Impact on the Quality of Life in a Sri Lankan Population


Department of Surgery, Faculty of Medicine, University of Peradeniya

Chronic prostatitis (CP) or Chronic Pelvic Pain Syndrome (CPPS) affects men in all ethnic origins where they experience considerable morbidity and may remain symptomatic for years as there is limited understanding of the pathophysiology and the optimal treatment. The data regarding Sri Lankan patients remain sparse. The objective of this study was to study the symptomatology associated with CP/CPPS in a Sri Lankan population and to evaluate its impact on their quality of life (QOL).

A descriptive cross-sectional study was conducted in the surgical unit and Genito-Urology clinic in Teaching Hospital Peradeniya from March 2010 to August 2011. The study group included all patients who were clinically diagnosed with CP/CPPS according to the National Institutes of Health (NIH) definition. Symptomatology and QOL were evaluated with NIH Chronic Prostatitis Symptom Index (NIH-CPSI), a nine-item tool with 4 subscores and a total score ranging from 0-43 points, and with higher scores indicating more severe symptoms.

The study group included 43 subjects with a mean age of 36.3 (SD=12.21) years with an age range of 18-65 years. The duration of symptoms at presentation ranged from 3 months to 7 years. The commonest presentations were pelvic pain (n=43) involving suprapubic area, urethra or testicles and urinary symptoms (n=38) including dysuria, frequency and poor emptying. Of the total study group 44.18% (n=19) experienced post ejaculatory pain. NIH-CPSI indicated that except 4, others had experienced pelvic pain commonly in suprapubic area (n=34) during the week prior to assessment while n=35 had dysuria and n=15 had post ejaculatory pain. The average pain was 8.95 measured on visual analogues scale. Most had poor emptying (n=30) and frequency (n=33) as urinary symptoms. Symptoms of 88.37% of patients (n=38) had interfered their usual activities. QOL was affected in all except one. Among affected, most (n=20) were unhappy to spend the rest of life with their symptoms and n=18 had mixed feeling about it. The Pain score ranged from 0-17 while the urinary symptom score, QOL Impact, Symptom Scale Score and Total score displayed a range of 0-10, 0-12, 0-27 and 0-37 respectively. Of the study population 55.81% (n=24) had symptoms of moderate severity while 27.9% (n=12) had severe symptoms.

Pelvic pain, urinary symptoms and post ejaculatory pain are the commonest symptoms among local patients with CP who show a broad age range. The symptoms display a wide range of degree of severity and it affects the QOL in 97.67%. Further extensive research are required regarding Sri Lankan patients.
Detection of *Helicobacter pylori* by Histology in Biopsy Specimens of Patients with Gastric Ulcers in a Selected Group of Patients from Teaching Hospital, Peradeniya

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In the medical literature, about 60% to 100% of benign gastric ulcers have been reported to be associated with *Helicobacter pylori* infection. However, in clinical practice such association is often not observed by histology.

The aim of this study was to assess the detection rate of *H. pylori* infection by histology in clinical biopsy specimens of patients detected to have benign gastric ulcers in teaching Hospital Peradeniya.

The study included 31 cases endoscopically detected to have gastric ulcers. Ulcers were biopsied as routine clinical specimens and the rest of the gastric mucosa was not biopsied. None of the cases had prior anti *H. pylori* therapy in this institution. However, most had been treated with proton pump inhibitors. Malignant ulcers were excluded. Histological assessment was performed using haematoxylin and eosin stain and toluidine blue stain. Following histological parameters were studied and graded according to the Sydney system: *H. pylori* organisms, acute and chronic inflammation, atrophy and dysplasia. Forty six cases with endoscopically detected other benign gastric abnormalities and 57 cases with endoscopically normal gastric mucosa were also assessed similarly. All cases were age and sex matched.

*H. pylori* detection rate among gastric ulcers was 3/31 (9.7%). The *H. pylori* density was Sydney grade 2 in all. Of the 28 cases without *H. pylori*, 21 (75%) did not have significant inflammation (no inflammation or Sydney grade 1 chronic inflammation); 4 (14.3%) had Sydney grade 2 and none had grade 3 chronic inflammation; 2 (7.1%) had active chronic gastritis; 1 (3.6%) had chronic atrophic gastritis. *H. pylori* detection rate in cases with other gastric abnormality group was 6/46 (13%) and in endoscopically normal group 2/57 (3.5%). The differences were not statistically significant (p>0.05). The *H. pylori* density in these 8 cases ranged from Sydney grade 1 to 2.

The *H. pylori* detection rate by histology in the gastric ulcer group appears to be low in the present study group. This detection rate appears to be more or less similar to non ulcer groups. *H. pylori* density is relatively low in all cases. Histology is a relatively specific but less sensitive method of detecting *H. pylori*. The density of *H. pylori* organisms and their distribution affect the histological detection of the organism. Inter-observer variation is high when the *H. pylori* density is low. Treatment with proton pump inhibitors is known to induce migration of the organisms from the antrum to body. Therefore, sampling of the antrum only, may give rise to false negative results. *H. pylori* infection is associated with significant mucosal inflammation. Therefore, the 21 cases without significant background inflammation are less likely to have undetected *H. pylori* infection. Since histology is a main mode of detection of *H. pylori* gastritis in Sri Lanka, it is important to investigate further whether or not histology under estimate the *H. pylori* infection in the biopsy specimens and if so the contributory cause/s.
Inhibition of Germ Tube Formation and Elongation of *Candida albicans* by Root Extracts of *Pongamia pinnata*

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*Pongamia pinnata* (‘Karanda’) is a plant used in Sri Lankan traditional medicinal systems to cure various ailments including oral infections. *Candida albicans* is an opportunistic human pathogen which produces diseases ranging from superficial infections (e.g. oral thrush) to life threatening invasive infections. The germ tube production by this organism is considered as a significant virulence determinant. Our previous studies have shown a powerful inhibitory activity of root extract of *P. pinnata* against several *Candida* spp. including *C. albicans*. Hence the objective of this study was to evaluate the effects of root extracts of *P. pinnata* on the germ tube formation and elongation by *C. albicans*.

Roots of *P. pinnata* were extracted in 75% ethanol and the extract was evaporated and freeze dried. Germ tube assay was performed with the Minimum Inhibitory Concentrations (MICs), 2 x MIC, 3 x MIC and 4 x MIC of the root extract of *P. pinnata* against five different clinical isolates of *C. albicans*. The percentage of germ tubes formed and the length of the germ tubes were evaluated by observing under the microscope. Data were subjected to analysis of variance (ANOVA) and means were separated by Duncan Multiple Range Test at P<0.05 significant level.

All five isolates showed a varied reduction in the percentage germ tube formation when treated with the root extract of *P. pinnata*. Extracts of *P. pinnata* inhibited the germ tube formation in a dose dependent manner. The least germ tube production was observed when they were treated with 4 x MIC of the extract, which was the highest concentration used in the experiment. Even the lowest concentration (MIC) used in the study resulted in a significant reduction (P<0.05) in the germ tube formation compared to the control.

In addition to the germ tube formation, the germ tube elongation was also affected by treatment with root extract of *P. pinnata*. Majority of the isolates achieved their least germ tube length when they were exposed to 4 x MIC of the extract. Except one isolate, all the other four isolates showed a significant reduction (P < 0.05) in the germ tube elongation when they were treated with their MICs of the extract, which was the least concentration used in the experiment.

Hence, results of the study show the potential of the root extract of *P. pinnata* in reducing the germ tube production and germ tube elongation of *C. albicans*, rendering it less pathogenic.
Anti-Candidal Activity of *Piper betle*, *Vitex negundo* and *Jasminum grandiflorum*

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With the evolution of resistance by microorganisms to prevailing antimicrobials and the potential health hazards of synthetic antimicrobial drugs, the need for the discovery of new antimicrobial compounds is evident. Several plant products have been proven to have a potential as antimicrobial agents. Betel leaves which are commonly used as a masticatory agent in some communities and two other oral medicinal plants were investigated for their anti-candidal activity in the current study. The objectives of the study were to determine the anti-candidal activity of young and mature leaves of *Piper betle* L., (‘Bulath’ [S], ‘Vettilai’ [T] ) collected from the dry zone and wet zone of Sri Lanka, leaves and roots of *Vitex negundo* L. (‘Nika’ [S], ‘Nir-nichchi’ [T] ) and leaves of *Jasminum grandiflorum* L. (‘Saman-pichcha’ [S], ‘Kodimalligai’ [T] ) and to determine their Minimum Inhibitory Concentrations (MIC).

Water and ethanolic extracts of the plant material were prepared and their anti-candidal activity against standard cultures of *Candida albicans* (ATCC 90028), *Candida glabrata* (ATCC 90030), *Candida krusei* (ATCC 6258), *Candida parapsilosis* (ATCC 22019) and *Candida tropicalis* (ATCC 13803) was investigated by the agar well diffusion bioassay. Extracts which gave a zone of inhibition of ≥ 3 mm radius were reckoned to be significantly active. The MIC values obtained for the ethanolic extract of young leaves of *P. betle* against the five *Candida* spp. were 1.6 mg/mL for *C. albicans*, 0.8 mg/mL for *C. glabrata*, 1.6 mg/mL for *C. krusei*, 0.6 mg/mL for *C. parapsilosis* and 3.2 mg/mL for *C. tropicalis*. There was no significant difference between the anti-candidal activity of leaves of *P. betle* collected from the wet zone and the dry zone (P > 0.05). The water extracts of leaves of *P. betle* and water and ethanolic extracts of leaves and roots of *V. negundo* and leaves of *J. grandiflorum* did not show a significant anti-candidal activity.

It could be concluded that the ethanolic extract of young leaves of *P. betle* has significant anti-candidal activity, and therefore has the potential to be used as a health care agent.
Road Traffic Injuries in Dogs

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Road Traffic Injuries (RTI) leading to death or permanent disability is a major concern to people in Sri Lanka. Increasing number of vehicles and reckless driving are the main causes for escalating number of road accidents in Sri Lanka. Approximately 6,000 RTIs are reported annually with 2000 fatalities. In human RTIs, all road users including drivers, riders, commuters, vendors and pedestrians are equally vulnerable but when animals are considered, only “pedestrian animals” are involved. Studies on RTIs in animals will help to formulate mitigation measures to minimise injuries and fatalities. This will ensure preservation of life, curb animal nuisance on roads, and in the long run, promote responsible animal/pet ownership.

RTIs in animals, are usually in the “hit and run” category with occasional injury to humans and/or vehicles. The animal with RTI suffers and the owner must go through the mental agony and financial burden of the treatment. This communication summarises all RTI cases in dogs reported to VTH during a 24 month period in 2009 and 2010, which were subjected to detail analysis to identify patterns and causes.

A total of 234 dogs with RTI (116 in 2009 and 118 in 2010) were studied. Among them, 18% succumbed to injuries and 28% were permanently disabled. Majority (61% in 2009 and 51% in 2010) were reported in the morning which may be a result of rush hour and the habit of owners unleashing their pets after dawn. The relatively higher proportion of males involved (68% and 59%, in 2009 and 2010 respectively) may be due to habits of maintaining larger territories compared to females, which makes them vulnerable to accidents. Sexually mature animals are more prone to RTI obviously due to their social behaviour especially when females are in oestrus. The higher frequency of RTI during festival months, namely April (17% in 2009 and 19% in 2010) and December (16% in 2009 and 18% in 2010), may be attributed to increased use of vehicles and/or drivers being under the influence of alcohol, which could disturb their alertness and vision. A substantial proportion of animals brought for treatment by their respective owners, shows that the RTIs could be prevented if responsible pet ownership is emphasised.
Occurrence of Nontuberculous Mycobacteria in Different Aquatic Sources of Sri Lanka

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Nontuberculous mycobacteria (NTM) have been reported to cause opportunistic infections with increasing frequency, especially in immunocompromised patients. Water plays a major role in the epidemiology of NTM infection in humans, as it is one of the natural sources and routes for transmission of this group of organisms. The present study focused on determining the distribution of NTM in different aquatic sources from all 25 districts of Sri Lanka by using phenotypic tests and polymerase chain reaction – restriction fragment length polymorphism (PCR – RFLP) analysis of the RNA polymerase beta subunit (rpoB) gene.

The number of samples collected from the districts varied from 3 – 27 and water samples from 18 districts yielded positive results for NTM. Of the total 255 water samples tested, 41 (16%) were positive for NTM on culture. The frequency of isolation of mycobacteria varied with the water sources tested and the values for aquarium water, surface water, ground water and chlorinated water were 30% (17/57), 22% (19/87), 6% (4/63) and 2% (1/48), respectively. The low mycobacterial load in chlorinated water observed in the study may be related to the lethal effect of chlorine on mycobacteria. The percentage of mycobacteria identified at species level by phenotypic tests and PCR – RFLP of the rpoB gene were 49% (20/41) and 93% (38/41), respectively. The PCR – RFLP of the rpoB gene proved to be simple, rapid and accurate in identifying NTM species, when compared to phenotypic tests. Furthermore, the routine phenotypic tests were unable to differentiate subtypes of M. fortuitum and M. gordonae. Fifty three percent (20/38) of the phenotypic test results were in agreement with PCR – RFLP results. The RFLP profiles of three NTM isolates did not match any known mycobacterium species and these might represent mutants or hitherto undescribed NTM species. Thirteen species of NTM were identified by PCR-RFLP, namely M. fortuitum type I (n=9), M. fortuitum type II (n=4), M. phlei (n=6), M. scrofulaceum (n=5), M. gordonae type I (n=2), M. gordonae type II (n=2), M. marinum (n=2), M. malmoense (n=2), M. terrae (n=2), M. avium (n=1), M. szulgai (n=1), M. gallinarum (n=1) and M. celatum type II (n=1). Of the positive isolates, potentially human pathogenic mycobacteria (M. fortuitum, M. marinum, M. malmoense, M. avium, M. scrofulaceum, M. szulgai and M. celatum) accounted for 61% (25/41) while the non-pathogenic species (M. phlei, M. gordonae, M. terrae and M. gallinarum) accounted for 32% (13/41).

This study confirms that water is an important environmental source harbouring NTM and that NTM are widely present in many aquatic sources throughout Sri Lanka, which can be a potential public health hazard especially for immunodeficient individuals.

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A Non-Invasive Alternative Treatment Approach for Canine Aural Haematoma: Three Case Reports


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Canine aural haematoma is commonly encountered in veterinary practices, and manifests as swelling of the ear pinna. This is usually caused by self-inflicted trauma due to scratching of the ear and head shaking, secondary to otitis externa, or immune-mediated disorders. The usual treatment for aural haematoma is surgical removal of the clot with post-operative compression. The aim of this study was to introduce an alternative treatment method for aural haematoma, which was tested in a 12-year-old male German Shepherd, 8-year-old male Dachshund and a 2-year-old pregnant Doberman Pinscher. The primary aetiology of aural haematoma in these three patients was otocariasis, ehrlichiosis and bacterial otitis externa respectively. All three patients were treated with serratiopeptidase tablets 5 mg/animal, thrice daily for two weeks together with treatment for the primary causes. After a week, all three haematomas had reduced in size and complete regression was observed at the end of two weeks.

Serratiopeptidase is a natural proteolytic enzyme derived from Serratia E 15 which is a nonpathogenic enterobacteria. The enzyme induces degradation of fibrin and inflammatory mediators and reduces the viscosity of exudates, dissolves necrotic tissue surrounding the injured area and accelerates the healing process by promoting the absorption of decomposed products.

This study revealed that aural haematoma can be cured by simple oral treatment without adopting an invasive surgical procedure under general anaesthesia. It will also be acceptable to many pet owners as it is convenient and less traumatic to their pets and avoids cosmetic alterations such as wrinkling and thickenings of the pinna due to scar tissue formation and post-operative complications such as wound infections. As this is a non-invasive procedure, it can be used in patients having anaesthetic risk, such as geriatric and pregnant animals. However, veterinary practitioners need to be aware of the cause and the severity of the haematoma and to use appropriate treatment for aetiological agent/s to prevent recurrence of the haematoma.
Retrospective Study on Spirocercosis in Dogs Presented for Necropsy

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Spirocercus lupi is a spirurid nematode of carnivores with worldwide distribution although it is most prevalent in the tropics and subtropics. Dogs become infected with the worm when they ingest either Spirocercus infected coprophagous beetle or a paratenic host. Following ingestion of infected paratenic hosts, the L3 larvae of S. lupi are liberated in the gastric lumen and subsequently the larvae penetrate the gastric mucosa and migrate towards the caudal aorta through the walls of gastric and celiac arteries. The larvae spend up to three months in the aortic wall, where they molt to L4 and finally to adults. Young adult worms then migrate from the aorta to the oesophagus or elsewhere. Groups of worms (3-6) cluster together in the oesophageal submucosa and induce the formation of nodules. Over a period of time, some of the oesophageal nodules may undergo malignant neoplastic transformation, with subsequent metastasis to other sites.

The aim of this study was to determine the prevalence of spirocercosis in 326 necropsies of dogs presented for necropsy to the Division of Veterinary Pathology at the Faculty of Veterinary Medicine and Animal Science during January 2008 to August 2011 and to assess the severity of infection.

Out of the 326, 161 (49.3%) necropsies showed Spirocercus nodules in the oesophagus, and among them 10 (6.2%) were reported as sudden deaths due to acute haemothorax caused by ruptured thoracic aortic aneurysm which was solely caused by Spirocercus infection. Another four (2.4%) had fibrosarcoma in the oesophagus which was not the cause of death. One case of death was due to pyothorax initiated by oesophageal perforation as a result of Spirocercus induced severe granulomatous inflammation in the wall of the oesophagus. Another case of aberrant migration of Spirocercus lupi into the spinal cord resulting in paraplegia and subsequent death was recorded. In the remaining 145 cases (90%) Spirocercus lupi was an incidental finding. The age of the affected dogs ranged between 5 months to 16 years; 53 (32.9%) were 6-9 years, 34 (21.1%) were 9-12 years, 25 (15.5%) were 3-6 years, 20 (12.4%) were between 12-16 years and 18 (11.1%) were between 1-3 years while 11 (6.8%) were less than one year old. Majority of the dogs affected were crossbreds (69, 42.8%) while the remaining cases were German shepherds (51, 31.6%), Doberman pinschers (21, 13%), Pomeranians (8, 4.9%), Rottweilers (7, 4.3%) and Labradors (5, 3.1%).

The findings indicate that the prevalence of canine spirocercosis was very high and therefore, more attention should be paid to control and prevent this infection. The potential aberrant migration of the larvae could lead to pathological changes giving rise to a variety of clinical manifestations. The severity of the clinical condition would depend on the organ/s affected and severity of the pathological process. Thus, the affected animal may not show clinical signs or may have noticeable signs only at later stage. If vital organs are affected or pathological sequelae are severe, the disease can be fatal. Since early diagnosis holds the key to successful treatment of the disease, further investigations are necessary to develop a reliable technique for early diagnosis of spirocercosis.
Spirocercosis-Associated Pyothorax in a Dog: A Case Report

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Spirocercus lupi is a nematode predominantly found in tropical and subtropical countries. In dogs, the L₃ larvae of S. lupi, after migrating along the aortic wall cross over to the oesophageal wall, mature as adults, and promote nodule formation in the oesophagus. The common clinical signs are related to the presence of oesophageal nodules and include regurgitation, vomiting and weight loss, with other non-specific signs such as pyrexia.

Pyothorax, an uncommon clinical condition of dogs, is characterised by a septic pleural effusion. The objective of this case report is to report atypical complication of spirocercosis resulting in pyothorax.

A two-year old, male Doberman pinscher was presented to the Veterinary Teaching Hospital with a complaint of inappetance for one week and profuse vomiting of bile for four days. Haematemesis was observed after presentation. The dog had been vaccinated and dewormed regularly and a past history of similar signs was not reported. The general clinical examination revealed poor peripheral perfusion, mucosal pallor, splenomegaly, melena, popliteal lymphadenopathy and a purulent penile discharge. Within a few hours of hospitalisation, the dog became obtunded with progressive dehydration, hyperthermia (106°F), tachycardia and tachypnoea indicative of cardiovascular compromise secondary to septic shock and hypovolaemia. Systemic antibiotic therapy with Augmentin® (20 mg/kg) and metronidazole (20 mg/kg) failed to control the sepsis. As the dog showed severe abdominal pain pethidine (2mg/kg) was administered intramuscularly as symptomatic treatment. Although the emergency and critical care was given with cardio-pulmonary resuscitation the dog succumbed to the condition.

Necropsy revealed three oesophageal granulomas (4x5 cm, 3x2 cm, 5x7 cm) at the caudal end of the thoracic oesophagus. The middle of the most caudal granuloma (5x7 cm) contained a 1-2cm long perforation that exposed the oesophageal lumen to the thoracic cavity. All three granulomas contained Spirocerca lupi adult worms. In addition, there was 1200 ml of pus (inflammatory cells and bacteria in the impression smear) in the thoracic cavity and several scars were present in the caudal thoracic aorta parallel to the oesophageal granulomas.

This was the first report of a rupture of the oesophagus due to Spirocerca leading to pyothorax was reported in Sri Lanka. In conclusion, S. lupi infection should be included in the differential diagnosis of canine pyothorax in endemic countries.
Biochemical Markers of Liver Injury in Keepers of Captive Elephants in Sri Lanka

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Most elephant keepers in Sri Lanka, who were un-educated, have left the profession due to various reasons. The current elephant keepers are better educated but they frequently smoke and consume alcohol. It is timely to screen all elephant keepers for illnesses and educate them on diseases that are related to their life-styles and habits. Such special medical attention would encourage them to provide better health care and to be more concerned about captive elephants under their care.

The objective of the present study was to detect liver and kidney related conditions in elephant keepers through blood samples and urine analysis. Urine samples were also taken whenever possible for kidney function tests. All elephant keepers were requested to come for blood tests after 12 hours of fasting when captive elephants were brought to Kandy for the annual procession during August 2011. Only 36 keepers reported to the clinic and were subjected to blood and urine examinations in a mobile laboratory. Full blood counts, ESR (Erythrocyte Sedimentation Rate), fasting blood sugar, liver and renal function tests on blood and full urinalyses were conducted. All keepers were educated about the study and its benefits and all of them signed a consent form.

Only 17 keepers had normal reports and could be categorized as “healthy”. A total of 19 out of 36 had pathological findings either in blood, urine or in both. Twelve keepers showed evidence of liver disease with elevated Serum Glutamic Oxaloacetic Transaminase (SGOT, Mean = 77.7 units/l, SD ± 7.9) and Serum Glutamic Pyruvic Transaminase (SGPT, Mean = 83.1 units/l, SD ± 15.3). Two (2) keepers showed evidence of thrombocytopenia (90,000/ml and 110,000/ml) probably due to hypersplenism secondary to portal hypertension and cirrhosis. One keeper had hyperglycemia (12 mmol/l) and two keepers had eosinophilia indicating a possibility of parasitic infestation or allergy. All together 15 keepers submitted urine samples, 5 of them had more than 5 pus cells/HPF and albuminuria, as evidence of Urinary Tract Infection (UTI) and one had haematuria.

It appears that approximately half the keepers tested were not healthy. A substantial proportion may be having life-threatening chronic liver conditions which could be prevented via health education. The keepers need to be educated on UTI and urethritis and they must be assisted with early medical assistance when required.
Prevalence of Tuberculosis in Keepers of Captive Elephants in Sri Lanka:
A Preliminary Study

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Captive elephants, numbering approximately 120 at present, are compelled to participate in functions, in which close interactions with humans are frequent. The diagnosis of the first captive elephant with clinical tuberculosis (TB) suggested that the infection was probably transmitted from the elephant keeper. In addition, mahouts frequently consume alcohol and smoke which are known risk factors for TB. The objective of this study was to screen keepers of captive elephants in Sri Lanka for tuberculosis.

In August 2010 keepers of 92 captive elephants brought to Kandy for the Asela Perahera were screened for clinical symptoms and signs of tuberculosis. Those who had clinical evidence of chest infection were referred to the chest clinic for Mantoux test, chest X-rays and sputum smears for Acid Fast Bacilli (AFB) for confirmation of TB.

Although 20 out of 78 keepers, 20 keepers with clinical evidence of chest infection were referred to the chest clinic, only five reported to the chest clinic. None of them were positive for AFB and two showed a positive Mantoux reaction (>10mm), but chest X-rays did not show evidence of active TB. Therefore, they were diagnosed as latent TB infections. One keeper had clinical and radiological features strongly suggestive of TB and was diagnosed as smear negative pulmonary TB.

One out of 78 diagnosed with TB is a substantially high rate compared to the national tuberculosis prevalence of 1 per 1000 Sri Lankans. Two elephant keepers, with latent TB infections and positive Mantoux tests have a 10% lifetime risk of developing active TB. It is well known that TB infected individuals can show negative results to all laboratory tests because the sensitivity of sputum smear is not 100%. It is strongly recommended that those keepers who did not come for review should be followed up.

The findings of this study show that the prevalence TB among keepers of captive elephants is higher than the prevalence in Sri Lankan population. It is important to screen all keepers regularly if elephants are to be protected from contracting TB. Most keepers did not comply with medical advice possibly because they are afraid of losing their current minimal social acceptance if they were detected as TB patients.
Management of Pleural Effusion due to Congestive Heart Failure in Dogs: A Case Series


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The pleural space contains 3-5 ml of low protein clear fluid, production of which is controlled by Starling’s forces. Excess fluid accumulation in the pleural cavity is called pleural effusion (PE). An effusion can be classified as pure transudate, modified transudate, exudate or chylous fluid according to its protein content, cellularity and specific gravity. The common causes of PE are congestive heart failure (CHF), neoplasia, hypoalbuminaemia, pleural infection and thoracic trauma. Clinical manifestation of PE is associated with respiratory signs including laboured inspiratory phase, easy expiration, abdominal breathing and tachypnoea. Reduced intensity of lung sounds upon auscultation and hyper-resonance of the dorsal lung fields during percussion are evidentiary of PE and can be confirmed by diagnostic imaging. Removal of a volume of pleural fluid by thoracocentesis is diagnostic as well as therapeutic as it facilitates breathing. This is performed by inserting a sterile IV cannula or butterfly needle through the mid 7th or 8th intercostal space.

The objective of this study was to discuss the management of PE in four canine (A, B, C, D) patients presented to the Veterinary Teaching Hospital (VTH) with clinical signs predominantly of respiratory origin and confirmed as PE due to CHF. Treatment was initiated for CHF and to reduce pleural fluid for dogs A and B by using digoxin (5.5 µg/kg PO), furosemide (4 mg/kg IV), spironolactone (3 mg/kg PO) and theophylline (10 mg/kg PO). Haematinics and amino acid supplements were given as liver supportives. PE subsided and they recovered from the respiratory distress.

As dogs C and D were presented in a critical condition, the excess pleural fluid was removed by thoracocentesis to facilitate breathing. This was performed under aseptic conditions, under ultrasonographic guidance to avoid damaging lung tissue. The fluid obtained was characterised as a modified transudate. Thereafter, they were treated similarly to A and B in order to manage CHF and PE. Dyspnoea was relieved only in dog C and it was discharged 10 days after hospitalisation. The prognosis of dog D was poor and the patient died 4 days after hospitalisation.

The findings of this study show that thoracocentesis is an option in managing PE in critical patients. Rapid removal of pleural fluid is not advisable as it can cause re-expansive lung injury.
Clinico-Pathological and Microbiological Findings of Infectious Canine Tracheobronchitis Caused by *Bordetella bronchiseptica* Infection in Two Pups

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*Bordetella bronchiseptica* is a Gram negative coccobacillus causing infection in both humans and animals. It infects the respiratory epithelium together with adenovirus and/or parainfluenza virus causing tracheobronchitis in dogs, also known as kennel cough. This organism transmits via direct contact with infected animals, contaminated fomites and aerosols. A dry hacking cough is the most consistent sign but it can progress into severe respiratory distress and death in immunocompromised animals. Although antibiotics are indicated, it is found to be ineffective at the early stage of the infection.

*Bordetella* infection, though prevalent in other countries, has not been recorded in Sri Lanka. This investigation was done on necropsy samples of two imported pups. Both pups were females of Saint Bernard and American Bully breeds and at the time of death they were 3 and 4 months old respectively. Clinical presentation at admission to the Veterinary Teaching Hospital was non-productive cough, serous nasal discharge and wheezing. The pups did not respond to the treatment and died after a few days.

Similar gross lesions were seen in necropsies of both pups, including pulmonary oedema, multiple patchy haemorrhages, serosanguinous pleural effusions and inflammatory changes in the trachea and bronchi. Histopathology revealed homogenous fluid accumulation in alveoli, massive infiltration of neutrophils in lung alveoli and diffuse haemorrhages with severe diffuse suppurative bronchopneumonia, hepatic and renal congestion. A pure culture of Gram negative haemolytic coccobacillus (*Bordetella bronchiseptica*) was isolated in sheep blood agar, and pale pinkish hue colonies in MacConkey agar. The isolated organism was negative for: acid production in the slant and butt of TSI agar; H₂S or gas production in TSI agar. The culture was positive for oxidase, catalase, urease, citrate, nitrate reduction tests and negative for the indole test.

According to the culture and biochemical characteristics and microscopic appearance of the isolated organism, it was presumptively identified as *Bordetella bronchiseptica*. The isolation of this pathogen together with the clinicopathological findings were consistent with those of infectious canine tracheobronchitis caused by *Bordetella bronchiseptica*.

We conclude that there is a risk of introducing new infections to our local dog population from improperly screened and unquarantined imported dogs. This study shows the importance of early diagnosis of infectious canine tracheobronchitis in pups, because they are relatively immune-compromised due to immature immune systems and because it is highly contagious and zoonotic for immunocompromised humans.
An Investigation on Papillomatosis in Two Sri Lankan Elephants
(*Elephas maximus maximus*) at Pinnawala Elephant Orphanage

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Papillomas are benign wart-like cutaneous tumours, caused by papilloma virus of
the Papovaviridae family. Papillomatosis is transmissible between elephants and has
been observed on the skin over the shoulder, hip, limb and trunk, nasal or oral mucosa
commonly at the oral mucocutaneous junctions.

Pinnawala elephant orphanage (PEO) currently has 90 elephants in an area of
23 acres. A 68-year-old tusker and a 27-year-old female elephant at PEO showed chronic
papillomatous tissue growths on the metacarpophalangeal region of the forelimbs. Histopathological and microbiological examinations were performed on biopsy samples
taken from the growths and nearby inflamed areas.

The white colour papillomatous growths were 1 – 8 cm in diameter in the tusker,
and diffused spread over the metacarpophalangeal region in the female. They projected
above the skin as cauliflower-like growths, with fine fissures on the surfaces. The
attachments with the skin were broad based or pedunculated. Histopathology revealed
elongated epidermal interdigitations covered by a stratified epithelium with a thickened
keratin layer showing parakeratosis and acanthosis. The upper keratinocytes were
swollen and contained eccentric nuclei and a perinuclear halo with irregular keratohyline
granules. These cells with pale basophilic intranuclear inclusion bodies were indicative of
papilloma viral infection. In addition, secondary inflammatory changes were also seen in
the lesion. The microbiological examination revealed the presence of *Klebsiella
pneumoniae* and *Candida albicans* suggestive of secondary invasions.

As treatment, an autogenous vaccine prepared from the papillomatous growths
of both elephants was subcutaneously administered to expose the viral antigen to
leukocytes. Papilloma growths initially subsided within 6 – 7 days after the vaccine, but
recurred after 1 – 3 months. The most effective remedy for papillomatosis is
electrocautery or excision. Excision of growths was performed in both elephants but the
growths re-emerged after a few weeks. The secondary bacterial and fungal infections
were treated with parenteral antibiotics and the excised region of the foot was cleaned
with povidone iodine solution followed by local application of a mixture of copper sulphate
(antifungal), zinc chloride (chemical cauterizer) and Stockholm tar (antiseptic sealant).
Application of aciclovir (antiviral) tablets showed a significant reduction of papilloma
growth in the tusker.

This study shows the importance of laboratory diagnosis of papillomatosis by
histopathological examination. Early diagnosis will be useful in order to provide specific
treatments and also to take precautions to prevent transmission of the virus to other
animals.
Case Report: Second Order Horner’s Syndrome in a Dog


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Horner’s syndrome (HS) is a group of clinical signs that results from loss or interruption of sympathetic innervation to the head with loss of cutaneous vascular tone. The neural lesions may occur at any point along the sympathetic pathway giving rise to clinical manifestations. The localisation of lesions in relation to the sympathetic pathway can be made with topical application of 1% phenylephrine or a similar sympathomimetic.

A 3-year-old female Labrador, weighing 30 kg was presented to the Veterinary Teaching Hospital with complaints of sudden paralysis of tongue and salivation. Upon clinical examination miosis of the left eye, hyperemic oral and conjunctival mucosae, congestion of the left pinna and elevated body temperature were detected. Miosis of the left eye, vascular congestion of the left pinna suggested HS. Pharmacological testing for HS was carried out with the topical application of 1% phenylephrine to both eyes and determining the time taken for pupillary dilation to occur. Complete dilation of the affected pupil occurred within 25 minutes. Treatment was initiated to counteract local toxicity, physical injury and infection caused by possible trauma to the sympathetic trunk using I/V hydrocortisone 100 mg, I/V chlopheniramine maleate 10 mg, furosemide (2 mg/kg), slow I/V antivenin, I/V metronidazole (20 mg/kg) and I/V ampicillin (20 mg/kg).

HS is classified as first, second or third order, depending on the location of lesion along the sympathetic pathway. Possible causes for first order HS are cervical spine lesions or rostral thoracic spine lesions. Second order HS arise from brachial plexus root lesions or injury to soft tissues of the neck. Mid-ear lesions, skull fractures or retrobulbar contusions are possible causes for third order HS. Complete dilation of the affected pupil occurred within 25 minutes suggesting second order HS, where the lesion is located at the second order neuron of the vagosympathetic trunk.

It should be emphasised that the pharmacological testing for HS helps detection of the site of the lesion, but is not diagnostic. The result of the pharmacological test as well as neurological signs should be taken into consideration when arriving at a diagnosis. The prognosis of first and second order HS is entirely dependent on identification of the specific cause, the nature of the neurologic lesion and the therapeutic regime. In the present case, prognosis proved poor as the animal was unable to prehend and swallow any solids or liquids and the enteral (naso-gastric) feeding of liquids led to aspiration and asphyxia.
INFORMATION TECHNOLOGY, MATHEMATICS & STATISTICS
Constant Time Encryption as a Countermeasure Against Remote Cache Timing Attack

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Rijndael was standardised in 2001 by the National Institute of Standards and Technology (NIST) as the Advanced Encryption Standard (AES). Therefore, AES is still being used as an encryption standard to store and transmit confidential data from financial, military and government institutions. Before its inception, AES was widely analysed for prevailing side channels and other vulnerabilities for a five year duration and was declared to be the encryption standard for the next 20 or more years. However, in year 2005, Daniel Bernstein illustrated a remote cache timing attack on AES using a client and a server. Therefore, he showed a side channel in the software implementation of the AES. He used client server architecture to demonstrate the attack. The server is fed with known and unknown keys and measures the timing details. Then by comparing timing differences for known and unknown secret keys, the secret key can be deduced and confidential data can be decrypted.

The vulnerability in AES exists due to the fact that there are T tables which are used to speed up the software encryption process. AES algorithm has four stages, 1. Sub Bytes, 2. Shift Rows, 3. Mix Columns, 4. Add Round Key. Since stages 1, 2 and 3 need huge computational power, those stages are pre-computed, and stored in tables called T tables. There are 4 T tables which have 256 entries, each of which takes 32 bit space per entry. During the encryption process, T tables may not fit into the cache with the encryption data, resulting in cache hits and misses. The attack is accomplished by performing several rounds of encryption and correlating the computation against the time taken to perform the encryption.

In this project, we propose a new countermeasure against Bernstein’s remote cache timing attack. We have illustrated that our countermeasure is not vulnerable even to statistical analyses which perform the attack for several iterations and then uses statistics to deduce the key. In our countermeasure, the AES encryption program is carefully rescheduled such that it will take a constant time for execution, irrespective of cache hits and misses. To make timing details constant we used the pipeline depth of the targeted processor. Therefore, the limitation of our approach is that we need rescheduling before using it in another processor which has a different pipeline depth. Security measures always ingest resources or time or both. The proposed countermeasure is approximately 1.22 times slower than the unprotected AES code which is vulnerable to the remote cache timing attack. In conclusion, we demonstrate that remote cache timing attacks are not possible when our countermeasure is applied on AES implementation and the cost is approximately 22% performance degradation of the system.
Eye Gaze Direction for Human-Computer Interaction

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Human Computer Interaction (HCI) is a technique used for interaction between users and computing systems which occurs through user interfaces (including both hardware and software) of a computing system. HCI devices can generally be divided into two: the input peripherals and the output peripherals. The objective of this study is to describe a new technique for the former. Although new HCI techniques and devices are being introduced and deployed in computing systems for input peripherals (from different types of keyboards to mice and touch screens), they essentially failed to address the problems encountered by a group of users who have difficulties (such as disabilities due to accidents, aging, etc.) in using their hands for handling such devices. Thus, the present research focuses on enabling the disabled to use computing systems through a new HCI technique, namely, eye gaze direction (i.e., a steady, fixed look; or simply, 'where we are looking').

As technology evolves rapidly, all individuals should benefit, irrespective of whether they are disabled or not. Unfortunately, a disabled person, who does not have the ability to move his / her hands (due to spinal cord injuries, brain injuries, multiple sclerosis, strokes, etc.), cannot use a typical computer due to inability in moving the mouse. Therefore, we propose to use eye-gaze direction as an input method to the computer. In such a setup, the eye-gaze direction of the user will be detected by an eye-gaze direction monitor, used as input to the computer. This will be useful not only for disabled persons, but as an alternative input method in environments such as gaming consoles.

We built a low-cost, nonintrusive system which can be used to move the mouse pointer through eye-gaze direction and perform mouse-actions. To achieve these goals, typical eye-gaze tracking systems use methods such as optics, electronics, mechanics, etc. In our system, we used a mounted camera (a low cost webcam) in front of the user to capture the images, which are then sent to the computer. The computer processes these images and determines the eye gaze direction and gestures necessary to control mouse-actions such as single-clicking, double-clicking and zooming. Although a few similar systems exist, they are very expensive (as they use special-purpose eye-gaze direction trackers, such as a high priced camera) and have limited functionalities.

There are obstacles when designing and implementing eye-gaze tracking systems due to trade-offs between requirements. The major challenges of such a system; ensuring smooth movement of the mouse pointer as the eye-gaze direction changes and real-time responsiveness of the system; were overcome in our project. We overcame drawbacks in the existing eye-gaze tracking systems by enhancing accuracy of the eye-gaze direction detection and by improving the efficiency of the existing algorithms. Effective image processing techniques and haar-like features were used to achieve our final goal, which is to help the disabled to cope with and to utilise the latest technologies.
Lehmer’s Conjecture and Minimal Absolute Height of the Algebraic Numbers of Cubic Polynomials with All Real Roots

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The Mahler measure of a polynomial with integer coefficients is defined to be the products of the absolute values of roots outside the unit circle and the absolute value of the leading coefficient of the polynomial. An algebraic number is a root of a non-zero polynomial in one variable with rational coefficients.

If an algebraic number \( \alpha \) is a root of an irreducible integer polynomial of degree \( d \), then the Mahler measure of \( \alpha \) is defined as the Mahler measure of the polynomial. The absolute height of \( \alpha \), \( H(\alpha) \), is defined \( (M(\alpha))^{1/d} \) as, where \( M(\alpha) \) is the Mahler measure of \( \alpha \).

In 1933, D. H. Lehmer raised his famous question referred to in literature as “Lehmer’s conjecture” on the lower bound for \( H(\alpha) \) which questions the existence of a constant \( c > 1 \), such that \( H(\alpha)^d \geq c \), when \( \alpha \) is not a root of unity. Lehmer has established that \( c = 1.117628\ldots \), where \( c \) is the largest real root of the polynomial \( l(x) = 1 + x - x^3 - x^4 - x^5 - x^6 - x^7 + x^9 + x^{10} \). It is believed that \( c \) cannot be made arbitrarily close to 1.

The question posed on the existence of a lower bound for the absolute height of an algebraic number has attracted much attention after Lehmer’s conjecture. Several important results have been established in the direction of the proof of his conjecture. In this endeavour, the absolute height of algebraic numbers corresponding to the set of irreducible integer polynomials of degree three having all real roots is investigated. In this effort, the greatest lower bound for the absolute height of the algebraic number associated with the class of polynomials under consideration was computed. Also, the irreducible polynomials associated with this value were found.
Multivariate Techniques in Analysing the Morphological Variations of the Genus *Monochoria*

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Multivariate analysis techniques are used to arrange biological data for interpreting and detecting variations among variable groups. The main objectives of this study were i) to analyse morphological variation in the genus *Monochoria* C.Presl (Pontederiaceae) in order to identify how raw data would be more useful for clear visualisation of characters, ii) to use multivariate techniques in analysing the morphological variations of the genus *Monochoria* and iii) to perform a statistical shape analysis to gain support for the groups identified in the analysis on the basis of leaf morphological variation observed in the field and thereby to re-assess the species boundaries of the genus.

The pie charts of qualitative characters had two categories with about 92% and 8% for the two pie divisions. The maximum cophenetic correlation value was obtained for the Un-weighted Pair Group Method with Arithmetic Mean (UPGMA) clustering algorithm. Therefore, classification was performed using a UPGMA clustering algorithm and the sample species visualised the first primary groupings, *M. hastata* (Group A) and *M. vaginalis*. The three sub-groupings of the species type *M. vaginalis* were named as Group B1, Group B2 and Group B3.

The non-parametric MANOVA test and the pair-wise non-parametric MANOVA test justified the significance of the difference among the four groups obtained and the significance of the pair-wise difference among each group at 5% significance level. The Principle Coordinate Analysis states that the sample specimens MV53, MV54 and MV56 are outliers of the Group B3, due to extreme outliers for individual characters measured for these 3 specimens. Similarity Percentage Analysis (SIMPER) revealed that the maximum separations of the groups correspond to Groups A and B1. The plant height up to leaf base and petiole length were the variables that contributed most for dissimilarity among Groups B1, B2, B3 and A.

The Elliptical Fourier shape analysis verified the dissimilarity of the shape of the leaves of all four groups, an observation made in the field for members of *M. vaginalis*. The shape patterns obtained by the Elliptical Fourier analysis confirmed the changes of the leaf shapes very clearly.

The analysis supported the morphological variations observed, especially the leaf shapes, which resulted in three primary groupings (Group B1, B2 and B3). Use of mixed data is recommended as it was more useful i) to obtain a clear idea regarding the distribution of each variable separately, ii) to identify groups with similar morphological characters and iii) as detailed analysis could be performed on the data sets.
An Assessment of the Coexistence of Humans and Elephants in Sri Lanka

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Sri Lanka has globally significant biodiversity that is currently threatened by deforestation, land degradation and unregulated exploitation of natural resources. With the increase in human population density and changes in land-use patterns, elephant habitat is being continuously reduced, and there is no longer much room for elephants to move about and adjust their densities to changes in the land-use. As a result, much of the present day elephant range extends into and overlaps with agricultural lands, hence aggravating the Human-Elephant Conflict (HEC). Mitigation of HEC requires a complete understanding of the problem and its specific causes.

This study was conducted by Feld Entertainment, Inc. and the Ringling Center for Elephant Conservation (CEC) in Florida, USA. The main objective was to get a clear idea on the significant factors affecting coexistence of humans and elephants. Secondary data collected by the third and fourth authors were used for the analysis. The assessment of the HEC was carried out by them from July to December 2009 during which information on HEC was collected through the use of a designed questionnaire in 185 villages selected by using judgmental sampling technique from seven provinces (North, North Central, North Western, Eastern, Central, Uva and South) within the elephants range.

An ordinal logistic regression model was fitted for the data by taking the “Severity levels of HEC” as the dependent variable. Independent variables such as elephant movement, group size, distance from the closest elephant habitat border and the availability of a water source were identified as significant factors affecting coexistence of humans and elephants. This model, with a logit link, appeared to be the best model in this study based on model fitting statistics, the accuracy of classification results and the principle of parsimony.

It can be assessed whether coexistence of humans and elephants is possible or not in each area according to the predicted probabilities of the severity level of HEC from the above model. As elephants are incompatible with peasant agriculture at high densities, if they are to coexist with humans, then the level of conflict must be substantially reduced. Although it is unlikely that the HEC can be eliminated altogether, every effort must be taken to reduce it to tolerable levels.
Forest dieback in Horton Plains National Park

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Horton Plains National Park is a protected area in the central highlands of Sri Lanka and is covered by montane cloud forests and grasslands. Forest dieback was first reported four decades ago, and still continues to deplete forest cover in the park. A study on forest dieback in the upper montane rain forest of Horton Plains was initiated by the Department of Wildlife Conservation during 1997-1999 to determine the status of dieback, species affected and its distribution pattern. The second phase of this project was carried out in 2005.

During the 2005 study, data were collected from three forest sites in the park which were selected visually depending on the degree of dieback. The selected sites were Thotupolakanda (severe dieback site), Anderson 1 (moderately dieback site) and Anderson 2 (comparatively healthy site). Each site was subdivided into 25 sampling plots and every individual tree in the sampling plots was examined to record tree health conditions. Graphical techniques (pie charts and bar charts) were used to illustrate qualitative variables such as species, stratum, percentage of bark damage, percentage of stem defects, healthy tree and site. The results show that \textit{Cinnamomum ovalifolium} is the most abundant tree species in the park and \textit{Pittosporum tetraperum} and \textit{Ilex zeylanica} are the least abundant species. The percentage of sub-canopy trees in the Horton Plains is more than 75% and there are about 22% of canopy trees. Also, most of the trees in the park area were not subjected to bark damage and there are only 0.63% of trees which carry signs of more than 75% bark damage. The largest bark damage category was between 1-25% of damage. The magnitude of stem defect is similar to the magnitude of bark damage. Box plots were used to illustrate the pattern of distribution of quantitative variables such as Diameter at Breast Height (DBH), percentage of crown dieback, percentage of discolouration of foliage, percentage of defoliation and number of dead branches. It was found that the average DBH is around 9.96 cm and the average percentage of crown dieback of trees in the study plots is about 10.89%. Most of the trees have undergone 0-5% foliage discolouration and the mean percentage of discolouration of foliage of trees is about 4.08%. The highest percentage of healthy trees was recorded from Anderson 2 site and the lowest percentage of healthy trees was recorded from Thotupolakanda site. The proportion of unhealthy trees in Horton Plains is significantly greater than the proportion of healthy trees at 5% significance level. It was identified that there is a significant ($p=0.05$) difference among the diversity indices of the three sites. Moreover, distribution of proportional abundance of tree species in all three sites fits into a truncated log normal model at 1% significance level. Also, significant relationships exist between species and variables such as stratum, tree stature, percentage of bark damage and percentage of stem defect. Further, there is a moderate positive relationship between bark damage and stem defect at 5% significance level. The fitted ordinal logistic regression model can be used to predict the probability of percentage of a tree to undergo dieback when species, stratum, DBH and site are given.
Impact of Stock Splits on Stock Return and Liquidity: A Case Study of Colombo Stock Exchange

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In the capital market, most companies split their shares and these splits have an impact on stock return and liquidity. A survey of corporate managers reveals that there are two most important reasons for undertaking a stock split: (1) to bring the stock’s price into an optimal trading scale; and (2) to enhance liquidity. There was an increment in the number of shareholders as well as the liquidity of companies in 1985 in NASDAQ stock exchange. This study was conducted based on 26 companies that had undergone stock splits during year 2010 in Colombo Stock Exchange (CSE). The specific objectives were to identify whether there was a significant increment or decrement of unexpected return as a result of the announcement of a stock split, known as abnormal return; to identify whether there was a significant difference in liquidity measures such as stock trading volume, market price and number of tradings after the stock split; and to identify the main factors affecting variation in stock trading volume.

Each company’s stock split data were divided into pairs: period prior to and after the effective date. A 20 day window was used for the comparison of behaviours of stock return and short term trading volume and a 120 day window was used for studying behaviour of long term trading volume, market price and number of tradings. *Abnormal Return* can be used as a proxy for stock return. *Abnormal return* is defined as \( \text{Actual Return} - \text{Expected Return} \). Due to non-normality and the small size of the data sets, non-parametric tests were used. For testing the equality of median of trading volume, market price and number of tradings, one-sample Wilcoxon signed rank tests were used since the data sets were dependent. To test stock returns, one-sample sign test was used. Using the Price-Earning (PE) Ratio, companies were evaluated as undervalued (PE< Benchmark PE) or overvalued (PE> Benchmark PE). Chi-square tests were used to find the dependencies between the change in trading volume after the stock split and the total number of shares, market price, split ratio, profit per share, and dividends, separately.

According to the analyses, 54% of companies recorded an increment of trading volume after the stock split regardless of length of the data frame, and the trading volume increased significantly in 60% of companies. From a total of 26 companies, 65% and 62% of companies have increased their market price and number of trading respectively. No significant decrement in stock return was observed during the 20-day window. Before and after periods of stock split show an increment in stock return. The days after the effective date of the stock split show a significant increment of the stock return when comparing with the days before the effective date. According to the purpose of the stock split, five companies have been able to convert their overvalued stocks to undervalued stocks with the stock split. The number of companies with undervalued shares was increased from seven to ten with the stock split. The total number of shares and their market price determines the change in the trading volume with stock split. No dependencies were observed between change in trading volume and split ratio, profit per share, dividend values. Overall, 96% of companies recorded an increment at least in one liquidity proxy and in six companies; all three liquidity proxies were increased with the stock split.
Sound Retrieval and Searching Technique for Web-Based and Application Specific Search Engines

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Recent improvements of multimedia technologies made legacy text based search techniques inefficient due to the fact that the content of those data units or files could not be represented in textual form. To solve this problem, Content Based Search techniques were introduced.

In this study, we propose an efficient method for audio data searching and retrieval where users can input queries as audio data (melody, sound slice etc.) and retrieve similar sound patterns from a reference index using an Artificial Neural Network (ANN).

An audio database containing 22 different audio patterns including male and female voices, sounds of musical instruments, classical and rock music etc. were created. A reference relation was created in a database storing a unique file ID and the reference to each audio file. Using these references, each audio file was retrieved and sliced into one second (1s) pieces and these slices were transferred into two wavelet domains, “Haar” and “Daubechies3” (Db3), with five scale levels to obtain the base feature matrix for analysis. This feature matrix was used as the input for a Feed Forward ANN by taking five means of five scale levels and four ratios between means that sum up to nine different feature values per second of audio data. These inputs and corresponding file IDs were passed as training data to the ANN. The query audio inputs were decomposed and transformed into a wavelet domain and used as the input to the trained ANN where the audio reference (file ID) that contains a similar pattern was produced as the output.

The results for each slice of audio data show an average of 71% of correlation with originally fed audio slices on both Haar and Db3 wavelets. Noise-added slices show 69% of similarity and scaled slices show 45% similarity on Db3 wavelets. Each test output was produced with maximum 5 s result latency.

It was observed that the proposed approach shows significantly accurate results and it could be used to search audio data efficiently for both web-based and standalone purposes with a certain tolerance limit. System improvements could be done by adding a Hopfield Network for preliminary classification and then proceeding with the current method or by converging multiple ANNs each of which is trained with different wavelet type.
Fingerprint Image Segmentation using Fuzzy Logic

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Image segmentation is an important pre-process to recognize the region of interest (ROI) for fingerprint matching. In order to extract minute points from the fingerprint image, the foreground of the image must be segmented from the background. In 2010, Malathi et al., have proposed a method to segment fingerprint images by using pixel distribution over a fingerprint image. In addition, Bazen et al., in 2001, proposed an adaptive method to segment the fingerprint image by using three pixel features; namely, coherence, mean and variance.

In this paper a Fuzzy logic approach is proposed for fingerprint image segmentation. In this method, fingerprint image is partitioned into 16*16 blocks and coherence, mean, standard deviation and ratio between the mean and the standard deviation were calculated for each block. The calculated values for coherence and the ratio between the mean and standard deviation were normalised into a value between 0 and 1. The calculated standard deviations and means were normalised into a value between 0 and 1.5. The normalised coherence, mean, standard deviation and ratio between the mean and the standard deviation values were taken as inputs for the Fuzzy logic system to determine whether the block is in the background or foreground.

All the above methods were tested for images from DB2_B of FVC_2004 and averages of matching percentage were calculated and compared with manually segmented images (Table 1).

<table>
<thead>
<tr>
<th>Method</th>
<th>Matching percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuzzy Logic System</td>
<td>88.47</td>
</tr>
<tr>
<td>Threshold</td>
<td>87.81</td>
</tr>
<tr>
<td>Adaptive</td>
<td>85.35</td>
</tr>
</tbody>
</table>

Table 1. Comparison of segmentation methods

High matching percentage gives better segmentation of the fingerprint image for further operations in fingerprint matching. According to the analysis, average matching percentage of the Fuzzy logic system is higher than that of the other methods (Table 1). Therefore, it can be concluded that the Fuzzy logic approach is the most appropriate method for fingerprint image segmentation.
Improved Night Driving: A System for Detecting Angle to Turn Head Lights of a Vehicle around Bends

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The objective of the research was to develop a system for turning head lights of a vehicle around bends, according to the bend angle, to improve night driving. This paper presents a system for detecting angle to turn head lights of a vehicle based on image processing and fuzzy techniques.

The first step in the proposed work was to obtain a clear digital image of the centre line of the road. Next, image processing techniques were used to extract the lines and peaks of the lines. Then, the image was blurred, subtracted from the original image, cropped to obtain the region of interest and converted into a gray-level image. An algorithm was used to increase the intensity of the centre line and the image was filtered using a median filter. Next, the image was converted into a binary image to extract the gradient. Hough transform was applied to extract the lines and peaks of the image and tangent lines were obtained using the peak points. Finally, the bend angle in the range of $-15^\circ$ to $15^\circ$ was obtained using the tangent lines.

The final outcome of the angle for turning head lights was obtained by using a fuzzy system. This system was developed by using two input variables: bend angle extracted and the speed of the vehicle. In this method, it was assumed that the speed of the vehicle is a constant value. The fuzzy system was used to obtain a zero output for the angle to turn head lights when the speed of the vehicle is comparatively low (< 20 km h$^{-1}$). In order to obtain an accurate result, this system was tested with 250 images. For every image the system will produce the angle in which the light needs to be turned.

Since many consumable cameras are available in the market for obtaining images with higher frame rates such as 10 frames per second, this system can be easily implemented to be used in vehicles for safety driving.

Since this system was not tested by actually implementing it on a vehicle; final light angles are not 100% accurate. However, we can adjust the fuzzy membership functions and guide the system to produce accurate results when testing this system on a vehicle.
Optimization Model for Cutting Stock Problem with Pattern Generation

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The efficiency of a production system becomes a key factor of success in today’s competitive manufacturing environment. Productivity can be improved by minimising waste, lead time and hence reducing the cost of production. Therefore, Operations Research plays a major role in minimising production waste. A cutting stock problem is basically described in two ways: One-dimensional (1D) and Two-dimensional (2D) cutting stock problems. It consists of cutting large pieces, which are available in stock, in different shapes to produce smaller pieces, which are known as items, in order to meet a given demand. This often results in leftover of small pieces which cannot be used for production and are considered as waste. Therefore, cutting items should be designed to minimise waste of raw materials. These problems arise in industries such as garment, paper, glass etc.

A computer programme using the Matlab software package was developed to generate feasible patterns using the Branch and Bound Algorithm (Saad M.A Suliman, 2001) for 1D cutting stock problem and the mathematical model was formulated based on the concept of cutting patterns to satisfy the requirements of each piece and minimise cutting waste.

A case study was conducted to illustrate the above procedure. Here, we consider 1200 cm long steel bars to be cut into eight types (different lengths) of pieces according to the requirements given below:

<table>
<thead>
<tr>
<th>Order number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Required length (cm)</td>
<td>930</td>
<td>780</td>
<td>630</td>
<td>590</td>
<td>493</td>
<td>300</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>Demand</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>250</td>
<td>2</td>
<td>2</td>
<td>100</td>
</tr>
</tbody>
</table>

Forty four feasible cutting patterns were generated using the Branch and Bound Algorithm out of which six optimum cutting patterns were selected by solving the corresponding Integer Linear Programming model satisfying the given demand as given below:

<table>
<thead>
<tr>
<th>Pieces (cm)</th>
<th>Optimal Patterns</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>930</td>
<td>1 0 0 0 0 0 2</td>
<td>493 0 0 0 2 0 250</td>
</tr>
<tr>
<td>780</td>
<td>0 1 0 0 0 0 2</td>
<td>300 0 1 1 0 0 1 2</td>
</tr>
<tr>
<td>630</td>
<td>0 0 1 0 0 0 2</td>
<td>200 1 0 1 0 1 0 2</td>
</tr>
<tr>
<td>590</td>
<td>0 0 0 2 0 0 2</td>
<td>100 0 1 0 0 0 9 100</td>
</tr>
</tbody>
</table>

| # of sheets | 2 2 2 1 125 11 |

130
Analysis of Technical Efficiency in the Banking Sector with Respect to Inputs and Outputs

V.K. Priyadarshani and W.B. Daundasekera

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The efficiency of a bank is examined by using Data Envelopment Analysis (DEA), which is a non-parametric analytical technique. DEA is an approach for evaluating the performance of a set of peer entities called Decision Making Units (DMUs). DEA technique was introduced by the company Charnes, Cooper and Rhodes in 1978 to measure the technical efficiency of decision making units. This technique has been extensively applied in performance evaluation and benchmarking of schools, hospitals and banks.

The efficiency score in the presence of multiple input and output factors is defined as:

\[ \text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}} \]

This study seeks to test the technical efficiency of a state bank in Sri Lanka. Two specifications of DEA were developed for analysis. The first model used in this study aims to measure technical efficiency in intermediation. For this specification, loans and advances, interest income and other incomes were considered as outputs of the bank while interest expenses, personnel costs, premises and establishment expenses were considered as its inputs. The second model aims to measure the technical efficiency of the asset transformation. For this specification, loans and advances and other earning assets were considered as outputs while number of deposits, other loanable funds and number of employees were considered as inputs. According to the DEA technique, the number of inputs and outputs is always restricted by the number of DMUs in the sample. The difference between efficient DMUs and inefficient DMUs depends on the number of inputs and outputs which are used in the DEA model.

The technical efficiency of National Savings Bank, Sri Lanka was measured by applying DEA with data from 2001 to 2010. These data are taken at a specific time period, from 1st January to 31st December each year. Microsoft Excel was used to solve the model. Data for this study were taken from the Annual reports of National Savings Bank from 2001 to 2010.
Applicability of Zimmermann Multi Objective Fuzzy Linear Programming Model Under Large Vagueness

S.M.N.S.K. Seneviratne and W.B. Daundasekera

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Problems related to agriculture that deal with nature often suffer from imprecision and vagueness. The most recent method developed in order to deal with these problems quantitatively, is Fuzzy Linear Programming (FLP). In 1978 Zimmermann developed a model to find a solution for the Multi Objective Linear Programming problem. This was done with the use of fuzzy decision theory presented by Bellman and Zadeh in 1970. In the present study, Zimmermann (1985) model was applied to three districts in Sri Lanka which are popular for vegetable cultivation, namely, Badulla, Matale and Nuwara Eliya. Badulla and Matale are in the Intermediate zone and Nuwara Eliya is in the up-country wet zone. These zones differ greatly with respect to temperature, rainfall and soil. This study was undertaken to find out the applicability of Zimmermann (1985) model when there is high vagueness within the system under study. Such a study has not been reported in literature. The applicability of Zimmermann (1985) model under such conditions was measured using how effectively the model chooses right crops for each district.

The most appropriate crops for each district is selected by considering the respective profit which is recorded in the Department of Agriculture. The most appropriate crops selected by the Zimmermann (1985) model were compared with the data obtained by the Department of Agriculture.
NATURAL SCIENCES
Analysis of Long-Term Climatic Trends in Selected Locations Representing Different Agro-ecological Regions of Sri Lanka

S. Karthika and W.A.J.M. De Costa

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Significant variations in time series patterns of key climatic variables of a particular region over a prolonged time period provide evidence of climate change. The objective of this study was to demonstrate the long-term variation patterns of air temperature and rainfall and to show their magnitude of variation between different locations of Sri Lanka representing different agro-ecological regions.

Fifteen locations (Anuradapura, Badulla, Batticaloa, Colombo, Diyatalawa, Galle, Hambantota, Jaffna, Kandy, Kurunegala, Mannar, Nuwara-Eliya, Puttalam, Ratnapura, Trincomalee) representing different agro-ecological regions of Sri Lanka were selected for this analysis. Annual mean temperature and annual total rainfall data from 1869 to 2009 were used. Different univariate non seasonal Auto-Regressive Integrated Moving Average (ARIMA (p, d, q)) time series analysis models were fitted to the data and predictions for the future were obtained.

Different types of best-fitting models for the mean annual temperature were identified for different locations. These included: a first order moving average (MA1) for Mannar, Colombo, Diyatalawa, Galle and Nuwara-Eliya; second order moving average (MA2) for Anuradapura and Kurunegala; and an autoregressive moving average with first order differentiated (ARIMA (1,1,1)) for Hambantota and Badulla. The predicted (2010 – 2020) mean annual temperature (T_{am}) of all Dry Zone locations was higher than their respective long term annual means, with T_{am} at Anuradapura (DL1b) expected to be higher by 0.95°C. For locations representing the Intermediate Zone, i.e., Badulla (IM1a) and Kurunegala (IL1a), the predicted T_{am} was higher than the long term mean by 0.8°C. Among the Wet Zone locations, Galle (0.84°C), Nuwara-eliya (0.88°C) and Colombo (0.73°C) showed the highest increases (> 0.7°C) in predicted T_{am} in comparison to their respective long term means. The predicted T_{am} of Kandy (WM3b) and Ratnapura (WL1a) were not significantly different from their respective long term means.

Only three out of the 15 locations showed auto-correlation within their data series. ARIMA (0, 1, 1) model was the best-fitting model for Colombo and Nuwara-Eliya while ARIMA (2, 0, 1) was fitted for Mannar. An average increase of 6.2% in annual rainfall was forecasted for Colombo for the period2010 to 2020, while a reduction of 18.5% is predicted for Nuwara Eliya. Long-term variation in annual total rainfall in the other 12 locations showed random series and hence, simple linear regression was done. Interestingly, trends of annual rainfall in Batticaloa, Hambantota and Galle showed increasing trends while Badulla, Kandy, Diyatalawa, Kurunegala and Ratnapura showed decreasing trends.

This analysis demonstrates significant vulnerability to long-term climate change in most areas of Sri Lanka with agricultural potential. Initiation of adaptive measures is most urgent in Anuradapura, Nuwara-eilya and Galle because of their greater increases in temperature and significant decreases in rainfall. Adaptive measures need to be initiated in other areas as well in accordance with their respective magnitudes of climate change and vulnerability.
Phytoremediation of Metal Polluted Soils by \textit{Ipomoea aquatica} and \textit{Colocasia esculenta}

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Heavy metals are one of the major means of environmental pollution, which heavily affect human health via ingestion through plants, foods, contamination of water bodies and other nutrient supplements. Various sources of heavy metal pollution include agro-chemicals, industrial waste, mine extraction operations, paints, lubricants, industrial wastes, etc. Phytoremediation is the use of plants to clean-up contaminated, hazardous waste sites. It is an economical, biocompatible, passive process which is faster than other natural processes. This study was executed in order to quantify the heavy metal contamination in soils near ten selected painting and motor repair industrial sites in and around Kandy, and accumulation of heavy metals in the plant species which are predominantly found in such areas.

Kankun (\textit{Ipomoea aquatica}) and Habarala (\textit{Colocasia esculenta}) were found to be the most predominant, common species in the sites selected. Plant (\textit{I. aquatica} and \textit{C. esculenta}) and soil samples were collected from four different places, downstream of each site. Plants of the same species were also collected from places in close vicinity, from a similar land, but cultivated or from a place where no apparent contamination was observed, as the control. The soils were air-dried and sieved using 1 mm sieve. The plants were oven dried at 95\(^\circ\)C and finely ground. 500 mg of each sample was digested using 10 ml of 67\% concentrated HNO\textsubscript{3} in a block digester for 8 hours and once cool, the solution was filtered and made to 50 ml volume. The concentrations of Pb, Fe, Mn, Zn, Cu and Cr were analysed using an atomic absorption spectrophotometer.

Both soil and plant samples were highly contaminated with Pb, Cu, Mn and Cr, compared to the control samples. In the soil, the concentrations of Pb, Cu, Mn, Cr, Zn and Fe were 7.57±2.49, 78.4±18.7, 445.9±86, 70.5±14.5, 109.2±18.6, 31214±8089 ppm respectively. In plant samples too, the concentrations of these metals were significantly higher than those in the control. In \textit{I. aquatica}, concentration of Pb, Cu, Mn, Cr, Zn and Fe were 3.68±1.45, 126.8±31.2, 500±105, 45.93±6.24, 49.50±7.46, 18809±5689 ppm respectively. Absorption of Fe was significantly high in \textit{I. aquatica} than in \textit{C. esculenta}. However, the concentrations of Pb and Cr were significantly higher in \textit{C. esculenta} than in \textit{I. aquatica}. In \textit{C. esculenta}, concentrations of Pb, Cu, Mn, Cr, Zn and Fe were 6.70±2.33, 147.0±37.6, 418±129, 49.50±7.46, 134.2±47.9, 17294±10610 ppm respectively. Although the concentrations of these metals were significantly high in these two species, toxicity symptoms were not shown by \textit{I. aquatica} and \textit{C. esculenta}. Therefore, it can be inferred that \textit{I. aquatica} than \textit{C. esculenta} are suited as potential phytoremediant species in Sri Lanka. However, if cultivated for food purposes, heavy metal contamination of soil has to be considered.
Study of Cytotoxic and Genotoxic Effects of Seven Water Sources in Sri Lanka

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¹Department of Anatomy, Faculty of Medicine University of Peradeniya
²Acharya’s Bangalore B-School (ABBS), Bangalore

Water sources used for drinking and irrigation are complex mixtures containing numerous inorganic as well as organic compounds when polluted. Higher plants have been proposed as test organisms for the detection of genotoxic substances in the environment since the target is DNA which is common to all organisms. *Allium ascalonicum* assay is an *in vivo* system that can be used effectively to assess the genotoxic and cytotoxic effects of substances present in soil or water. The objective of this study was to assess the cytotoxic and genotoxic effects of several water sources that are used for human consumption and irrigation, using *Allium ascalonicum* assay.

The water samples used were from a stream at University of Peradeniya [US], tap water from Meewathura purification centre [PT], bottled drinking water [BW], Kandy lake water [KL], Mahaweli river water [M], Anuradhapura tank water [AP]. De-ionized water [DW] was used as a negative control.

Onion root tips of 3-5 cm in length were harvested and stained with 2% acetic orcein and 3 slides were prepared from each sample according to Feugen squash technique. Random observation fields with well spread cell arrangement from each slide were scored for mitotic index using an Olympus microscope at [X 100 (oil emersion) or X 40] X10 magnification. Mitotic Index was calculated as dividing cells out of total cells counted. Chromosomal aberrations too were observed in the same fields.

Significantly low mean mitotic index was observed in AP sample (p=0.036) and significantly high mitotic index was observed in samples US (p=0.0488) and PT (p=0.0114). Chromosomal aberrations such as micronuclei, chromosome bridging, lagging, nondysjunction and binucleate cells were observed. Binucleated cells were exclusively seen in AP sample. Following repeat assay in the same water source if similar results were observed, analysis of water samples may give an insight to causative substances.
Bird–Plant Interactions and Bird Diversity in Unrestored and Restoring Habitats in Lower Hantana

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Bird-plant interactions are of prime importance in evaluating the health of ecosystems. This study focused mainly on bird diversity and bird-plant interactions in four habitats; un-restored grassland (UG), restoring grassland (RG), unrestored pine stand (UP) and restoring pine stand (RP) in Lower Hantana. Birds were censused from 7.30 am – 11.00 am, once a week for a period of 24 weeks, from August 2010 to March 2011 (except January), using the point transect method.

A total of 65 species of birds, including seven endemic and five migrant species, were observed during the study. Forty species of plants including four endemic plant species were used by birds for feeding, nesting and perching. The bird species richness was highest in UG (54), followed by that in RP (52), UP (43) and least in RG (39). Across all habitats the most abundant bird species was the Pale-billed Flowerpecker (Dicaeum erythrorhynchos). The mean number of bird encounters in UG was significantly higher than that of RG, whereas the difference observed between the two pine stands was not significant. Of the total number of bird encounters (4117), over 60% exhibited perching behaviours while the remaining included feeding and nesting behaviors. Nesting activities were recorded only in the RG and the UP. Mixed species flocks comprising of Minivets, Velvet-fronted Nuthatch, Babblers, Common Iora, Bar-winged Flycatcher Shrike, Grey Tit, Golden-fronted Leafbird and Jerdon’s Leafbird were observed only in pine stands and these flocks were followed by the Sri Lankan Torque Monkey.

Based on diversity indices, considering the two pine habitats, RP had the highest bird diversity. Although less than RP, bird diversity was relatively high even in UP. This may be due to the high number of insectivorous bird species using this habitat especially to feed on bark insects living in Pinus caribaea. In contrast, the diversity of UG was higher than that of RG. The latter habitat had the least diversity, among sites. The difference is attributed to abundance of food resources (grass seeds and isolated fruiting trees) among sites and the wider distribution of UG in the area. The higher total count of birds recorded in UG than in any other habitat is probably due to high visibility in this habitat compared to the other sites. Results from this study can be used (i) to lay out trails for bird watching for ecotourism, (ii) to select plant species to enhance bird attractive habitats and (iii) to design undergraduate and postgraduate field studies in ecology in the Lower Hantana area.
Two methods of measuring thermal conductivity ($k$) of small samples were tested: (1) Differential Scanning Calorimetry (DSC) method developed by Hu and Wey (2007), using cylinders of 6 mm diameter and (2) 2-8 mm length and a radial method using cylinders of 5-10 mm diameter and 10-20 mm length.

The DSC method utilises the DSC instrument for measuring $k$ of small samples. The method does not require any use of temperature sensors. In contrast to the existing DSC methods wherein thermal contact resistance usually leads to great deviation in thermal conductivity measurement of samples, this method minimises the effect of thermal contact resistance. Thermal conductivities have been obtained from Polyethylene samples using this method and the results showed good agreement with the literature values. The thermal resistance ($R$) is given by the ratio of difference in temperature to difference in heat flow ($H_2 - H_1$) shown in Figure 1. The thermal conductivity was calculated from the gradient of the graph shown in Figure 2 (Thermal conductivity = 1/gradient).

In the radial method, a nichrome heating element was used to heat the sample from the centre and the temperature measurements were measured in a radial direction at two separate points. Two separate theoretical equations were used to calculate the thermal conductivity. Samples of Ebonite, Wood, Teflon, Rubber, and Polyethylene were tested and yielded thermal conductivity values that were in good agreement with the standard values. The method was tested against the Lee’s disc method for comparison of several materials.
A Comprehensive Study on a Hydroxy Gas Boosted Internal Combustion Petrol Engine

G.A.N. Perera and N.F. Hettiarachchi

Department of Physics, Faculty of Science, University of Peradeniya

In this study, hydroxy gas (Hydrogen + Oxygen) was produced by an electrolysis process in a cell (hydrogen generator). Hydroxy gas was used as a supplementary fuel in a four cylinder, four stroke, petrol, Internal Combustion (IC) engine without any modification and without the need for storage tanks. Its effects on exhaust emissions and engine performance characteristics were investigated. Experiments showed that the constant hydroxy gas flow rate at low engine speeds (under the critical speed of 1500 rpm for this experimental study), resulted in knocking of the engine. Investigations demonstrated that hydroxy gas flow rate had to be diminished in relation to engine speed due to the variation of opening times of intake manifolds at various speeds. Therefore, an electronic control unit was used to decrease hydroxy gas flow rate by decreasing voltage and current. The flow rate of hydroxy gas was measured by using various amounts of KOH (catalyst), variation of the expose surface area of the plates and variation of the number of plates in the cell. The catalyst was added into water to diminish hydrogen and oxygen bonds because it increases the ionic conductivity of the medium rapidly. It was observed that when the concentration by weight of KOH in solution reached 22%, electrical current supplied from the car battery was maximised.

The effect of adding hydroxy gas as a supplementary fuel to the IC engine was measured in five categories, namely, Fuel economy, Specific Fuel consumption (SFC), Torque, Horsepower and Emission. To measure the fuel economy, the car was driven in similar driving conditions with and without the addition of hydroxy gas and the volume of petrol being used at each drive was averaged to obtain the final result. It was observed that the fuel economy had an average increment of 32.33%. Then the SFC was measured at different engine speeds for both the systems. It had a decrement of 15.96%. Also the torque at the back driving wheels and the horsepower that the car produced were measured for both systems. The torque was increased by 15.83% and the horsepower by 16.08%. Finally the car was tested for emissions in a Laugfs- Eco Sri emission testing facility. There was a decrement in CO emission by 19.01%, CO₂ emission by 4.75% and HC emission by 5.96%.
Quasi-Solid State SnO$_2$/CaCO$_3$ Solar Cells Sensitized with Indoline D-358 Dye

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Dye sensitized solar cells (DSSCs) have drawn the attention of researchers due to simplicity of preparation and low cost compared to conventional solar cells. Even though the liquid electrolyte DSSCs shows the highest efficiencies in their class, there are draw backs in these systems such as solvent evaporation and sealing problems. As such, there have been attempts to replace the liquid electrolyte by a hole collector or a quasi-solid electrolyte in order to overcome these problems.

In present study, quasi-solid dye-sensitized solar cells were prepared using CaCO$_3$-coated SnO$_2$ sensitized with indoline dye D358. The quasi electrolyte was prepared using polyacrylonitrile polymer with ethylene carbonate and propylene carbonate as plasticizers. The CaCO$_3$ insulating layer inhibits the recombination and increases the open circuit voltage $V_{oc}$ of the cell from 330 mV to 700 mV while not affecting the short-circuit current $I_{sc}$ significantly. For this system we have achieved a best photo conversion efficiency of 4.0 % for a molar ratio of SnO$_2$ : CaCO$_3$ = 1 : 0.02 under 1.5 AM conditions.
CdS Based Quantum Dot Sensitized Solar Cells

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Dye sensitized solar cells have been developed as an alternative to Silicon Solar cells to cut down the cost of solar cells. Dyes are used to harvest sunlight in this type of solar cells and high efficiencies are possible only with ruthenium based dyes which are expensive. An alternate approach to harvest light in sensitized solar cells is to use semiconductor quantum dots (QDs) instead of dyes. QDs can be easily prepared and they have better ability to absorb light as their band gaps can be controlled by their sizes because of quantum confinement. Due to absorption of light over a wider spectrum and due to the possibility of generating multiple carriers, the quantum dot sensitized solar cells (QDSSCs) can have theoretical conversion efficiencies in the range of 44%. In spite of these advantages, there are relatively few studies on such solar cells and the maximum efficiency reported so far is around 1.8% for cells employing liquid electrolytes. CdS, CdSe, PbS, PbSe, InP QDs which can absorb light in the visible region are used in QDSSCs. Among these, CdS QDs are widely used because of their suitable band gaps, long lifetime, important optical properties, excellent stability and easy fabrication.

Cadmium sulphide (CdS) based QDSSC have been fabricated with QDs prepared using sequential chemical bath deposition (CBD) technique and their photo-responses were investigated using one sun (AM 1.5, 100 mW cm\(^{-2}\)) illumination. The QDs were prepared in different concentrations of CBD solutions and tested in QDSSCs. The QDs grown in low concentration electrolytes showed best performance indicating that better quality QDs with good light absorbing property are produced when they are grown slowly.

The effect of different electrolytes on the QDSSC performance was investigated using standard commercially available iodide solution, 0.5 mol dm\(^{-3}\) aqueous Na\(_2\)S solution or a 1:1 mixture of above two solutions. The performance of the QDSSCs are strongly depends on the redox mediators present in the electrolyte. A QDSSC with mixed iodide and sulphide redox mediators showed the best performance with a \(J_{sc} = 2.1\) mA cm\(^{-2}\), \(V_{oc} = 386\) mV, FF = 31.5 and efficiency of 0.26 %.
Design and Construction of a Low Cost Antenna which Receives UHF TV Signals


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Antennas play a major role in transmitting and receiving signals starting from microwaves to low frequency radio waves. Out of many types of antennas, Television Antennas (TV antennas) are the type of antenna widely used in day to day life. Television antennas are specifically designed for the reception of over the air broadcast television signals, which are transmitted at frequencies from about 41 MHz to 250 MHz in the VHF band, and 470 MHz to 960 MHz in the UHF band. There are various types of antennas available nowadays, such as Wire antennas, Aperture antennas, Microstrip antennas, Array antennas, Reflector antennas and Lens antennas. The particular type of antenna selected for a certain application depends upon system requirements. Although TV antennas have been dramatically developed over the last few decades, still there are major problems in receiving good TV signals. Here, we present the construction and design of a low cost antenna with a high gain reception in order to receive analog and digital TV signals.

We constructed a new design of the TV antenna to receive signals in the frequency range 400 MHz to 1000 MHz (UHF) with high gain with a combination of a log-periodic dipole array with a bowtie corner reflector. Instead of normal straight dipoles, improved V-shaped dipoles which receive multi-channels made of Aluminium beams with diameter 0.32 cm were used in the dipole array. The ‘4NEC2 Antenna Modeler and Optimizer’ software were used to select different parameters to optimize performances of the antenna. The reflector was designed in order to reflect electromagnetic waves back in to the dipoles of the antenna.

The maximum gain of the constructed antenna was found to be around 14 dB in the frequency range from 650 MHz to 700 MHz. The calculated average gain in the frequency range 400 - 1000 MHz was about 9 dB. Reported average gain in the same frequency range of the commercially available Corner reflector Antenna is less than 8 dB. Radiation patterns of the tested design for different frequencies were obtained using the 4NEC2 antenna modeller software. Because of the radiation pattern with the high gain side lobes, the user does not need to rotate the antenna like other antennas to capture TV channels. This antenna can be made at home easily at a very low cost.
A Possible Gamma Ray Detector using Hydroquinone

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There are a number of methods to detect gamma radiation. Almost all of these methods involve either complicated or expensive instrumentation. The best gamma-ray detectors currently in operation are those that use germanium as the sensor material. However, these detectors are very expensive to be used in regular applications. The main aim of this research was to find a cost-effective mechanism to measure gamma radiation exposure using a simple organic compound, hydroquinone (benzene-1, 4-diol).

Upon exposure to gamma radiation, certain organic compounds oxidize into their corresponding oxidized species. Hydroquinone in an oxygen saturated acidic medium oxidizes into quinone (cyclohexa-2,5-diene-1,4-dione) and 2-hydroxybenzoquinone (2-hydroxycyclohexa-2,5-diene-1,4-dione) upon exposure to gamma radiation. Hence, different concentrations of hydroquinone in oxygen saturated 1.0 mol dm$^{-3}$ sulfuric acid medium were exposed to various doses of gamma radiation to study the amount of oxidation products. Both hydroquinone and quinone show strong absorption in the ultraviolet region. Hence, UV-visible spectroscopy was used to find the amount of hydroquinone which had been oxidized. There were two specific peaks in the UV-visible spectrum of hydroquinone at 221 nm and 289 nm with extinction coefficient of 477.1 m$^{-1}$mol and 259.54 m$^{-1}$mol respectively. Quinone had a peak only at 246 nm with a high extinction coefficient of 2245.6 m$^{-1}$mol.

First, the hydroquinone samples ($1 \times 10^{-3}$ mol dm$^{-3}$) were exposed to low activity gamma radiation sources such as Cs-137 (4.08 µCi) and Co-60 (0.059 µCi). However, detectable changes in the UV-visible spectrum were not observed. Then the samples were exposed to a high activity Co-60 (9492.5 Ci) gamma radiation source with a dose rate of 2.74 Gy/min at different time intervals. It was found that with the increase in the amount of gamma radiation dose, the height of the absorption peak at 246 nm due to quinone absorption increased linearly. Auto-oxidation of the hydroquinone solutions was found to be negligible within few hours of preparation. The optimum concentration of hydroquinone was selected so that the absorbance due to quinone at 246 nm was less than a unit.

This leads to the conclusion that the amount of hydroquinone oxidized to quinone changes linearly with the amount of gamma doses at high activity. Hence, it can be suggested that hydroquinone be used as a gamma detector in combination with UV-visible spectroscopy to detect gamma radiation doses from high activity sources.
Diversity and Abundance of Termites in a Mahogany Plantation in the Gannoruwa Hills

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\end{itemize}

Natural forests in the Gannoruwa hills have been subjected to many disturbances: slopes (518-670 m) converted into cocoa plantations, which are much degraded now and parts of the summit planted with mahogany (712 m). Only the rest (>700 m) remains less disturbed. The impact of the mahogany plantation on forest termite fauna (an indicator taxon) was examined with the objective of determining species composition, species richness, abundance and feeding habits of termites. Termites were sampled using the standard belt transect (2 x 100 m) method. Their identity was determined and abundance recorded based on number of encounters/hits of different species. Species richness and feeding habits of termites were based on their taxonomic identity. Comparisons were made with the less disturbed natural forest (741 m) and degraded natural forest (578 m) in the Gannoruwa hills.

A total of ten termite species in five genera of the Family Termitidae namely, \textit{Bulbitermes} sp.1, \textit{Ceylonitermellus hantanae}, \textit{Dicuspiditermes incola}, \textit{Nasutitermes} sp.1, \textit{Odontotermes bellahunisensis}, \textit{O. globicola}, \textit{O. guptai}, \textit{O. hainanensis}, \textit{Odontotermes} sp. 6 and \textit{Odontotermes} sp. 5 were recorded from the mahogany plantation. Genus \textit{Odontotermes} (6 spp.) had the largest representation. \textit{Odontotermes} sp. 5 (8 hits) was the most abundant followed by endemic \textit{C. hantanae} (5 hits). The least abundant were \textit{O. globicola} and \textit{Odontotermes} sp. 6 (1 hit each). Termite fauna was dominated by fungus growing wood feeding \textit{Odontotermes} spp. (6 species). \textit{Nasutitermes} sp.1 and \textit{Bulbitermes} sp. 2 are non-fungus growing wood feeders. Of the other two species, \textit{D. incola} is a soil–wood interface feeder and \textit{C. hantanae} is a soil feeder.

Termite fauna of the mahogany plantation differed from the other two forest types. Mahogany plantation yielded the least number of species (10), degraded forest the highest (13), followed by the less disturbed forest (12). Three species were common to all three forests, while 5 species in disturbed forest and 4 species in degraded forest were shared with the plantation forest. \textit{Odontotermes} sp. 6, \textit{C. hantanae}, and \textit{D. incola} were recorded only from the plantation. All species in the plantation forest belonged to the family Termitidae and those in the other two forests to Termitidae and Kalotermitidae. Absence of Family Kalotermitidae (dry wood termites) in the plantation reflects the resistant nature of mahogany wood. The most abundant species, both in plantation (8 hits) and natural forest (9 hits) was \textit{Odontotermes} sp. 5, which was absent from degraded forest. The most abundant species in degraded forest, \textit{Nasutitermes} sp.1 (8 hits), was less abundant in plantation (4 hits). Majority of species (16/23) in all 3 forests are wood feeding termites.

The slight differences in species richness among the forest types is in agreement with previous reports that moderate levels of forest disturbances are favourable for termites, while high levels of disturbance are unfavourable. Woody litter resulting from forest disturbances accounts for the high number of wood feeders. Termite species richness reflects the degree of disturbances to natural forests.

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Effect of Temperature on the Developmental Stages of the Two Colour Leaf Beetle *Plesispa reichei*, a Pest of Coconut

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*Plesispa reichei* Chapuis (Coleoptera: Chrysomelidae) is a recently introduced pest of coconut in Sri Lanka. Both adults and larvae attack coconut seedlings and young palms. Since its accidental introduction, *P. reichei* has spread to the coconut triangle and many other coconut growing areas in the country. Plans are under way to develop a mass rearing programme for the pest for use in a biological control programme using a parasitoid for which life cycle information is important. This investigation was carried out to determine the effect of temperature on growth and duration of development of the different life cycle stages of *P. reichei*. One day old eggs collected from laboratory cultures were placed on immature coconut leaf pieces and held in boxes (4×9×6 cm) that were kept inside incubators maintained at 25°C, 28°C and 31°C under 12:12 photo period and 75% relative humidity, to determine the effect of temperature on development. Leaf pieces were renewed every two days. Thirty eggs were maintained at each temperature in this manner and the development followed through until adult emergence. Head width and body length of larvae and size of pupae were measured daily.

Incubation period of eggs varied from 8.9±2.0, 8.0±1.0 and 7.9±1.0 days at 25°C, 28°C and 31°C, respectively. Four larval instars were identified based on head capsule width measurements. Temperature had a significant effect on the development of 2nd and 4th instar larvae, where development times of 5.4±0.2, 4.0±0.2 and 4.6±0.2 days were recorded for 2nd instars and 14.24±0.2, 10.32±0.1 and 10.13±0.1 days for 4th instars at the three temperatures respectively. Thus, the duration of larval instars was higher at lower temperatures.

Mean body length of larval instars was significantly different at the three temperatures, in 1st instar (2.88 ±0.2 mm, 2.32±0.2 mm and 2.41±0.2 mm) and 2nd instar larvae (4.2 mm, 3.9 mm and 3.0 mm), with larvae having a shorter body length at higher temperatures. Temperature had a significant effect on pupal development as well. Lower temperatures produced larger pupae with a longer pupal period. Total duration of development of *P. reichei* from egg to adult was 39.0, 30.2 and 29.7 days at the three temperatures, 25°C, 28°C and 31°C, respectively.

Lower temperatures had a significant effect on the duration of development and the size of the developmental stages of *P. reichei*. These findings provide baseline data for mass rearing of *P. reichei* under laboratory conditions and the suitability of host stages (in terms of size) for oviposition by the parasitoid in a biological control programme.

Financial assistance by the Coconut Research Institute is acknowledged.
Parasitism is one of the major economic and health problems affecting the sheep industry. The present study determined the prevalence, intensity and types of gastrointestinal (GI) and blood parasites of a sheep flock at Kaithady in Jaffna district. Fresh faecal samples (~5 g) from a sheep breed known as ‘Jaffna Locals’ were collected in September 2010 (during the dry season) and March 2011 (after the rainy season). Fifty samples (10% of the sheep in the farm) were collected in one season and were processed by modified salt floatation and by direct iodine smears. Fifteen blood samples were collected only once in September 2010 and thin blood smears were prepared and stained with Giemsa stain. Identification of parasites in the faeces and blood was based on light microscopic morphology. Some nematode eggs were cultured to obtain larvae to confirm identification. Seven genera of GI parasites namely, *Haemonchus*, *Toxocara*, *Trichuris* (*Nematoda*), *Praephistomum* (*Trematoda*), *Moniezia* (*Cestoidea*), *Eimeria*, *Giardia* (*Protozoa*) and unidentified strongyle type eggs were recorded in this study. Although the overall prevalence of GI parasitism after the rainy season was higher (92%) than that of the dry season (84%), this difference was not statistically significant ($\chi^2 = 2.9536; P>0.05$). Moreover, there was no difference in the prevalence or intensity of GI parasitism between males and females or between lambs and adults (chi square test; $P>0.05$). Eight types of GI parasites were recorded after the rainy season while only five were found in the dry season. The most common type of infection was strongyle type eggs (78%) followed by oocysts of *Eimeria* spp. (76%). Four species of *Eimeria* were identified namely, *E. ovinoidalis*, *E. ovina*, *E. intricata* and *E. parva*. Concurrent infections of *Eimeria* spp. and GI nematodes were common. Infections of *Moniezia*, *Giardia* and *Trichuris* were recorded only after the rainy season. The intensity of infections of nematodes and *Eimeria* spp. was significantly higher after the rainy season compared to dry season (Mann Whitney U test; $P<0.001$). A wider range of parasite species and a higher intensity of infection after the rainy season could be due to the free grazing management of animals and favourable climate (high moisture content and low temperature) for the development and survival of the infective stages on pasture. According to the farmer, only few animals of the flock were dewormed at a time due to high cost of drugs. A tick-borne haemoparasite, *Theileria* sp. was found with a very high prevalence of 87%. The sheep at the Kaithady farm harboured many parasites and the intensity of infection and types of parasites increased after the rainy season. Long term monitoring of this flock will help to develop strategic control measures of these parasites in sheep.
Termite Assemblages in Lower Hanthana Forest and Variation in Worker Mandible Structure with Food Type

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Termites are the most important of the wood destroying insects. They are important as super decomposers and as organisms that maintain carbon, nitrogen balance in ecosystems. Generally termites feed on wood and soil. Therefore, their mandible structure varies depending on their food type, wood and soil. The present study examines the species composition and diversity of termites in five different forest types in Lower Hanthana area and relate worker mandible teeth pattern to their food habits.

Termites were collected in 2 m X 5 m plot areas, in both wet and dry seasons, from five selected forest types: open woodland (495 m), mixed pinus (538 m), pure pinus (535 m), riverine forest (504 m) and dense woodland (618 m). The number of encounters was taken as the number of individuals of each species. Collected soldier termites were identified using taxonomic keys. Mandibles of identified worker termite species were slide mounted. A total of 14 species of termites (Coptotermes gaurii, Nasutitermes ceylonicus, N. fletcheri, N. kali, Nasutitermes sp. 1, Hypotermes obscuriceps, H. xenotermis, Odontotermes globicola, O. horni, O. obesus, Odontotermes sp. 1, Odontotermes sp. 2, Odontotermes sp. 3 and Dicuspiditermes incola) belonging to five genera, four subfamilies and two families were collected from different microhabitats of the five forest types. Of them, 13 species belonged to the higher termite family Termitidae and one species, C. gaurii to the primitive termite family Rhinotermitidae. Termite diversity decreased with increasing altitude, temperature and humidity but the relationships were not significant. This may be due to the small sample size. Among the five sites, the highest diversity of 1.6959 (Shannon-Wiener diversity index) was recorded from riverine forest during the wet season. However, open woodland at the lowest altitude had the highest diversity of termites in both seasons (Wet: 0.4505, Dry: 1.6297). This may be due to favourable temperature with a low level of humidity and rainfall prevailing in this site that facilitated their survival. Of the species encountered, H. xenotermis is a new record to Sri Lanka and C. gaurii for Lower Hanthana forest. Odontotermes horni, the most abundant species was recorded only during the wet season. Nasutitermes ceylonicus was the most abundant, in both wet and dry periods. During the study period, the amount of woody tree parts on the ground was high, facilitating the presence of Nasutitermes spp. Teeth patterns of worker mandibles revealed three feeding groups, Group I (wood feeding lower termites), Group II (wood feeding, non-fungus growing termites) and Group III (humus-soil feeding termites). True soil feeding Group IV termites were not recorded from the Lower Hanthana area during the present study. Group II wood feeding non-fungus growing termites were the most abundant. The high amount of fallen twigs in each site may be the reason for the highest abundance of Group II termites in the Lower Hanthana area.
**Cuphea hyssopifolia** (Lythraceae): Floral Morphology and Associated Insects

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Flowers of most plant species are visited by a diverse array of floral visitors. Specific insect-plant interactions are often considered as mutualistic, highly coevolved relationships. Floral biology studies usually test the assumption that floral traits have some adaptive value to reproductive success. *Cuphea hyssopifolia* (Family Lythraceae), commonly called the Mexican heather, is native to America and is grown as a hedge plant. This perennial shrub produces flowers throughout the year. Preliminary observations revealed that its tiny flowers are visited throughout the day by a large number of insects belonging to many different orders. The present study was conducted to determine the floral morphology and associated insect diversity in *C. hyssopifolia* grown in three selected sites: Department of Zoology, University of Peradeniya; Royal Botanic Gardens, Peradeniya (wet zone); and a home garden in Narammala, Kurunegala (intermediate zone).

Floral biology was studied by investigating floral morphology, flower abundance, stigma receptivity, characteristics of pollen grains, anther dehiscence and time of nectar availability over a period of six months. Random collections of insects were made from July–December 2010 from plants in the sites at the home garden and Department of Zoology for two consecutive days in each week. Insects were hand collected and by sweep netting. Taxonomic keys and reference specimen collections were used for identification. Time of floral visits of insects, their abundance, richness and diversity were recorded between 07.00 a.m. to 5.30 p.m. at 30 minutes intervals.

Flowers of *C. hyssopifolia* have six purple colour petals forming a long corolla tube with a diameter of 2.13 mm and a length of 4.96 mm. Life span of a flower range from 17-20 days. The stigma was receptive from 8.00 to 11.00 a.m; anthers dehisced between 8.00 - 8.30 a.m. and pollen was available until 5.00 p.m. Nectar was available from 8.30 to 9.30 a.m. A total of 47 species of insects belonged to the orders Hymenoptera, Lepidoptera, Coleoptera, Diptera and Hemiptera were collected from flowers of *C. hyssopifolia*. Among them Hymenoptera (15) and Lepidoptera (11) were the most dominant groups. Site in the Department of Zoology harboured 37 species of insects while the sites in the Botanic Gardens and home garden harboured 29 and 25 species, respectively. The study of flower characteristics of *C. hyssopifolia* revealed that they are associated with entomophilous syndrome that facilitates the visits of many different types of insects to gather its resources and thereby facilitating pollination of its tiny flowers. Hymenopterans and Lepidopterans benefited by the presence of longer proboscis to reach the deep seated nectaries at the base of the long corolla tube in the tiny flowers of *C. hyssopifolia*. Pollen and nectar were the main resources provided by *C. hyssopifolia* flowers for its visiting insects. Site in the Department of Zoology had the highest species diversity, richness and abundance of insects visiting flowers of *C. hyssopifolia*. This may be largely due to the high abundance of flowers and the larger size of the flower patch. The temporal variation in activity of flower visiting arthropods gave two peaks, around 9.30 a.m. and 3.30 p.m. This may be largely due to the optimum environmental conditions and food resources such as nectar, pollen and floral tissues provided for the flower visiting insects during the study period.
Experimental Determination of Microhabitat Preferences of
Pseudophilautus hallidayi (Ranidae: Rhacophoridae)

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Pseudophilautus hallidayi is a mid-elevation frog species endemic to Sri Lanka found in Peradeniya, Namunukula and lower elevation areas of Knuckles mountain range. It lives in crevices of emergent boulders in shaded streams. IUCN (2006) has categorised this frog as a vulnerable species and at present the species faces a risk of extinction due to habitat degradation. Hence, immediate steps should be taken to conserve this frog species, especially in a backdrop where nearly 19 species in this genus have become extinct due to habitat destruction. So far in Sri Lanka, focus has been on systematics of amphibians, and no studies have been done to determine preferred conditions and microhabitat selection of amphibians that are vital information for effective conservation.

This study was conducted from June 2010 to June 2011, during which attempts were made to determine the preferred physical conditions (temperature, relative humidity, light and Ultra Violet radiation) of P. hallidayi under laboratory conditions using an apparatus that was custom made for this study and further improvised for different experiments. Data collected from the present study were tested for statistical significance. Further, experimental findings were compared with data gathered from their natural microhabitats in Hantana region, to understand the biological significance of the experimental results.

Within temperature, humidity and UV+light gradients, frogs were significantly more active than in the light only gradient (p < 0.05). Activity was pronounced for gravid females in UV+light gradient; female frogs tend to show a high preference for UV radiation by spending significantly more time remaining stationary under high UV+light intensity (p < 0.05). Under the light only gradient, they significantly altered the way they responded (p < 0.05); instead of well-distributed activity throughout the day within the UV+light gradient, a significantly high activity was observed only at the beginning of each day (p< 0.05). The highest preference for high light intensity was recorded from gravid females. Female frogs exhibited strong positive correlation with light intensity preference and body size, whereas male frogs showed a strong negative relationship.

The information gathered in this study is useful for conservation planning, both in enhancing (restoring) natural habitats and in captive breeding. In captive breeding, knowledge of the exact conditions needed for breeding to occur must be known. In restoration ecology, preferred environmental conditions must be known to aid population recovery.
Limnology and Cyanobacterial Species Composition of the Padawiya Tank during the Dry Season

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Cyanobacteria is an important group of phytoplankton in fresh, brackish and marine waters and shows a cosmopolitan distribution. Under favorable conditions, this group tends to form blooms, which cause environmental problems as well as human and animal health problems. Elevated levels of temperature in aquatic systems are known to promote the growth of these organisms. According to literature, over a 100 species of cyanobacteria produce toxins. However, Anabaena, Aphanizomenon, Cylindrospermopsis, Lyngbya, Microcystis, Nostoc, Nodularia and Oscillatoria are recognized as the most important genera having toxigenic species. Aquatic systems, especially lentic systems in the tropical region are known to provide favorable conditions to such toxin producing algae. As 4% of land in Sri Lanka is covered by ancient and recent reservoirs, in which the temperature and nutrient levels provide optimum environmental conditions to primary producers, it is becoming important to explore the prevalence of cyanobacteria in those systems to assure the well-being of human, animals and the ecosystem. The current study explores the species composition of cyanobacteria in Padawiya tank (an ancient reservoir of the northern region of Sri Lanka) during its driest period and assesses the quality of its water.

As the dry season provides optimum environmental conditions for cyanobacteria, the survey was carried out during May – August 2011. Monthly sampling was done from three sites (one located in the northern shore, near the tank bund, another two at the entry points of the Makunu oya and Mora oya, in the southern shore). Plankton sampling was done using 10 µm net and Lugol’s iodine solution was used to preserve cyanobacteria. Limnological variables were also measured at each sampling interval using portable field instruments and laboratory analysis. Measurements of the limnological variables also indicate that the Padawiya tank has extreme environmental conditions. The total phosphorus level reached 230 µg/l during high drought period, which is well above even hypereutrophic condition. In addition, dissolved phosphorus was about 10µg/l. Nitrate-nitrogen, nitrite-nitrogen and ammonia-nitrogen were 0.09 mg/l, 0.03 mg/l and 0.49 mg/l, respectively. The chlorophyll-a value was also relatively high reaching 159.02 mg/l. Turbidity was 66.2 NTU which is also an above average value. However, dissolved oxygen was 8.43 mg/l at the surface of the water column during the daytime showing high photosynthetic activity. Water temperature (average = 32°C) was also conducive for growth of cyanobacteria.

Ten species of cyanobacteria belonging to three orders, Nostocales, Oscillatoriales and Chroococcales were identified. Cylindrospermopsis raciborskii was the dominant species. Pseudoanabaena sp. was the sub-dominant species, while Planktolyngbya sp. was the third dominant species. Other phytoplankton and zooplankton diversity was low showing the low maturity of the ecological pyramid, which is one of the best indicators of the dominance of toxin producing species in the system. Among the recorded cyanobacteria species, C. raciborskii, Microcystis flosaquae and M. aeruginosa produce toxins. In Padaviya tank, C. raciborskii was the dominant during the sampling period. As C. raciborskii is a hepatotoxic species, water in this tank may contain hepatotoxins, which could affect the organs of animals including liver and kidney of mammals.
Study of Migratory Patterns of Zooplankton in “Lanka Pokuna” at Royal Botanic Gardens, Peradeniya

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Plankton are free floating organisms that occur in aquatic habitats including fresh, brackish and salt water. Most of them are microscopic and some are macroscopic. They are mainly divided into two broad groups as zooplankton and phytoplankton. Many zooplankton and some phytoplankton exhibit vertical and horizontal migration within aquatic systems for various purposes such as to find food, to avoid sunlight and predators. Such migrations are important for the survival of biota and to maintain the ecological balance and stability of the system. A study was conducted to investigate the daytime migratory pattern of zooplankton in a shallow ornamental pond in the Kandy region of Sri Lanka (“Lanka Pokuna” at Royal Botanic Gardens, Peradeniya). The study was carried out for three months from 14th of January to 15th of March, 2011 and sampling was done biweekly. Samples were collected from the surface and 0.5 m below the surface.

According to the results obtained it was found that many zooplankton exhibit migratory patterns during daytime. The relative abundance of some zooplankton such as Eucyclops serullatus, Dunhevedia sp., chironomid larvae and ostracod sp. decreased gradually from morning to evening. This could be due to migration of zooplankton to deeper locations or attaching to different substrates such as aquatic plants and stones. The relative abundance of Eudiaptomus cinctus, Keratelle tropica, Brachionus falcatus, Notholca sp. and nauplius larvae decreased from morning to noon and increased from noon to evening. Therefore, it can be stated that they tend to migrate downward from morning to noon and upward from noon to evening. Some other zooplankton such as Lecane sp., Diaphanosoma sp., insect larvae and protozoa sp. show completely different phenomena than the above where they tend to migrate upward from morning to noon and downward from noon to evening.

According to Friedman test, E. cinctus and K. tropica exhibited a significant variation of their relative abundance in daytime, which indicates that they exhibit significant migration in daytime. Therefore, many zooplankton species exhibited migratory patterns during daytime, which was species specific and light intensity could be the potential factor for their migration. They may tend to migrate to different locations which have favourable light intensities for their survival. As the temperature of the water column fluctuates during daytime, this could be another reason for their migration. Therefore, some species tend to migrate in daytime to deeper locations, which have lower temperature and some tend to migrate upward towards higher temperature.

However, detailed studies that cover all the environmental conditions and nighttime are also required to understand complete migratory behavior of zooplankton in “Lanka Pokuna” at Royal Botanic Gardens, Peradeniya.
Synthesis of a Novel Glycoside to Use as a Liquid Crystalline Material and a Surfactant

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Carbohydrates act as a promising source of liquid crystals due to their amphiphilicity in the form of glycolipids which show many physical, biological and technical properties. They form supramolecular aggregates that collectively exhibit lyotropic mesophases and most of these liquid crystals are non-ionic surfactants. The present work consists of the synthesis of a novel glycoside, 2,3,4,6-tetra-O-acetyl-1-O-3-epiandrostenyl-β-D-glucopyranoside and its deacetylated compound followed by the study of its liquid crystal and surfactant behaviour.

The glycoside was synthesized using glucose as the source material, and its β-configuration was established with spectroscopic data. The thermotropic texture observed is suggested to be Sm A phase and it did not show any lyotropic mesophase behaviour with dichloromethane or chloroform. The DSC thermogram showed a peak at 77°C in the cooling scan indicating the phase transition from isotropic liquid to Sm A phase. The deacetylated product showed thermotropic mosaic like texture at 75°C in the cooling process suggesting Sm B phase. It also showed lyotropic lamellae type texture. The critical micelle concentration (CMC) value of the deacetylated compound lies within the typical CMC range for nonionic surfactants: 10⁻⁵ – 10⁻⁴ M. The hydrophilic lipophilic balance (HLB) value suggests that it can be used as a good stabiliser for oil-in-water emulsions.

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Preparation, Characterization and *In-Vitro* Release Study of Ascorbic Acid-Encapsulated Liquid Crystal Liposomes

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The use of liquid crystals at the nano level shows some valuable applications in numerous areas. Liposome formulations are used in the medical, food and cosmetic fields after the encapsulation with bioactive ingredients. Generally, liposomes are mainly formed of phospholipids and are used as a store and vehicle for bioactive ingredients.

The purpose of the present research was to formulate effective and controlled drug release liquid crystal liposomal formulations. Water soluble ascorbic acid (vitamin C) was used as the model drug and carbohydrate liquid crystal, ETAGP (2,3,4,6-tetra-o-acetyl-epiandrosteronyl-1-O-β-D-glucopyranoside) was used as the model liquid crystal. For comparison, conventional liposomes were formulated with phospholipids (egg yolk lecithin) and mixed liposomes with phospholipids and carbohydrate liquid crystals in different compositions. Characterization of the prepared liposomes regarding encapsulation efficiency, pH dependence, particle size analysis and *in-vitro* release were performed.

Carbohydrate liquid crystal liposomes show some characteristics similar to conventional liposomes, such as the drug encapsulation efficiency and pH dependence, whereas the drug release rate is significantly increased in the carbohydrate liquid crystal liposomes. Interestingly, the particle size in the carbohydrate liquid crystal liposomes is in the nano range and the particle size remains the same without forming clusters for several weeks. These novel liquid crystal liposome formulations may have potential applications in encapsulation and delivery of drugs and bioactive ingredients in cosmetic formulations.
Corrosion Prevention of Galvanized Steel in Sodium Chloride Solutions

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Galvanized steel (GS), due to its protective zinc coating, is fairly stable under normal atmospheric conditions for short periods of time. Upon prolonged exposure to normal conditions or short term exposure to corrosive environments, it undergoes corrosion. Exposure of corrosion-resistant metal surfaces in a harsh environment for a short period of time is equivalent to, in many aspects, exposing such surfaces in mild environmental conditions for long periods which simulate real environments. In this respect, the effect of methanol extract of dry tea leaves as a green inhibitor on GS corrosion in an aerated 0.1 mol dm\textsuperscript{-3} NaCl at pH = 2 was investigated within the laboratory time scale by mass loss measurements of GS specimens, time dependence of pH in corrosive media, electrochemical impedance spectroscopic (EIS) analysis and Tafel slope analysis.

Rate of corrosion is found to be decreased with the introduction of the tea leaves extract to the corrosive environment. Results obtained from all the above techniques reveal that the extract of matured tea leaves has inhibition potential on GS corrosion in 0.1 mol dm\textsuperscript{-3} NaCl at pH=2. According to EIS measurements, the inhibition efficiency for 10% extract of dry tea leaves is about 85% after 18 h exposure to the corrosive medium.
Structure Optimization and IR Frequency Interpretation of Fe₆(OH)₁₆(H₂O)₆ Nano Particles by DFT Calculations

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γ-Fe₂O₃ nanoparticles were synthesised by the co-precipitation method and these particles are in 5-20 nm range in size. Plausible molecular structures (Figure 1) of γ - Fe₂O₃ were examined by density functional theory (DFT) using the cluster modelling method. Cluster configurations and IR frequency calculations of Fe₆(OH)₁₆(H₂O)₆ were performed using the DFT hybride B3LYP function with 6-31G (d, p) basic set. The average bond lengths of Fe-Fe and bulk Fe-O entities as 2.93 Å and 1.92 Å, respectively. The calculated bond lengths are comparable with the crystallographic data. Vibrational frequency calculations and experimental data are in good agreement with the observations in the range of 900 cm⁻¹ to 1024 cm⁻¹ (Figure 2). However, OH stretching frequencies at (1640), 3000, 3500 cm⁻¹ of γ -Fe₂O₃ is significantly different due to H-bonding nature.

Figure 1. Structure of Fe₆(OH)₁₆(H₂O)₆ cluster. Region a: cluster cavity, b: Fe²⁺ bonded water, c: O-OH bond.

Figure 2. Comparison of experimentally derived and calculated vibrational frequencies of succinic acid - γ – Fe₂O₃ nanoparticles.
Chitosan based Nano-Carrier System for Controlled Release of Ascorbic Acid

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There is an increasing interest in the development of new delivery systems for the controlled release of drugs and bioactive agents. Among these delivery systems, encapsulation of the drugs using a biodegradable matrix shows a promising pathway for the enhancement of the bioavailability of the drugs.

The aim of the present study was to produce a chitosan-based nano-carrier system and check the release properties of the entrapped drug comparatively to the release of the free drug, to ensure whether there is a controlled release property in the nano-carrier system.

Chitosan is a non-toxic, biodegradable and biocompatible polymer with interesting biological and chemical properties. Ascorbic acid (Vitamin C) was used as a model drug for the process.

Ascorbic acid trapped liposomes were coated with chitosan, with the aid of Tween 80 and sodium sulphate. The chemical structure was analyzed by FTIR and controlled release of ascorbic acid from encapsulated particles over seven hours shows a distinguishable enhancement comparable to free ascorbic acid release.

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Antioxidant, Cytotoxic and Phytotoxic Activities of *Schumacheria castaneifolia*, a Plant Endemic to Sri Lanka

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Investigation of the bioactivity of plants and their constituents is an important step in the discovery of novel drugs. The genus *Schumacheria* belonging to the family Dilleniaceae is endemic to Sri Lanka and contains three species, *S. castaneifolia*, *S. alnifolia* and *S. angustifolia*. There has been no systematic search for bioactive agents from the genus *Schumacheria*. This paper describes antioxidant, cytotoxic and phytotoxic properties of *S. castaneifolia*.

The plant was collected from Thummodara in the Sabaragamuwa Province. Air-dried leaves, root-bark and stem-bark were separately extracted into methanol and dichloromethane, and the extracts were tested for antioxidant activity using the 2,2-diphenyl-1-picrylhydrazyl assay, cytotoxicity using the brine shrimp (*Artemia salina*) assay and phytotoxicity using the lettuce (*Lactuca sativa*) seed assay.

In the antioxidant assay the IC₅₀ values of methanol extracts of the stem-bark, root-bark and leaves were 11, 7.6 ppm and 9.2 ppm, respectively; the dichloromethane extracts had relatively low activity with the corresponding IC₅₀ values at 212.2 ppm, 196.4 ppm and 210.5 ppm. The antioxidant activity of the known antioxidant, (±)-α-tocopherol showed an IC₅₀ value of 11.4 ppm. Methanol and dichloromethane extracts of the stem bark, root-bark and leaves showed low cytotoxic activity having LC₅₀ values for methanolic extracts at 903.8 ppm, 81.6 ppm and 66.0 ppm and for dichloromethane extracts at 74.4 ppm, 30.9 ppm and 340.1 ppm, respectively. A lactone isolated from a *Hortonia* sp. in a previous study was used as a positive reference control and showed an LC₅₀ value of 0.14 ppm. Phytotoxicity assay revealed root inhibition of 80.2% and shoot inhibition of 83.9% for the dichloromethane leaf extract at 2000 ppm level while the corresponding values for the methanolic extracts were 28.7% and 35.5%, respectively.

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A Preliminary Study on Bioactivities of *Agave vera - cruz* Leaf Extract

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*Agave vera-cruz* is a perennial plant with large, spine-tipped leaves and short thick stems. It belongs to the family Agavaceae. It appears to be well established in Badulla, Nuwara Eliya and Kandy districts. Fibre obtained from this plant is used to make ropes, baskets and cloths. Freshly ground leaves of *Agave vera-cruz* are currently used as a piscicidal agent in fishing by remote farmers in the Knuckles region. The present study is an attempt to evaluate bioactive properties of *Agave vera-cruz*. Antioxidant, cytotoxic and phytotoxic properties were investigated.

Plant materials were collected from Wattappola in Paranapattiya area. Freeze-dried plant materials were ground into a powder and extracted into methanol (MeOH). Concentrated crude extract was subjected to bioassay. Phytotoxic activity against *Lactuca sativa*, cytotoxic activity against *Artemia salina* and antioxidant activity were evaluated. Fractionation involved the use of VLC chromatography using Merck 9385 (40-63 µm) silica gel, gravity column chromatography using 7734 Merck silica gel (63-200 µm) and analytical thin layer chromatography.

LD\(_{50}\) value for cytotoxic bioassay was 675 ppm for the MeOH extract. IC\(_{50}\) value for the DPPH radical assay was 62.0 ppm. IC\(_{50}\) value for shoot inhibition was 1000 ppm and that for root inhibition was 1800 ppm. These results show that there are some allelopathic compounds present in *Agave vera-cruz*. 
A Preliminary Study on the Use of Carbohydrate Liquid Crystals as Emulsifiers in Cosmetic Chemistry

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Carbohydrate liquid crystals are a special type of liquid crystals. It has been shown that the carbohydrate liquid crystal used in the present study has surfactant properties. The carbohydrate liquid crystal, 3-pentadecylphenyl-2,3,4,6-tetra-O-acetyl-1-O-β-D-glucopyranoside is an amphiphilic molecule, has a polar head group and a non polar long hydrocarbon tail group. As the overall molecule is non-ionic, its structure is compatible to function as an emulsifier. The objective of the present study is to evaluate the ability to use the liquid crystal as an emulsifier in cosmetic products.

Emulsifier, Tween 80, and olive oil were mixed and stirred at 1500 rpm speed for 40 minutes at 70°C. Deionized water was then added and restirred at the same speed at the same temperature for the same period of time. Emulsions were kept at room temperature and morphologies were observed soon after, two hours after, one day after, and ten days after preparation. A ternary phase diagram was constructed. Emulsions were prepared with the liquid crystal, 3-pentadecylphenyl-2,3,4,6-tetra-O-acetyl-1-O-β-D-glucopyranoside dissolved in distilled ethanol as the emulsifier by varying the ratio of deionized water : olive oil : emulsifier within the microemulsion region of the ternary phase diagram. The ability to formulate emulsions by the liquid crystal and their stabilities were determined using the Storage Test, Polarized Light Microscope and Differential Scanning Calorimetry. The emulsion made using the liquid crystal as the emulsifier had an appearance similar to a microemulsion. The commercial surfactant, Tween 80, a non ionic surfactant, was used as the model emulsifier in order to determine the microemulsion region by constructing a ternary phase diagram. The liquid crystal used has the ability to function as an emulsifier, although it alone cannot form stable emulsions.
Jurassic Palynomorphs from Andigama, Sri Lanka: Some Morphological Details

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Jurassic sedimentary rocks are known to occur in a few isolated and small faulted basins in the northwestern province of Sri Lanka. One such basin is situated at Andigama in the Puttalam district. The present study was carried out with the objective of identifying and describing the details of two of the palynomorphs found in Andigama carbonaceous shale. Shale samples were collected and analyzed using standard palynological technique of hydrochloric acid and hydrofluoric acid digestion. Samples were observed under the transmission light microscope. Microflora assemblages from Andigama were found to consist of upper Jurassic Pteridophytic spores with dominance of Contignisporities sp., Cicatricosisporities sp., and to a lesser degree Classopolis sp. No angiosperm members have been found so far from this basin. Gymnospermae spores were rarely represented.

Classification (Fig.1): Contignisporities sp. Anteturma: SPORITES, Turma: TRILETES, Feature Description: Palynomorphs are microspores and shape is trilete. These are bilaterally symmetrical, and slightly convex on the distal surface. An intra-radial surface is strongly arched. Amb varies triangular to sub-triangular and slightly convex in lateral view. Laesurae is extending towards the cingulum’s inner margin. Cingulum is simple, elongated, thinly layered, laminated and often shrunk. Width of the cingulum varies between 2 \( \mu m \) - 3 \( \mu m \). Apices of the spore are curved. Muri on the distal surface are parallel and directly encroach into the cingulum. On the radial region, some of the muri are bisected. Margins of muri are smooth; thickness varies between 2 - 4 \( \mu m \).

Classification (Fig.2): Cicatricosisporities sp. Anteturma: SPORITES, Turma: TRILETES Feature Description: Palynomorphs are microspores and shape is slightly elliptical and trilete. These spores are radially symmetrical and characterized by distal or equatorial sculpture of more or less parallel to the muri. Muri are arranged in a center closely and terminate along the amb on distal region forming an acute angle to the equator. Some of these muri are bisected and fused with the neighboring muri. Each Muri are elongated and margins are entire but not smooth. Thickness of the muri varies between 2 \( \mu m \) - 5 \( \mu m \). These species do not comprise Cingulum. Amb is strongly triangular with convex or concave to distal region. Apices are curved.

Andigama shale has a great affinity with Rajmahal formation, India. The evidence of present microfloral assemblage of Contignisporities and Cicatricosisporities has been considered as significant evidence for the exact dating of Late Jurassic and Early Cretaceous palynoflora. Earlier workers have also compared Indian Jurassic-Cretaceous palynoflora with those known from Australia and have reported that stratigraphic age ranges from Bathonian (167.7 my) to Berriasian (145.5 my) for the above taxa. Since the aim of this report was to present an outline of spore–pollen affinity of Sri Lankan palynological studies, these findings must be viewed as preliminary rather than comprehensive. Detailed descriptions of the spore-pollen and distribution data are being undertaken for further confirmatory studies.
A Morphological Comparison of Some Jurassic Plant Fossils from Sri Lanka and Other Parts of the World with Type Specimens of the Natural History Museum, U.K.

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The present study compares the features of some plant fossils found in the Jurassic beds of Sri Lanka, Australia, India, Russia, and United Kingdom with the features of the original “type specimens” kept at the Natural History Museum, United Kingdom. This paper describes the morphological features and the observed evidences of the species of Cycadophyta, a common plant that prevailed during the Jurassic period.

Sedimentary rock samples with fossil imprints were collected and identified in the field for laboratory studies. The surface structures were studied under reflected light and all specimens were photographed to reveal surface details. Then morphological features were compared and their features are listed below in the standard format accepted internationally.

Classification: Division: Cycadophyta, Order: Bennettitales, Species: *Ptilophyllum acutifolium* of Morris (1840), Material Examined: 8 specimens.

Feature Description: Comparison with the type-specimen of Morris, *Ptilophyllum acutifolium* found in 1840 in the British Museum, confirms that the pinnae of *Ptilophyllum* found in all localities are characterized by their attachment to the upper face of the rachis. This is nearly completely covered and pinna attachment is sub-opposite. The upper angles of the pinna are mostly rounded and in a few samples it is auriculate. The lower angle of the base is slightly rounded and infrequently hidden by the imbrications of the adjoining pinna. Some of the pinna attached to the rachis along the whole width of the base but the upper angle is free. The veins are parallel, sub parallel or oblique to the lamina. The pinnae are linear or lanceolate and can vary in length, width and the shape of the apex. Most of the pinnae are straight or more or less falcate and the apices are sharply pointed. Pinnae are sessile, and margins are entire. In sample F, pinnae are smaller compared to those of the type specimen.

This comparison of the features of Jurassic plants from Sri Lanka, India, Australia, Russia, and United Kingdom with type-specimens reveals that they are of the same species. This confirms their unique and similar palaeo-environment prior to fragmentation. Since there are no previous detailed morphological descriptions given for the Sri Lankan plant fossils comparing the features of type specimens, we consider that above descriptions provide specific details of Jurassic Sri Lankan Cycadophyta for future plant fossil investigators.

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Characterization and Beneficiation of Montmorillonite in Clay Deposits, Murunkan, Sri Lanka

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Montmorillonite is by far the most abundant of the smectite clay minerals. Montmorillonite clay is commonly used in drilling, mineral processing, pharmacological and agrochemical applications. Montmorillonite deposits elsewhere in the world are commonly formed as a weathering product of volcanic ash. In Sri Lanka although such deposits are absent, montmorillonite-rich clay occurrences can be found in arid regions. Murunkan is an area which is composed of soil with higher montmorillonite content.

Clay samples were collected from 7 boreholes drilled within the Murunkan basin. The grain size analysis showed the fine fraction (<63 µm) from 85% to 30% averaging at 46%. X-ray diffraction (XRD) analysis, Differential Thermal Analysis (DTA) and Thermal Gravimetric Analysis (TGA) revealed the presence of montmorillonite in all the samples.

During the beneficiation process, the coarse fraction (>63 µm) was separated by wet sieving. The impurities in the finer fraction were identified by XRD analysis. The major impurity identified was quartz. Sedimentation technique was used to minimise quartz content and beneficiation of montmorillonite rich portion in the fine fraction. After suspending the finer fraction in water, the aliquot was pipetted out at different settling times and constituents were analysed using XRD. The results revealed a rapid increment of montmorillonite up to 60 minutes, and thereafter a fluctuation of montmorillonite/quartz ratio. The most appropriate time to decant the suspension was found to be after 60 minutes. The 180 minutes settling time was selected as the most suitable decanting time.

The purified montmorillonite rich fraction was compared with commercially available bentonite. The swelling capacity was tested by adopted ASTM D 5890 method. It showed 24.5 ml/2 g for commercial bentonite and 10 ml/2 g for purified Murunkan clay. According to the chemical analysis of purified fraction and commercial bentonite, comparable SiO$_2$ and Al$_2$O$_3$ content were present in both samples. In addition, Fe$_2$O$_3$ content was low in purified Murunkan clay while MgO and CaO contents were nearly similar.

Further beneficiation should be done for the purified fraction depending on the application to be used. The swelling capacity is not reached to the level of commercial bentonite. The activation processes are needed for raising the swelling capacity.
Surface and Groundwater Pollution at Gohagoda Solid Waste Dumping Yard

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Solid waste products are one of the main sources of environmental pollution in heavily inhabited and industrialised Sri Lankan urban areas. Solid waste products pollute the surface and groundwater sources at their dumping sites. Gohagoda solid waste dumping yard is situated near the Gohagoda area in Kandy and is the main solid waste site which takes all waste products from the Kandy Urban area. The Mahaweli River flows along the eastern boundary of the site. The area is the narrow valley which slopes from west to east. Municipal solid wastes are dumped in comparatively high elevated west part of the area. The Gohagoda groundwater intake plant is located at a distance 70 m upstream from the landfill site. Most solid waste disposal and sewage discharge are done without treatment. Therefore, it was essential to undertake a study to investigate surface and groundwater pollution at the Gohagoda solid waste dumping yard.

Leachates of the landfill were most likely to exist in a methanogenic phase according to the results obtained from the analyses which had slightly alkaline pH values. There was no significant groundwater contamination according to the results obtained from the water samples collected from nearby wells. The effect on the intake of Kandy water supply is almost negligible as the contaminants get diluted within the Polgolla reservoir water despite the fact that the intake is located upstream from the landfill site. It was observed that the existing shallow water sources and the river water were biologically contaminated with significant numbers of total coliforms and faecal coliforms. Therefore, these water sources are not suitable for drinking purposes.

According to the results of the study, this landfill can be considered as a threat to the local environment. Therefore, the responsible local and directorial authorities should take immediate actions to control solid waste disposal practices at Gohagoda solid waste dumping yard to prevent further contamination of surface water as well as groundwater and soil at the site.
A Spatial Analysis of the Human-Elephant Conflict in Sri Lanka

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The Human-Elephant Conflict (HEC) is normally viewed from the point of view of the elephants, but this survey was conducted to identify the difficulties farmers face due to elephants in their day-to-day life. With the increase in human population density and changes in land-use patterns, elephant habitat is being continuously reduced and as a result, much of the present day elephant range extends into and overlaps with agricultural lands. The main objectives of the survey were to discover a spatial pattern of the conflict, identify hot spots and formulate a plan to decrease HEC in Sri Lanka based on the identified spatial pattern.

An assessment of HEC by the Ringling Center for Elephant Conservation (CEC) was carried out from January to March, 2009, within 186 villages in seven provinces (Central, Northern, Uva, Eastern, North Central, North Western and Southern). The sample was selected using judgmental sampling within the elephant range and was collected by stopping every 10 km. Ordinary statistics and geospatial statistics were used to analyse in this survey. All variables were examined separately in order to identify its behaviour and plots were drawn based on preliminary analysis. A spatial analysis was performed to identify the high conflict areas. The tabular and graphical forms of the severity points were included and a spatial model found. R, Minitab and SPSS statistical software and ArcGIS spatial software were used in this analysis.

According to the spatial analysis, a Gaussian model could be identified as the spatial model for severity of the conflict. The minimum minimised square was obtained using weighted least square methods (WLS). Therefore, the model obtained for WLS was used as the best-estimated variogram. Due to small sample size, a provincial level krigging could not be done.

Based on the plots and model obtained, it was noted that Puttalam and Kuchavelli are the areas with the highest level of conflict. Correlations among parameters affect the spatial distribution of the conflict level. Therefore, krigging and co-krigging methods could be used to identify highly correlated variables in further studies.
Chemically bound Silver Nanoparticles on Cotton Textiles Exhibiting Efficient Inhibition of *Escherichia coli* and *Staphylococcus aureus*

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This study describes a convenient method for production of highly durable antimicrobial textile against laundering. The method involves layer-by-layer electrostatic self-assembly process. Here, natural cellulose substrate was modified with chloroacetic acid in the presence of sodium hydroxide, followed by drying and curing. Then it was immersed in silver nitrate solution for reducing the electrostatically attached silver ions into nanosized silver coatings on textile using sodium citrate as the reducing agent. Average particle size obtained was approximately 16.54 nm. The modified textile was tested for Gram positive *Staphylococcus aureus* and Gram negative *Escherichia coli* and showed antimicrobial activity even after 30 washing cycles. Antimicrobial activities were tested for the silver nanoparticles chemically bound on textile subjected to 5, 10, 15, 20, 30 washing cycles and found that a constant inhibition zone of 2 mm was obtained in each case. Control experiments done with silver nanoparticles physically entrapped in cotton showed progressive decrease in the inhibition zone due to excessive washing cycles.

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A Preliminary Study on Gastrointestinal Parasites of Captive Primates in the National Zoological Gardens Dehiwala, Sri Lanka

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Fifteen different species of primates representing New World and Old World monkeys and apes from different countries are housed in the National Zoological Gardens, Dehiwala (NZGD). These are: Symphalangus syndactylus, Semnopithecus entellus, Macaca sinica, Macaca fuscata, Macaca cyclopis, Presbytis cristata, Symphalanges syndactylus, Saimiri sciureus, Cebus capucinus, Cerco cebusatyis, Pongo pygmaeus, Pan troglodyte, Papio hamadryas, Cebus paella, Cercopithecus ascanius, and Erythrocebus patas.

Previous studies in other countries have reported occurrence of many species of gastrointestinal parasites (e.g. Entamoeba spp., Giardia spp., Endolimax nana, Chilomastix mesnili, Balantidium coli, Trichuris spp., Strongyloides fulleborni, Cryptosporidium spp.) in both captive and non-captive primates. The objective of this study was to identify the gastrointestinal parasites of primates housed in NZGD.

A total of 85 freshly voided faecal samples were randomly collected during a seven month period from the cages where the primates are housed. Faecal samples were transferred to the laboratory in cool containers. The following tests were performed for all the faecal samples: direct faecal smear observation, formol ether technique, Shether’s modified sugar flotation technique, modified salt flotation method, iodine stain and Ziehl-Neelsen staining. Furthermore, some of the protozoan cyst positive samples were cultured using Tanabe-Chiba medium. In addition, Polymerase Chain Reactions (PCR) were performed with species specific primers to amplify the 18S rRNA gene of Entamoeba coli, Balantidium coli, and Entamoeba chattoni. Results revealed the following: 4/15 positive for Cryptosporidium species, 3/15 positive for Coccidial oocysts, 4/15 positive for Balantidium spp., 2/15 positive for Blastocyst spp., 1/15 positive for Giardia spp. Unidentified protozoan cysts were detected in three species (Morpho 1, Morpho 2), Ascaris eggs were present in three species, nematode larvae and strongyle eggs were present in two species. Hook worm larvae and Trichuris eggs were present in three and two species respectively. We successfully amplified a 180 bp in length fragment with Entamoeba coli specific primers using PCR techniques. We were not able to amplify the partial sequence of B. coli and E. chattoni.

In the present study, primates did not show any clinical infections although they harboured many pathogenic gastrointestinal parasites. We suggest that further studies should determine the parasitic burden with relation to clinical infection.
Ticks are a group of ectoparasitic blood sucking arthropods, reported worldwide on mammals, reptiles, birds, amphibians and insects. They are primarily parasites of wild animals and only 10% of the species feed on domestic animals. The objective of this two and a half year long study was to identify the species of ticks in domestic and wild animals in Sri Lanka. Sixty locations were selected from 22 districts in Sri Lanka using convenience sampling, and ticks collected from dogs, cattle, buffalo, cats, sheep, goat, pig, and domestic poultry. They were transported to the laboratory in 70% ethanol medium and morphologically identified. Ticks present on wild animals in parks at Minipe, Mihintale, Udawalala, Randenigala, Yala and Wasgamuwa were also collected and identified. Wild animals sampled were wild boar, deer, sambar, mouse deer, barking deer, pangolin, mongoose, porcupine, wild buffalo, elephant, bear, monkey, flying squirrel, cobra, python and boiga snake. Citizens in Kandy district, through personal contacts, collected and handed over ticks they could find on wild animals encountered and also from domesticated animals. A total of 1376 ticks were collected from wild animals while 13,170 were collected from domestic animals. We were also able to collect 43 ticks from human, by direct removal from the body. According to the results, 11 new species of ticks, which were originally found only in wild animals, were found on domestic animals. Species recorded from domestic dogs were *Haemaphysalis turturis*, *H. cuspidata*, *H. histricis* and immature *H. spinigera*, *H. aculeata*, *Amblyomma testudinarum*, *A. clypeolatum*, *Hyalomma marginatum*, and *Dermacentor auratus*. Domestic cattle harboured *H. turturis*, *H. cuspidata*, *H. kyasanurensis*, *H. histricis*, *A. testudinarum*, and *Amblyomma* sp. We recorded *H. turturi* and *Amblyomma* sp. from buffaloes; *H. cuspidata* from sheep; *H. turturis*, *H. spinigera*, *H. histricis*, *A. testudinarum*, and *A. integrum* from goats. Species recorded from domestic poultry were *H. turturis*, *H. aculeata*, and from domestic pig were *H. bispinosa*, *Rhipicephalus sanguinus*, *R. haemaphysaloides*. Cats were infested with *R. boophilus*, *R. haemaphysaloides*, *H. turturi*, *H. cuspidata*, and nymphs of *H. spinigera*. Tick species generally found on dogs and cattle were *R. boophilus*, *R. sanguinus*, *R. haemaphysaloides*, *H. bispinosa*, *H. intermedia*, *A. integrum*. *Hy. marginatum*, *Hy. bravipuctata* and *Nosomma monstrosum* were found only on buffaloes.

Five unidentified species were found both from domestic animals and wild animals. Of these, two belonged to the genus *Haemaphysalis* while the others were from genus *Amblyomma*. The *Haemaphysalis* species resembled *H. bispinosa* and *H. spinigera* but the shape of the scutum was different. Two unidentified *Amblyomma* species were found only on pangolins. The other female *Amblyomma* species was found from wild boar, sambar, cattle and buffalo. *Aponomma* species were found only on pangolins and reptiles, while immature of *H. cornigera* and adults of *A. clypeolatum* were present only on wild animals. According to previous studies, *A. testudinarum* and *A. clypeolatum* had been recorded only from buffaloes and *H. cuspidata* in goats living in jungle areas. We were able to collect these three species from other animals in urban areas. We suspect that wild animals including wild boar, mouse deer, barking deer, porcupines, and monkeys, may have introduced these tick species to domestic stock. Since ticks are vectors for many diseases such as tick borne rickettsiosis, babasiosis, theileriosis, Kyasanur forest disease, tick- borne encephalitis, hemorrhagic fever varieties, and Lyme disease, it is very important to conduct further studies on these new invaders to investigate their potential role in transmission of zoonotic diseases.
PLANT SCIENCES & FORESTRY
Effect of Calcium, Magnesium and Boron on Yield and Quality of Cauliflower
(*Brassica oleracea* L.)

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A field experiment was conducted at the University Experimental Station, Dodangolla (AER - IM3a) during the *Maha* season of 2008/2009 to study the effect of Calcium (Ca), Magnesium (Mg) and Boron (B) on yield and quality of cauliflower. At present, local and overseas demand for cauliflower has been increasing. In Sri Lanka, poor yield and quality of the produce are the major constraints in obtaining a profitable income from agriculture. The Department of Agriculture (DOA) recommends a blanket fertiliser for all types of cabbage. In literature it was found that inadequate supply of micro nutrients may be a reason for lower yield and poor quality of cauliflower in Sri Lanka.

Soil samples were analysed for available nutrients and the most deficit micro nutrients were identified as Ca, Mg and B. The field experimental design was a randomized complete block design with four replicates. Six fertiliser treatments were imposed as recommended by DOA: NPK only, NPK with Ca, Mg and B, NPK with only Ca, NPK with only Mg, and NPK with only B. Plant culture and management were practiced according to DOA recommendations.

Plant height and leaf area were measured up to 50% flowering stage. Time taken to 50% flowering and final yield were measured. Post harvest keeping quality was measured under open air conditions and packed in 150 gauge low density polythene bags at room temperature (28°C) by counting the number of days to show initial signs of rotting, decaying or change in colour.

Plants grown with N, P, K, Ca, Mg and B showed a significant positive effect on yield, leaf area, time taken to 50% flowering and final yield. The highest yield of 7.8 t/ha was recorded with NPK with Ca, Mg and B treatment at Dodangolla soils with a yield gain of 8.3% compared to the DOA recommendation. The results revealed that cow dung increased the yield by 28.6% and the fertiliser mixture with nutrients corrected for deficiencies in soil increased the yield by 39.3%. Significant differences were observed between treatments at both storage conditions. The shelf life was longer in the curds obtained from NPK with Ca, Mg and B treatment irrespective of the storage conditions.

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Potential of Minituber Production of Four Potato Cultivars in a Hydroponics System

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Although potato cultivation is an economical venture in Sri Lanka about 60% of its cost of production is spent on seed potatoes. Reduction in profit is also attributed to poor quality and lack of availability of quality seed potatoes. Minitubers are more economical and preferred by farmers due to its high quality. Presently mini tuber production from hydroponics system is only limited to varieties, Granola and Desiree. As this is not sufficient to cater to the high demand for seed potatoes, a study was initiated to evaluate the minituber production of four potato cultivars (99-2, Hill star, 99-5 and 99-6) in a hydroponics system. Lines 99-2, 99-5 and 99-6 may be preferred by farmers in the future due to its high yield. However, before release, their multiplication ability using the present agronomic package, had to be evaluated.

In-vitro plants of four potato cultivars (99-2, Hill star, 99-5, 99-6) and Granola were planted in separate trays filled with sterilised coir dust media. Plantlets of about 15 cm in height were chosen and established in the developed Nutrient Flow System (NFS) using Albert solution. Vegetative growth of shoots and numbers of harvested tubers were recorded in each cultivar. The data was analysed using Analysis of Variance (ANOVA) with mean separation by Least Significant Difference (LSD) in SAS statistical software.

There were no significant differences in the performance of cultivars 99-2 and 99-6 in terms of all growth parameters measured. Similarly cultivars 99-5 and Granola were not significantly different. Variety Granola, Hill star and 99-5 successfully produced mini-tubers while cultivars 99-2 and 99-6 did not produce any tubers within the time period of 2 ½ month. Cultivar 99-5 and Granola were well adapted to the hydroponics system and cultivar 99-2 and 99-6 were not adapted to the system because of their extensive vegetative growth. Variety Hill star was adaptable to the system to some extent. Further studies must be carried out to recommend a system for minituber production of cultivars 99-2 and 99-6.
Impact of Relative Humidity and Temperature during Cold Storage on Quality of Seed Potato (Solanum tuberosum L.)

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A study was conducted to evaluate the impact of relative humidity and temperature on quality during storage of different weight classes of seed potato. Three different weight groups of seeds 2-4 g, 20-30 g and 35-55 g of the variety Granola were subjected to storage in two humidity levels (85-90% and 90-95%) and temperature regimes of 5°C and 10°C under dark conditions. The ambient humidity of 80% and temperature of 14°C to 26°C conditions were considered as the control. Pre-basic seeds (G0) were used for the seed group 1 (2-4 g) and basic seeds (G2 generation) used for seed groups 2 (35-55 g) and group 3 (35-55 g). Data was collected on the incidence of disease, weight loss, appearance, sprouted tuber percentage and chilling injury in all the combinations developed. The ANOVA procedure of the SAS package was used in order to examine parametric data. Data of disease incidence and appearance were analysed using the chi-squared test. The Kruskal Wallis test was performed to analyse data on appearance and chilling injuries.

Storage at RH of 90-95% and 5°C induced the minimum weight loss for seed group 1 (2-4 g) and seed group 3 (35-55 g). In seed group 2 (20-30 g), the minimum weight loss was a RH of 85-90% and 5°C. Prolonged dormancy was seen when stored at 5°C under both selected humidity regimes. The results of the study indicate that a RH of 90-95% and 5°C are optimum for seed potato storage and that a low temperature is essential for successful seed potato storage.
Development of Roof Vegetation as Influenced by Substrate Composition and Depth in an Extensive Green Roof

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Green roofs involve growing plants on rooftops, partially or completely covered with vegetation grown on a growth substrate, laid over a waterproofing membrane. Extensive green roofs are shallow, with less than 15 cm of substrate. The interest for green roofs are increasing because of the enormous benefits that these roofs render, such as decreasing the urban heat island effect, storm water runoff mitigation, saving on energy consumption, increasing the life span of a typical roof, ability to filter harmful air and water pollutants, sound insulation, fire resistance and especially because these green roofs provide aesthetically pleasing open spaces in ultra urban areas. Although green roofing is a good solution to address the issues created by urbanisation in Sri Lanka, few scientific studies have been carried out on green-roofs. Thus, the present study was carried out to determine an appropriate growth substrate and optimum thickness for extensive green roofs in Sri Lanka since composition of the growth substrate and depth play a pivotal role in development of roof vegetation in any green roof system.

The experiment was conducted throughout 12 weeks at Dodangolla Experimental Station (IM$_{3b}$), Kandy. Sample plots were arranged in plastic trays ($30 \times 40$ cm), on a conventional asbestos roof with a $25^\circ$ slope. Three different depths 4 cm ($D_1$), 7 cm ($D_2$), 10 cm ($D_3$) and five different substrate compositions, i.e. compost, sand, coir dust, half-burnt paddy husk and polystyrene beads mixed in various ratios (M$_1$ to M$_5$) were evaluated. Alternanthera sessilis, one of the potential plants species for extensive green roofs in Sri Lanka, was grown to evaluate the suitability of substrate mix. The amount of plant cover was measured using a grid (frequency-cover) at two weeks intervals. Chemical and physical properties of the substrate mixes were measured at the beginning and at the end of the experimental period. Data were analysed using ANOVA procedure.

Establishment was successful on most trays, but there were significant differences ($P<0.05$) in the frequency-cover among the different substrates. Among the three different substrate depths used, $D_3$ (10 cm) was best suited for local conditions, irrespective of the composition of the substrate used. By the end of the experimental period, the highest vegetation cover, the lowest depletion of N, P and K nutrients and the lowest change in pH ($P<0.01$) were recorded in the media filled up to 10 cm depth ($D_3$).

Among the five different substrate compositions, from the beginning of the experiment, M$_2$ (compost, sand, coir dust and polystyrene beads in 25, 25, 25, and 25% respectively) and M$_3$ (compost, sand, coir dust, half-burnt paddy husk and polystyrene beads in 25, 25, 25, 12.5 and 12.5% respectively) showed a better and quick roof cover compared to others. Nutrient depletion (N, P and K) was also lower in these two mixtures. Total vegetation cover of the plot area was achieved by the 9$^{th}$ week in M$_2$D$_3$. When water-saturated weight was also taken into consideration, the ideal substrate among the 15 different treatment combinations used in this investigation for extensive green roofs in Sri Lanka was M$_2$D$_3$. 
Use of Phenotypic Plasticity in Selecting Low-Maintenance Landscape Plants

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Plants that can tolerate environmental stresses without altering much of their aesthetics are the best candidates for low-maintenance landscapes. Even though some ornamental plants have generally been considered as low-maintenance plants, an objective measure to decide their tolerance to changing environmental cues is lacking. Phenotypic plasticity as quantified by phenotypic plasticity index (PPI) is one of the phenomena that can be used to cater to the said purpose. The present study was conducted to probe the applicability of the use of phenotypic plasticity as measured by phenotypic plasticity index (PPI) in identifying low maintenance landscape plants.

Five popular ornamental plant species were selected for the study (Scindapsus aureus, Codiaeum variegatum, Aglaonema crispum, Dracaena sanderiana and Livistonia rotundifolia). The study was carried out in a glass house at Dodangolla experimental station, Kandy (IM3). All five species were exposed to a light gradient continuum; 20, 50 and 100% of full sunlight. Initial measurements of plants were taken at the beginning of the experiment and thereafter bi-weekly for 2 months. Different morphological and physiological parameters were measured; plant height, stem diameter, internodal length, leaf area, stem, root and leaf biomass separately, total biomass, chlorophyll a, b and total chlorophyll content. Phenotypic plasticity index was calculated for all characters of each species.

The results of the present study revealed that chlorophyll content, chlorophyll b in particular, was the trait that has showed the highest plasticity (P<0.05) among all phenotypic traits measured, irrespective of the plant species. The highest and the lowest phenotypic plasticity index (PPI) for chlorophyll b was recorded in C. variegatum (0.92) and L. rotundifolia (0.40) respectively. The increase in chlorophyll b is a common response in ‘shade tolerance syndrome’. Thus, all five species tested in the present study can be considered as shade tolerant species, although the degree of tolerance varies.

Surprisingly, the leaf mass ratio (LMR) of all five species was non-plastic (PPI < 0.15) within the light gradient tested, which indicates that light gradient does not hamper the allocation pattern of these species to alter their foliage mass. If an ornamental plant species can maintain its foliar display irrespective of the light environment within which they exist, such a species can easily be employed in low-maintenance landscapes. Although the leaf size and the number did not change considerably, variegation of C. variegatum was lost under 80% shade.

All the species assessed in the present study showed variable degrees of phenotypic plasticity in response to a light gradient continuum. However, most of the morpho-phenotypic traits seem to be less-plastic which suggests these species do not alter their morphology considerably depending on the light environment within which they grow. This validates the use of the concept of phenotypic plasticity to select plants for low-maintenance landscapes.
Shoot Bending for Improved Plant Training of Cut Roses (*Rosa hybrida*)

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Roses (*Rosa hybrida*) are one of the most popular cut flowers all over the world. The demand for roses is increasing in Sri Lankan as well as export markets. However, the small scale rose growers in Sri Lanka are not in a position to supply the flowers in times of high demand. Therefore, flower production needs to be increased through increasing productivity. It has been revealed that more shoot yield can be obtained through shoot bending compared to conventional plant training methods. Hence, this research was conducted to determine the positive yield responses of bending.

The research was conducted in Keppetipola (agro-ecological region; IU3) using three varieties of budded roses, namely White Success, Black Magic and Peach Pope. Mother shoot bending method and conventional training (without bending) were practiced in separate replicated raised beds. Recommended agronomic practices for roses along with application of cow dung and few other commercial fertilizers at the rates in commercial floriculture were used. Watering and application of other agro-chemicals (fungicides, pesticides, liquid fertilizer) were done as general cultural practices. Pinching, disbudding and pruning were practiced to train the plant from initial stage and bending was done five weeks after planting.

Shoot height, shoot number and leaf number did not significantly increase when mother shoot was subjected to bending at 5 weeks after planting. However, there was a significant increase in leaf area (bending: 1861.5; without bending: 1390.4 cm²) and the flower bud yield (bending: 18.5; without bending: 10 buds plant⁻¹) in the bending treatment, determined in all varieties (within the first month). This could be a result of formation of more ground shoots in bended plants, giving an adequate floral initials within the improved plant structure. None of the floral qualities such as height and diameter of the flower bud and the length of flower stalk were affected by mother shoot bending in all three varieties (length of flower stalk when bending: 72.3cm, and without bending: 64.3cm; height of the flower bud when bending: 3.4cm, without bending: 3.2cm; diameter of the flower bud when bending: 2.5cm, while without bending: 2.5cm).

Results revealed the success of mother shoot bending at the initial stage of growth under moderate field conditions. As it increases the ground shoot number, it could be identified as a better method to train rose plants at the initial stage in order to form a better plant structure and a yield. Although mother shoot bending increased the leaf area and the flower yield, the flower quality of the three selected varieties was not significantly improved.
Potentials of Biochar as a Soil Amendment in Comparison to Some Other Materials

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Continuous practice of organic farming is associated with several problems in soils and in plant growth such as nutrient imbalances, increasing soil pH and very high C:N ratios of the soil. Incorporation of soil amendments is considered as one of the best solutions to overcome some of these problems. Biochar, a recently introduced soil amendment, made by thermal decomposition of organic materials under limited oxygen supply and at temperatures around 700 °C (i.e. pyrolysis), is claimed to be having its own unique properties on improving soil physical, chemical and biological properties.

The suitability of locally available biochar as a soil amendment was evaluated in comparison with some other materials in two experiments. The experiment was conducted at Dodangolla Experimental Station during May to August 2011. The treatments used were the plant species (i.e. tea (Camellia sinensis L. (O.) Kuntze, cultivar TRI 4006) and tomato (Lycopersicon esculentum L. variety Thilina)) and the amendments {Biochar 1 (3mm particles), Biochar 2 (2.5cm particles), Natural Zeolite, Chena Charcoal and Activated Carbon}. Natural Zeolite was mixed with the soil at the rate of 1% fresh weight basis and other four amendments at 0.2% fresh weight basis. Compost application was done prior to the planting at the rates of 2kg per plant for tea and 400g per plant for tomato. The treatments were arranged as a two factor factorial in a complete randomised design. Plant growth and soil parameters were measured up to 12 weeks after planting.

Tomato yield was significantly higher (p < 0.05) with biochar 2 amendment, only at 12 weeks after planting. The yield with all other treatments was not statistically significant. This was also reflected in the plant growth, i.e. the number of leaves and leaf area, which were significantly higher (p < 0.05) with biochar 2. Other treatments did not show a significant difference with the control. In tea, none of the growth parameters analysed showed a significant difference. The pH, electrical conductivity, available phosphorus and calcium of the soils showed a significant difference (p < 0.05) between the two plant species. Soil potassium and calcium showed significant differences among the five amendments. All the other soil parameters analysed did not show a significant difference between the treatments.

In conclusion, any of the soil amendments used in the given rates did not show promising results, except biochar 2 with tomato. Further experiments will be required to check for reasons and for consistency of results. The reason for not seeing any response in tea may be due to its perennial nature. Growing tea for a longer period of time with these amendments can be recommended. Also, in this experiment, only one rate was used for the amendments. Expanding this experiment for different numbers of rates can be suggested for obtaining better results.
Morphological Characterization of Sweet Potato \textit{(Ipomoea batatas (L.) Lam)}

Accessions

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Sweet potato \textit{(Ipomoea batatas (L.) Lam)} is a widely grown and consumed root crop in Sri Lanka. Sweet potato germplasm maintained at Plant Genetic Resource Centre, Gannoruwa (PGRC) contains 129 sweet potato accessions from different areas of the country. Understanding the genetic diversity of germplasm of crop species is of importance for its rational management and use. Morphological characterisation of germplasm facilitates the identification of duplicates and unique traits and to develop useful core collection. The data will also help in the future improvement endeavours of the crop having with desired characteristics.

The experiment was carried out at the research field of PGRC, Gannoruwa from April to July. Thirty sweet potato accessions along with three recommended check varieties of the Department of Agriculture were used for characterisation. Cuttings were established in an augmented plot design with five blocks. Each accession allocated randomly in blocks without replication and check varieties were allocated to every block randomly. Observations were recorded after the establishment of the crop. Twenty one qualitative (i.e. ground cover, leaf shape, tuber colour etc.) and nine quantitative characters (i.e. leaf length, vine internode length, yield etc.) were measured starting from one month after planting upto harvesting according to the sweet potato descriptors of International Potato Centre. Harvesting was done at 3.5 months after planting. Powdered sweet potato tubers dried at 40˚C, was used to analyze starch and total soluble sugar.

The accessions exhibited high morphological diversity in aerial and root characteristics. Analysis of variance showed that out of 30 characters evaluated 29 characters were significantly different (p<0.05) between accessions. Leaf length did not show any significant difference. The dendrogram obtained using phenotypic characteristics, separated the accessions into four major clusters with Euclidean distances ranging from 0.00 to 1.25. Cluster 1 contained only ‘Ama’ a recommended variety and cluster 2 consisted of 8 accessions. Cluster 3 consisted of 14 accessions together with recommended variety ‘Gannoruwa Sudu’. Cluster 4 consisted of 8 accessions and all the clusters had sub clusters. Accession BTSP 4 showed the highest yield of 33.07 t ha\textsuperscript{-1}. BTSP 32 contained the highest sugar percentage (29.0%) while BTSP 7 was the lowest (4.7%). Accession BTSP 34 contained the highest starch percentage (97.0%) whereas BTSP 35 was the lowest (19.0%).

Accessions with a high yield (BTSP 2, BTSP 4, BTSP 16, and BTSP 20), high starch content (BTSP 7, BTSP 20, BTSP 27, BTSP 31, BTSP 34) and high total soluble sugar content (BTSP 13, BTSP 25, BTSP 28, BTSP 29) from cluster 2, 3 and 4. Hence, the present study revealed suitable accessions with distant parental lines for hybridization.
Toxic Effects of Selected Insecticides on Honey Bees and Earthworms

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Application of pesticides is an integral part of crop production in protecting crops from various pest damages. Pesticide usage and safety are monitored by means of setting Pre Harvest Intervals (PHI) and Minimum Residue Levels etc. but attention given to ill-effects of pesticides on non-target organisms is inadequate. In tea, majority of international markets require guarantees on conservation and safety of biodiversity components. Through adherence to such requisites, growers can fetch higher premiums for the produce.

A study was carried out to evaluate the non-target effects of pesticides on honey bees (Apis cerana) and earthworms (Eudrilus sp.) in aerial and soil environments using five pesticides Fipronil (Class II), Fenthion (Class II), Carbofuran (Class I and II), Carbosulfan (Class I and II), Imidacloprid (Class II and III) which are used in tea plantations under standard protocols. While toxicity of pesticides on honeybees in aerial environment was determined by exposing honeybees to pesticide fumes emanating from pesticide soaked cotton wool kept in insectaries, toxicity on earthworms was determined by placing earthworms in soil treated with pesticides in bags.

The pesticidal effects were shown to be significant with respect to risks on important non-target organisms. The mean mortality of honey bees and earthworms varied significantly (P < 0.0001) with different treatments. Results were ranked according to the ranking method adopted for toxicity by Selvasundaran and Muraleedharan (1995). Fipronil, ranked as very toxic, showed 87.5% mortality of honey bees. Carbosulfan, ranked as toxic, Imidacloprid, ranked as tolerable and Fenthion, ranked as harmless, showed honeybee mortalities of 57.5%, 20% and 15% respectively. No dead honey bees were found in the untreated control. Out of five pesticides assessed in this study, Imidacloprid, Carbosulfan and Carbofuran resulted in very low survival of earthworms while Fipronil (Regent) and Fipronil (3GR) resulted in high survival rate. Hence, pesticide recommendations need to be perfected not only with bio-efficacy on the targeted pest but also concerning valuable biodiversity components which govern natural balances in agro-ecosystems. Therefore, it is increasingly important that pesticides are used with safely to minimise non-target effects.
Internal Transcribed Spacer Sequences of Three *Exacum* Species

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The *Exacums* are members of the family Gentianaceae. These annual species are grown as flowering pot plants in the Western hemisphere for its beautiful and profuse blue or white flowers. There are eight *Exacum* species found wild in Sri Lanka: *E. axillare*, *E. macranthum*, *E. pallidum*, *E. trinervium*, *E. walkerii*, *E. pedunculatum*, *E. petiolare* and *E. sessile* (Klackenberg, 1983) of which four are designated as threatened species. This study was conducted to determine phylogenetic relationships of two of the endemic Sri Lankan *Exacum* species: *E. trinervium* and *E. macranthum* which show potential for the floricultural industry with the non-endemic, commercial species *E. affine* and to compare their sequences of the Internal Transcribed Spacer (ITS) region as a possible DNA typing technique.

DNA was isolated from younger leaves of the plants and purified using the protocol modified from Keb-Llanes *et al.* (2002). The ITS region was amplified by Polymerase Chain Reaction (PCR) using two primers designed specifically for the ITS region and its sequences were determined.

The amplified ITS region was estimated to be around 600 bp. The sequences for the ITS region of the three species are reported for the first time in Sri Lanka. Multiple alignments of the three sequences were performed using the ClustalW software. ITS sequences of the two Sri Lankan species appeared to be much similar to each other than they were to *E. affine*.

Accordingly, the two endemic species *E. macranthum* and *E. trinervium* clustered together in the phylogenetic tree while *E. affine* separated itself from them.
Screening for Antibacterial Activity of *Rhinacanthus* Species Used in Traditional Ayurvedic Medicine in Sri Lanka

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The antibacterial activity of *Rhinacanthus nasutus* and *R. polonnaruwensis* (Family Acanthaceae) used in traditional Ayurvedic medicine in Sri Lanka were tested against standard Gram-negative and Gram-positive bacteria and clinically isolated Gram-negative and Gram-positive bacteria. The study was carried out on six species of bacteria: *Escherichia coli*, *Staphylococcus aureus*, *S. saprophyticus*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Shigella flexi*. A water extract of the concentration of 0.2 µl/ml of *R. nasutus* inhibited growth of all standard Gram-positive bacteria, whereas, 0.2 µl/ml extract of *R. polonnaruwensis* inhibited the growth of standard Gram-positive *S. aureus NCTC 6571*. Clinically isolated *S. saprophyticus* was inhibited by both *R. nasutus* (> 0.1 µl/ml) and *R. polonnaruwensis* (0.2 µl/ml). However, none of the tested concentrations of both *Rhinacanthus* species inhibited the growth of any Gram-negative bacteria.

It can be concluded that both *R. nasutus* and *R. polonnaruwensis* studied have antibacterial properties against Gram-positive bacteria. Previous studies show that 75% aqueous ethanolic extract of *R. nasutus* used was found to have potent anti-bacterial effect on many Gram positive bacteria, but no inhibitory effect on gram negative bacteria. Rhinacanthin-C, rhinacanthin-D and rhinacanthin-N possessed antifungal, antibacterial, antiviral, anti-inflammatory, anti-allergic and anti-cancerous properties. Out of the two *Rhinacanthus* species found in Sri Lanka, *R. nasutus* has higher antimicrobial activity. The plant extract taken by boiling the leaves in water was effective against most standard Gram-positive bacteria and Gram-positive bacteria isolated from wounds of patients.
Control of Rice Sheath Blight by Solid and Liquid-based Spore Formulations of a Sri Lankan Isolate of *Aspergillus niger*

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Sheath blight caused by *Rhizoctonia solani* Kühn is a major biotic constraint of rice production worldwide. Our previous investigations have identified *Aspergillus niger*, a fungus dwelling on the sheath of local rice varieties, as an effective biological control agent in controlling sheath blight *in vitro*. Moreover, phosphorus solubilization ability of *A. niger* has been reported by previous workers. The present study was conducted to determine the effectiveness of different solid and liquid based formulations of *A. niger* in controlling rice sheath blight together with their effects on increasing phosphorus content in plant tissues and soil.

Nine different treatments involving three different formulations (i.e. spore suspension, talc-based and straw-based) of the antagonist and the presence or absence of the pathogen, along with positive and negative controls, were applied on rice (variety BW 361) using a completely randomised design with four replicates. ERASER 5 EC (hexaconazole 50 g/L EC), a recommended fungicide for sheath blight was sprayed on the sheath as one of the treatments at the recommended dosage to compare the effectiveness of the formulations of *A. niger*. Rice plants were established in 5 L pots at five hills per pot. *R. solani* was inoculated to the soil (one sclerotium/tiller) 45 days after transplanting (DAT). Plants were treated with different treatments three times, namely 60, 68 and 75 DAT. Disease incidence and disease severity (i.e., % area of lesion development on sheath) were quantified over a period of 32 days after inoculation of *R. solani* and phosphorus content in rice sheaths and soil was quantified three weeks after the final application of treatments. Treatment effects were highly significant (p<0.0001) on disease incidence and disease severity. According to the findings, out of the three formulations of *A. niger*, the straw-based formulation showed the highest sheath blight control both in terms of disease incidence and severity. All the tested formulations of *A. niger* had similar levels of disease control as the fungicide treatment recommended for controlling sheath blight. Phosphorus content in rice sheath differed significantly (P<0.01) between treatments. Plants treated with straw-based formulations containing *A. niger* had higher sheath phosphorus contents than plants treated with straw without *A. niger*. The soil phosphorus content did not differ significantly between treatments.

Based on the findings, it can be concluded that the biological control agent, *A. niger*, in solid and liquid-based formulations has the potential to replace fungicide applications, either partially or completely, to control rice sheath blight. An additional advantage of *A. niger* was its ability to increase the availability of phosphorus to the plant, when applied as a solid-based formulation with straw.

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Comparative Pharmacognostic Studies on *Cyperus rotundus* Linn. and *Kyllinga monocephala* Rottb. (Cyperaceae)

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*Cyperus rotundus* Linn., a perennial grass like herb of Cyperaceae family which is widely used in Ayurvedic medicine, cosmetics and new drug formulations in allopathic medicine, is officially known as “Mustha” in the Ayurvedic Pharmacopeia. Locally, the plant is known as “Kalanduru”. *Kyllinga monocephala* Rottb of the same family has similar characteristics to *C. rotundus* Linn. and the latter is adulterated by *K. monocephala* Rottb. In addition, *K. monocephala* appears under the official Ayurvedic name of *C. rotundus* in many documents and web sites which triggered the question of its usage as a substitute since it might be affecting the quality of the final product. Rhizomes of both plants are the parts used as medicine, and have similar appearances when presented as a crude drug and are hard to differentiate. This research was designed to compare the two plants using pharmacognostic methods employed to analyse plants or plant related substances. The methods comprised macroscopic, microscopic and chemical analyses.

Fresh plants of *C. rotundus* and *K. monocephala* were collected from Seeduwa, Anuradhapura, Nawinna and market samples of crude drug were collected from Seeduwa, Peradeniya, Nawinna and Anuradhapura. Identification of the two plants was performed at the National Herbarium, Royal Botanical Gardens, Peradeniya. Comparative studies of the two plants were performed macroscopically and microscopically, by comparison of plant morphological structures such as rhizomes, stems, leaves and inflorescences. For microscopic analyses, slides were prepared from fresh rhizomes of both plants and also from the market samples of the crude drug. The thickness of the exodermis, endodermis and parenchyma were measured using Image J 1.43U software. Iodine, Safranin and Sudan III tests were carried out to identify ergastic cell contents in rhizomes of both plants. Ten replicates (each containing three measurements) from each location were used for all the measurements mentioned above.

Upon completion of the comparative study and statistical analyses it was evident that these two plants could be easily distinguished mainly from their inflorescences and from the width of the leaves which is larger in *C. rotundus*. However, most of the other morphological structures were similar. From microscopical studies, it was apparent that rhizomes of the two plants and their contents were very similar except the thickness of exodermis, parenchyma and endodermis, which were greater in *C. rotundus*. In conclusion, more advanced procedures such as chemical assay tests, ash value tests, quantification analysis of ergastic cell contents should be employed to compare the crude drug as well as the fresh rhizome of these two plants to evaluate the substitution of *K. monocephala* over *C. rotundus* in Ayurvedic medicine, cosmetics and drug formulations.
Allelopathic Effect of *Prosopis juliflora* (Mesquite) on Seed Germination of Native Coastal Dry Forest Species


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*Prosopis juliflora* (Mesquite) is an evergreen tree species which had been introduced to Hambanthota district as a shade tree in the early 1950s. This species has invaded coastal dry forests of southern Sri Lanka and has become a threat to natural vegetation in these forests. Allelopathic compounds are found to be present in leaves, roots, pods and flowers of this species. This study aims to examine the impacts of allelopathic compounds present in *P. juliflora* on germination of seeds of six native dry forest species; *Bauhinia racemosa*, *Cassia occidentalis*, *Drypetes sepiaria*, *Flueggea leucopyrus*, *Salvadora persica* and *Ziziphus mauritiana*. Seeds of these species were kept in a concentration series of an aqueous root extract of *P. juliflora* (0%, 2%, 5% and 10%) for 48 hours and on soil collected from a natural forest and at a *P. juliflora* stand in Bundala National Park under *in vitro* conditions. Further investigations were done by adding activated charcoal to the soil collected from the *P. juliflora* stand.

While the seed germination of *B. racemosa*, *C. occidentalis*, *D. sepiaria* was significantly reduced (P<0.05) in the presence of the root extract of *P. juliflora*, germination was delayed only in *C. occidentalis*. The results imply that allelopathic compounds are present in the root extract of *P. juliflora* which affect seed germination of some native plant species. Percentage seed germination was lower on the soil collected from the *P. juliflora* stand than that on natural forest soil, however, addition of activated charcoal to the *P. juliflora* stand soil enhanced germination. These results imply that allelopathic compounds may accumulate in the soil, adversely affecting seed germination of some plant species. However, the responses to allelopathic compounds of *P. juliflora* may vary among native coastal dry forest plant species. Plant species that are very sensitive to allelopathic compounds are at risk of being eliminated from the dry zone ecosystems where *P. juliflora* has invaded. Species that are less sensitive to these allelopathic compounds may be recommended to be grown as an attempt to restore *P. juliflora* invaded lands.
Effect of Storage Methods on the Postharvest Quality of *Amaranthus tricolor* (‘Thampala’) Leaves

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*Amaranthus tricolor* (‘Thampala’) is widely cultivated and consumed as a green leafy vegetable in many tropical countries including Sri Lanka. Short postharvest shelf life due to leaf wilting is one of the major problems associated with this crop. Their shelf life depends on conditions of storage. The aim of this study was to evaluate postharvest keeping quality of four new genotypes of *A. tricolor* named ‘Red’, ‘DOA green’, ‘Pure green’ and ‘Diyapalagoda’, introduced by the Horticultural Crops Research and Development Institute (HORDI) at Gannoruwa, Sri Lanka.

*Amaranthus tricolor* was cultivated in research fields at HORDI according to Department of Agriculture recommendations. The crop was harvested 40-45 days after sowing, before onset of flowering. A 250 g bundle of leaves (including stems) from each genotype was considered as one replicate. Treatments (storage conditions) were: cut stem ends dipped in water and stored under room temperature (27 ± 2°C) and relative humidity 60% (RH), leaves sprayed with 200 mL tap water daily [T1 (control)], packaged in Low Density Polyethylene bags (LDPE 150 µm gauge film) and stored under room temperature and relative humidity (T2) and packaged in LDPE 150 µm gauge film bags and stored under 10°C and 90% RH (T3). Each sample was weighed daily and the percentage weight loss was calculated. The visual quality was assessed using a self-prepared scale based on leaf wilting, yellowing and defoliation. Shelf life was determined as time (in days) taken to show moderate wilting (for samples not packed in poly-film) or moderate defoliation (for poly-film packed samples). The experiment was laid out according to complete randomized design, with six replicates per treatment. Data was analysed using SAS package by ANOVA and means were separated using LSD.

The shelf life of *A. tricolor* leaves varied significantly (p<0.05) among treatments and also among genotypes. ‘Red’ genotype exhibited the longest shelf life under all three storage conditions. Leaf samples stored without LDPE packaging had the shortest shelf life and their quality deterioration was mainly due to wilting, resulting from rapid water loss. Polyethylene film-packaging significantly (p<0.05) extended the shelf life of leaves both at room temperature and 10°C. This could be attributed mainly to reduced water loss inside the package. In all four *A. tricolor* genotypes, polyethylene film-packed samples, stored at 10°C (T3) showed the best postharvest longevity. Under T3, 5-fold, 6-fold, 6-fold and 8-fold extension of shelf life was observed with genotypes ‘Red’, ‘DOA green’, ‘Pure green’ and ‘Diyapalagoda’, respectively, against their corresponding controls (T1). The packed samples did not show any sign of wilting during storage but some defoliation was evident. Polyethylene film-packaging, combined with low temperature storage could be recommended as an appropriate method for extending the postharvest quality of *A. tricolor* leaves.


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Inoculation of grain legumes with rhizobia is an important process to maximize biological N\textsubscript{2} fixation in these crops. Green gram is one of the most important grain legumes in rain-fed farming systems in dry and intermediate zones of Sri Lanka. However, it is a promiscuous host and frequently forms nodules with indigenous rhizobia. Rhizobia of wild non-edible legumes have higher tolerance to prevailing adverse conditions. The main objective of the current study was to test the ability of certain rhizobial isolates from wild legumes to overcome competition by indigenous strains and effectively nodulate green gram in order to use them as rhizobial inoculants.

A field trial was conducted at the Department of Botany, University of Peradeniya, with four strains (M6, VD1, VW1 and VW2) which were previously selected as effective rhizobial strains. A Randomised Complete Block Design (RCBD) was used with three replicate blocks for each treatment. Seeds were mixed with a coir-based inoculant prior to sowing. Recommended agronomic practices were applied. Before harvesting, the plants were visually rated. Three plants from each plot were harvested after 8 weeks and a nodule count was taken. These plants were oven dried and weighed. Numbers of pods were recorded in the remaining plants. Physiological and biochemical characterisation of rhizobia was done by assessing their growth in media with different pHs (pH 5, 7 and 9), salt concentrations (0.5 %, 1 %, and 2 %) and different sugars (Lactose, Sucrose and Maltose).

Inoculation with all four strains showed increases in nodulation compared to the uninoculated N+ and N- controls. Dry matter production with M6 and VW2 were significantly higher (p< 0.05) even above the N fertiliser application. VW2 showed a higher ability to use all sugars while M6 was moderate and VD1 and VW1 showed similar patterns of low and moderate utilisation. M6 and VW2 grew at basic pHs. All the strains showed moderate tolerance to salinity except M6 which showed a high tolerance to 0.5% and 1% NaCl. Strains M6, VW1 and VW2 appear to be capable of overcoming competition by indigenous rhizobia and suitable to be used as inoculants for green gram.

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Effect of Plant Growth Hormones and Potting Media on the Growth Performance of Ophiopogon japonicus (Ornamental Foliage)

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Ophiopogon japonicus (L.f.) Ker-Gawl. (Chinese grass or Mondo grass) is an ornamental foliage plant (Family Convallariaceae) which has a good local and foreign market as potted plants and cut foliage. High quality, lengthy leaves have the highest demand. However, as these plants are very slow-growing obtaining leaves with the required length is difficult. Growth regulators (cytokinin and auxins) and the growing medium are two important factors affecting the plant growth. In this study, the effect of potting medium and plant growth hormones on growth performance of O. japonicus was tested.

Experiment 1 and 2 were done with IAA (Indole acetic acid/ natural auxin) and BAP (Benzylaminopurine/ synthetic cytokinin) respectively. Each growth hormone consisted of five concentrations (0 mg/l, 25 mg/l, 50 mg/l, 75 mg/l, and 100 mg/l) and both experiments were carried out in potting medium 1 (Coir dust: compost: sand in 1:1:1) and potting medium 2 (leaf mould: soil: sand in 1:1:1). Experiments 1 and 2 consisted of 8 and 10 replicates respectively. Fresh weight of plants, length of leaves, and chlorophyll content of leaves (plant pen NDVI 300) were measured and root morphology was observed. Experiments were carried out in a completely randomised design and data were analysed using Statistical Analysis Software.

In experiment 1, there was a significant increase (p ≤ 0.05) in fresh weight (11.56 g) in potting medium 2, and leaf length (21.6 cm) in potting medium 1, at 100 mg/l IAA. In experiment 2, the highest fresh weight (6.52 g; potting medium 2) and the highest chlorophyll content (-0.2632; potting media 1 and 2) were obtained at 75 mg/l BAP. Leaf length (18.69 cm) was higher in all the BAP treated plants compared to the control (11.4 cm). Potting medium 2 showed a significantly higher performance in fresh weight of plant (7.54 g) and leaf length (17.25 cm) than potting medium 1 (5.93 g and 13.68 cm). There was a significant interaction (p ≤ 0.05) between potting media and hormone treatments for the mean leaf length.

Both BAP and IAA have a stimulatory effect on the growth of O. japonicus. The optimum IAA and BAP concentrations for improved growth of O. japonicus were 100 mg/l and 75 mg/l respectively, irrespective of the potting medium used. The composition of the potting medium has an effect on the root morphology and overall growth of these plants. Leaf mould: soil: sand was the best potting medium for growth of O. japonicus than coir dust: compost: sand, irrespective of the hormone treatments. Further investigations are necessary to observe the synergistic effect of IAA and BAP.
Seed Development, Dormancy and Germination of the Alien Invasive Species, *Lantana camara* (Verbenaceae)


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*Lantana camara* L. of family Verbenaceae, a native to West Indies, is considered as an invasive species in many tropical and sub-tropical countries including Sri Lanka. Information on seed biology is important in developing control strategies for invasive species. However, little information is available on seed biology of *L. camara* in literature. Thus, the main objective of this study was to gather preliminary information on germination, dormancy and development of *L. camara* seeds.

Seeds were collected from numerous *L. camara* shrubs in Kandy and Ambalangoda regions separately. Seed moisture content, imbibition and germination percentages of non-scarified and manually scarified seeds were determined. Effect of dormancy breaking treatments (Gibberellic Acid treatments [100 ppm and 500 ppm], dry storage) on germination was examined. Seed ontogeny was investigated using seeds collected from plants growing in the premises of the Faculty of Science, University of Peradeniya. Fruit length, width, mass, seed moisture content and germination were examined in developing fruits (1, 2, 3, 4 and 5 weeks after pollination).

Seed moisture content of *L. camara* was 12.9% suggesting that seeds are orthodox. Both non-scarified and manually scarified seeds imbibed water at a similar rate (T =1.39, P = 0.175). Thus, *L. camara* seeds have no physical dormancy or combinational dormancy. Germination of non-scarified and manually scarified seeds in light/dark and constant dark conditions was 0%, suggesting that *L. camara* seeds have dormancy. Seeds contained a fully developed embryo and this suggests that they do not have morphological or morphophysiological dormancy. Thus, *L. camara* seeds may have physiological dormancy. A very few number of *L. camara* seeds responded to dormancy breaking treatments used in the experiment (F=19.13, p<0.001) concluding that *L. camara* seeds have deep physiological dormancy. According to the ontogeny experiments, *L. camara* seeds attained physiological maturity and dispersal maturity by the 4th and 5th week after pollination, respectively. Since the germination percentage of seeds throughout the seed development period was 0%, it can be concluded that onset of dormancy occurs before seeds attained physiological maturity. According to the results obtained, *L. camara* seeds show the potential to remain in the soil seed bank for a long period of time.
Extending Postharvest Longevity of *Calathea zebrina*


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*Calathea zebrina* (Sims) Lindl. (Family Marantaceae) is exported as cut foliage from Sri Lanka for its attractive zebra-like patterns on the leaf blade. Short vase life has been identified as a limitation during export. In order to extend the vase life (VL), several vase solutions were tested, that included different concentrations of CuSO$_4$.5H$_2$O (0.05 mM, 0.25 mM, 0.50 mM and 1.00 mM), different sucrose concentrations (0.5%, 1% and 2%), combination of the above sucrose concentrations with 0.05 mM CuSO$_4$.5H$_2$O and use of some household solutions (viz. cinnamon oil from the local market [1%, 2% and 5%], Sprite® [10% and 25%] and aspirin [0.0125% and 0.025%]). VL, relative fresh weight (RFW) and vase solution uptake rate (VSU) were measured. A plate count was carried out in order to assess the effectiveness of different CuSO$_4$.5H$_2$O concentrations on bacterial growth. Turbidity of the vase solutions was measured using a UV spectrophotometer at 620 nm at days 0, 4 and 7 during the vase life. Possible causes for leaf spot of *C. zebrina* was investigated using Koch’s postulate.

Based on VL, the effective treatments were 0.05 mM CuSO$_4$.5H$_2$O, mixture of 0.05 mM CuSO$_4$.5H$_2$O and 1% sucrose, 10% Sprite® and 0.025% aspirin. In all experiments, RFW showed significant differences in treatments when compared with the control, while VSU was variable. All tested CuSO$_4$.5H$_2$O solutions significantly reduced (p<0.05) the number of colony forming units of bacteria in the vase solutions, in comparison to the distilled water control. Turbidity of vase solutions showed significant reductions with 0.25 mM CuSO$_4$.5H$_2$O and higher concentrations compared to the control. *Curvularia sp.* was identified as the causative agent of the leaf spot in *C. zebrina*.

Copper ions play multiple roles in inhibition of wound healing compounds (e.g., suberin and lignin), biocidal effect, ethylene synthesis/action inhibition etc. Sprite® may contain sugars, citric acid and carbon dioxide. Exogenously added sucrose contributes to, cell metabolism as an energy source, increases the osmotic value and enhances the ability of maintaining turgidity of tissues. Acidic solutions (pH 3.5 - 4.0) reduce vascular occlusion by inhibiting bacteria and facilitating water uptake and improve vase life. Though essential oils have antimicrobial properties, tested concentrations of cinnamon oil were phytotoxic. Extension of this research is necessary to develop a standard vase solution formula for *C. zebrina*. 
Comparison of Rhizobial Inoculants and Fungal-Rhizobial Biofilms on Nodulation, N-Yield, Growth and Development of Green Gram (*Vigna radiata*)

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Nitrogen, an essential nutrient for plant growth, is supplied mainly by chemical fertilisers in cultivation of crops. The natural process of biological nitrogen fixation can be utilised as an alternative for chemical N-fertilisers. The objective of this research was to compare the effects of rhizobial inoculants and a fungal-rhizobial biofilm on nodulation, N-yield, growth and development of green gram.

The study included four different steps: 1) Development of rhizobial inoculants using four highly infective and effective rhizobial strains for green gram (BG⁷, GG₃, GG₈ and GG₁₂) identified from previous studies, 2) Development of biofilms using all the four strains of rhizobia with two separate species of fungi, *Penicillium* sp. and *Acremonium* sp. isolated from soil, 3) Screening the nitrogenase activity of the biofilms to select the most suitable biofilm, and 4) Testing the infectivity and effectivity of the rhizobial and biofilm inoculants under aseptic conditions in a pot experiment with 2 plants per pot, 5 pots per treatment.

The results indicated the highest nitrogenase activity in the *Penicillium-Rhizobium* biofilm with the combined strains of BG⁷, GG₃, GG₈ and GG₁₂. Hence, this biofilm was selected for pot experiments. The four individual rhizobial isolates and the biofilm formed root nodules six weeks after inoculation. The highest number of nodules (average of 36 per plant) and the highest nodule dry weight per plant (0.0335 g) were observed with the biofilm treatment. The biofilm was therefore rated as the most infective inoculant. No nodulation was observed in the N- and N+ controls showing the complete destruction of indigenous rhizobia in the sterilised soil used. While the growth performance of the plants inoculated with rhizobial isolates was significantly higher than that of N-control, the growth of the N+ treated plants was equivalent to that of the highest growth shown by biofilm treated plants. This indicates that the growth differences observed were primarily due to N-nutrition. Highest nodulation by the biofilm has enhanced nitrogen fixation and increased growth performance of these plants. The N-yields and flowering of the plants inoculated with the rhizobial isolates were significantly higher (p< 0.05) than those of N-control. This indicates enhanced N₂-fixation due to rhizobial inoculation. Both N-yield and the reproductive performance were highest in the biofilm treatment, indicating further improvement of the symbiosis by the biofilm.

Therefore, it was concluded that rhizobial inoculants enhance symbiotic N₂-fixation in green gram and this was further improved by inoculating with biofilmed biofertiliser which had an effect equivalent to the plants that received the full recommended level of chemical N-fertiliser (N+ treatment).
Forest Dieback at Horton Plains, Sri Lanka: The Potential Role of Arbuscular Mycorrhizae in Enhancing the Growth of the Native Tree Species, *Syzygium rotundifolium*

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One of the most striking observations that one could make during a visit to Horton Plains is the dying of trees at an alarming rate, which is termed ‘forest dieback’. Although research has been performed on forest dieback in montane forests, the aetiology of forest dieback at Horton Plains remains largely unresolved. This preliminary study was undertaken to investigate the effect of arbuscular mycorrhizae on forest dieback in Sri Lanka. The findings would make a significant contribution to the conservation and sustainable management of this montane forest.

Twenty four permanent plots (20 m x 20 m) were established randomly to cover an affected area in the Horton Plains National Park. Four treatments; control (T1), addition of compost (T2), compost with native montane mycorrhizae (T3) and native montane mycorrhizae only (T4) were used. The treatments were initiated in September 2008 and were repeated every six months, to five randomly selected *Syzygium rotundifolium* saplings in each plot. After 18 months composite soil samples from each experimental plot were analysed. Roots of *S. rotundifolium* saplings were also assessed for arbuscular mycorrhizal colonisation. Certain soil physical, chemical and biological properties were determined.

*Syzygium rotundifolium* saplings showed higher arbuscular mycorrhizal colonisation in T2, T3 and T4 than in the control (T1). The addition of native arbuscular mycorrhizae significantly increased (P<0.05) the arbuscular mycorrhizal colonisation in *S. rotundifolium* compared to the control. Soil analyses showed a relatively low fungal spore count compared to studies done in similar ecosystems. Soil pH, soil organic matter content and total nitrogen showed no significant difference between treatments. However, total phosphorus content significantly increased in plots with mycorrhizal addition compared to the control. Foliar heavy metal levels decreased in compost and arbuscular mycorrhizae added treatments (T2 and T3). Results suggest that addition of native arbuscular mycorrhizae together with compost can enhance certain edaphic characteristics and thereby enhance the growth of *S. rotundifolium* saplings. These findings may highlight the significance of using arbuscular mycorrhizae and compost to enhance the regeneration potential of native saplings in forest dieback areas in Hortain plains.
Progeny Screening for Yield Related Traits in Several Wide-Crosses of *Camellia sinensis* (Tea)

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*Camellia sinensis* (L.) O. Knutze yield is a complex multi-component phenomenon determined by simultaneous action of a number of traits. The current study aimed at evaluating performance of several wide-cross progenies for yield and related traits to identify heritable variability.

The study was carried out at the Tea Research Institute of Sri Lanka, Talawakelle. The field trial was laid out in a single bush randomized design. Sixteen progenies derived from fifteen different female parental lines that included TRI developed lines (TRI 62/3), introductions (INTRI 1, INTRI 5) and estate selections (2077, 2137, DEL 40, DUN 7, W 14, C 103, GF 7/6, K 136, LLEF 14/2, PING 2/1, S 106, TC 10), and two male parental lines, namely, ‘China’ and ‘Yabukita’ were used. Vegetatively propagated cultivars, DT 1 (quality standard) and TRI 2025 (yield standard) were used for comparison.

Yield related traits (viz. numbers of shoots, shoot fresh and dry weight, percentages of active shoots and three and a bud shoots) were used to determine the yield potential of the progenies. Shoot fresh and dry weight, bud fresh and dry weight were investigated further for broad sense heritability. Rate of shoot growth was measured based on a visual scale developed for this purpose.

The progenies DUN 7 ‘Yabukita’, W 14 ‘Yabukita’ and DEL 40 ‘Yabukita’ were superior in number of shoots, shoot fresh weight and shoot dry weight compared to all other progenies and the standard. In the progenies, C 103 ‘China’ and 2137 ‘China’, percentage active shoots and percentage of three and a bud shoots were high compared to the standard respectively. When considering female parental effects, except for percentage active shoots, positive female parental effects were observed in all other traits. When considering male parental effects, except for percentage active shoots, where the ‘China’ progenies performed better, ‘Yabukita’ progenies performed better in all other traits. Broad sense heritability estimates were comparatively high for shoot fresh weight ($h^2 = 0.83, p = 0.00, R^2 = 83.15\%$) and dry weight ($h^2 = 0.81, p = 0.00, R^2 = 80.64\%$). The same estimates were moderate for bud fresh weight ($h^2 = 0.53, p = 0.02, R^2 = 52.84\%$). It was not significant in bud dry weight ($h^2 = 0.37, p = 0.28, R^2 = 37.42\%$). Seventy eight individuals that showed a high rate of shoot growth were identified.

Individual plants having high yield potential that were genetically superior in specific traits were identified by this study. With proper validation, such material can be used in vigorous selection programmes and in future breeding programmes to develop superior tea cultivars.
Morphological Variation and Species Boundaries of the Genus *Monochoria* (Pontederiaceae) in Sri Lanka

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The genus *Monochoria* C.Presl belongs to the family Pontederiaceae and is represented in Sri Lanka by two native species, namely, *M. vaginalis* (Burm. f.) Presl, and *M. hastata* (L.) Solms-Laub. Field observations suggest the taxonomic keys and characters listed for identifying the two species overlap and, populations with distinct sets of characters exist, especially in *M. vaginalis*. Therefore, a detailed morphological and anatomical study was carried out to evaluate the species limits of the genus *Monochoria* in Sri Lanka.

Live plants from *M. vaginalis* and *M. hastate* were collected from all possible locations. The specimens were examined for different morphological characters in detail and anatomical studies were carried out with leaves of *M. vaginalis*. Fifty seven individuals were studied in detail and forty eight characters representing vegetative morphology, anatomy and reproductive morphology were identified for the study. The characters included 31 quantitative characters and 17 qualitative characters. Characters were coded into discrete character states and entered into a data matrix using the Microsoft Office Excel (2007) computer package. A cluster analysis was carried out using PCORD version 4.

The dendrogram that resulted from the cluster analysis initially identified two phenetic groups, separating one phenetic group of *M. vaginalis*. The larger cluster further divided into *M. hastate* and two separate phenetic groups that included members of *M. vaginalis*. Re-evaluating the three *M. vaginalis* clusters on the basis of the characters of the individuals grouped, several characters could be identified supporting the clusters. The leaf width, leaf base, leaf shape, leaf texture, absence/ presence of red pigmented glands in the mesophyll layer, leaf petiole length at the point of inflorescence emergence, number of flowers per inflorescence, distance between flowers on the peduncle, peduncle length, number of flowers open at a given time, flower diameter, shape of the inner tepal, arrangement of the persistent tepals around the ripe capsule and shape of the seed provided distinct variations among the clusters. Since the characters supporting the phenetic groups are features that are stable and do not change with the environment, the results strongly suggest that *M. vaginalis* encompasses an assemblage of different species or need recognition of below species level taxa.
Conservation Importance of the Vegetation of Galamuduna Area in the Knuckles Region

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Conservation of natural forests is a national responsibility towards future generations. The habitat diversity in Galamuduna area was determined by the use of aerial photographs, a ground survey and sampling five 100 m² plots. Since semi-evergreen forests are the natural vegetation type in the area, further sampling was done in this habitat, in order to study the structure, physiognomy and floristic composition using ten, 100 m² plots.

Eight types of habitats were identified at Galamuduna area. The highest percentage of endemic species was recorded in the riverine forest (20.6%) followed by semi-evergreen forest (16.7%), which also had the highest percentage of threatened species (9.5%). These include Diospyros ebenoides Kosterm, D. ebenum Koenig, Syzygium makul Gaerth and Aidia gadneri (Thw.) Tirv. The tree species dominated the semi-evergreen and the riverine forests in the area, whereas shrub, climber and herb species dominated the early to mid successional vegetation type. Fern species were found mainly in the riverine habitat.

The vertical distribution of the semi-evergreen forests at Galamuduna comprised a canopy layer (15-22 m), sub-canopy layer (5-12 m) and a shrub layer (1-3 m). Most stems belonged to diameter classes of 5-10, 11-15 and 16-20 cm. Aglaia apiocarpa (Thw.) Hiern had the highest mean dbh (45.8 cm). The canopy tree species had medium branching habit, tabular to spreading crowns and composed of dense leaf clumps distributed unevenly. The species with the highest frequency in the vegetation ≥ 5 cm dbh was Ellipanthus unifolius (Thw.) Thw. (90%) and that in the vegetation < 5 cm dbh was D. ebenoides (70%). The highest density was recorded for Ellipanthus unifolius Thw. (340 individuals ha⁻¹) and the highest family density was recorded by family Conclaraceae (392 individuals ha⁻¹) for the vegetation with 5 cm ≥ dbh. The highest density was recorded for D. ebenoides and Streblus taxoides (Heyne.) Kurz each with 4560 individuals ha⁻¹ and Moraceae (728 individuals ha⁻¹) recorded the highest family density for vegetation < 5 cm dbh. A total of 775 individuals belonging to 26 families, 51 genera and 55 species were enumerated. In Galamuduna forests 12.7% of plant species were endemic while 7% were threatened.

According to the results of this study, due to its high habitat diversity and presence of endemic and threatened species, Galamuduna (200-700 m) area should be conserved in a sustainable way for future generations by promoting ecotourism and education in the area.
Validation of Known Randomly Amplified Polymorphic DNA Markers for Molecular Breeding of Salt Tolerant Rice Varieties in Sri Lanka

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Soil salinity is a major problem in Sri Lankan rice industry. Breeding of salt tolerant rice varieties is considered as the most feasible solution to address this problem. Production of salt tolerant rice varieties through conventional breeding is time consuming and difficult as salt tolerance is controlled by polygenic factors and the varietal selection using phenotypic data is not accurate. Molecular breeding is a significant improvement to conventional breeding where varietal selection is done by using DNA markers.

DNA markers are specific landmarks of genomes that can be linked to physiological traits such as salt tolerance. DNA markers that are linked to traits of interest accelerate the process of selection in breeding and reduce the amount of resources needed for breeding and provide precise results. DNA markers for various molecular breeding programmes of rice have been established by international research groups. However, their applicability in Sri Lankan rice breeding programmes must be validated prior to utilisation because DNA markers discovered internationally have to be polymorphic in the local germplasm to be used in marker assisted selection. This study was performed to validate the applicability of three previously reported Randomly Amplified Polymorphic (RAPD) DNA markers (UBC9, UBC244 and UBC251) for salt tolerance in Sri Lankan rice breeding programmes.

Six salt tolerant and four salt sensitive rice varieties were used in the study. The effect of salinity on seed germination was evaluated by soaking seeds in a saline solution and in distilled water followed by seed germination. The percentage of germinated seeds was taken as the response to salt stress. Genomic DNA was extracted from young leaves of rice seedlings and Polymerase Chain Reaction (PCR) was carried out for three RAPD markers followed by separation of PCR products by using agarose gel electrophoresis. The PCR procedure was carried out three times to see the repeatability of results with conditions reported by original work on three RAPD markers.

The rice varieties BG300, BG358, BG360, At408 and Line 4-91 showed less tolerance to saline condition in seed germination tests, whereas rice varieties At354, Pokkali, Nonabokra, Line 11-139 and Line 5-110 showed higher tolerance. All three RAPD markers produced bands. However, the DNA markers tested were not polymorphic enough to differentiate salt sensitive and salt tolerant varietal groups for rice varieties used in this study. This could be due to the genetic fixation of three RAPD loci in Sri Lankan rice germplasm that led to homozygosity/monomorphism. Therefore, these three RAPD markers cannot be used in molecular breeding programmes of Sri Lankan rice varieties for salt tolerance. This shows the importance of validating DNA markers in local germplasm resources before using in molecular breeding programmes.
A User-Friendly Java-Based Statistical Tool to Analyse the Segregation Data of Crosses in Genetics and Breeding

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Genetic and breeding studies are characterised by making crosses between selected parental organisms and establishing segregating populations such as $F_2$, back crosses, test crosses, pseudo test crosses and recombinant inbred lines followed by detailed observations and statistical analyses of phenotypic data for traits of interest. The phenotypic data are often considered as ratios (e.g. 26 short: 37 tall in plants) for both major gene and poly gene controlled traits. In genetics, there are standard ratios for genetic segregations and using standard ratios as expected ratios. A goodness of fit test for observed phenotypic ratios is also conducted. When a geneticist or a breeder comes up with a ratio for observed phenotypic data, multiple comparisons could be made against many standard genetic segregation ratios to select the highest significant match for biological interpretation and practical uses. The multiple comparisons under different probability levels are time consuming and demand considerable expertise in non-parametric statistics. Therefore, an attempt was made to design a user-friendly Java-based statistical tool to analyse segregation data from crosses in genetics and breeding. This statistical tool can be used by geneticists and breeders with limited statistical knowledge to get most approximate ratios for observed phenotypic crosses. A statistical tool was developed by using Java programming language in NetBeans IDE 6.8. The population size in number of individuals, standard ratio and observed ratio for phenotypic data have to be entered and highest matching ratio and goodness of fit for other possible standard ratios can be obtained as the output. The tool was tested and validated by using already published data from genetic crosses.

The developed statistical tool is user-friendly and quick in finding the significant standard ratios in genetic and breeding studies. This is useful for purposes of genetic research, breeding, and teaching genetics to undergraduate, postgraduate and Advanced Level Biology students.
The Eleventh Article of the United Nations Universal Declaration of Human Rights and Offenders’ Rights Represented in Buddhism: A Comparative Study

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The eleventh article of the United Nations Universal Declaration of Human Rights (UNUDHR) about offender’s rights is a controversial topic in the present post-conflict context in Sri Lanka after its success in defeating long term terrorism. As a well-established philosophy, where an impartial judicial system beyond spatiotemporal boundaries can be traced, Buddhism represents a humanitarian perspective towards the operation concerning offenders. The substratum of Buddhist legal system is heavily concerned about human rights and freedom. Some of these ideas were included in the governance policies of many ancient Buddhist rulers, such as Asoka, and had been in practice as attested in historical records. Therefore, it is timely and significant to investigate the Buddhist interpretation and perspective towards offender’s rights in the contemporary context.

Buddhism emphasises that responsibilities and rights are interrelated phenomena. The Buddhist judicial system is an impartial, open and equitable one. It is enacted not only to perceive offences of a convict but also to reveal justifiable evidence so that they could stand as law abiding people in society. According to this, Buddhism bears a positive and progressive attitude regarding offenders. As the UNUDHR points out, Buddhism accepts that everyone charged with a penal offence has the right to be presumed innocent until proved guilty according to law in a public trial at which they have had all the guarantees necessary for their defense. In the Buddhist legal system, no one shall be held guilty of any penal offence on account of any act or omission which did not constitute a penal offence at the time when it was committed. Thus, Buddhism has provided sufficient provision to safeguard the rights of offenders.

This paper compares the Buddhist attitude towards offenders and the UNUDHR. It emphasises the need of a humanitarian approach for democratic administration of offenders as argued and practiced by the Buddhist legal system.
Substitution of “S” to “M” or Regressive Assimilation (Pararūpa) in Pali Euphonic Combinations (Sandhis): Is it a New Sandhi Pali?

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Pali is a language, highly venerated in Sri Lanka and other Theravada Buddhist countries, since it has become the medium of Theravada sacred texts. Although Pali is not widely used as a language for communication, as it is used in day-to-day religious activities, some radical changes and new tendencies of the Pali language occur from time to time. This study intends to examine a new (Sandhi) euphonic combinational formula that originated in Practical Pali language.

The main objective of this research was to reveal how new tendencies occur in Pali language when it is utilised in recitations. Especially, utility of a new Sandhi formula, initiated in recitations, is presented here.

The grammar of the Pali language has been widely explained by many scholars. There are mainly three traditions of Pali grammar which elaborate Sandhi rules in Pali in detail. Here, my intention is to describe the substitution of “s” (sakāra) into “∝” (niggahīta) or how “Pararūpa Sandhi” occurs in Practical Pali language. Traditional texts and modern views on Pali Sandhi Formulas are also referred to as points of illustration.

The substitution of “s” (sakāra) into “∝” (niggahīta) has been pointed out previously, but practical examples were not provided as evidence. It is discussed in this paper how “Pararūpa Sandhi” progresses in practical Pali by using three practical examples.

The substitution of “s” (sakāra) into “∝” (niggahīta) or “Pararūpa” may be a Sandhi Formula either forgotten or missed out by traditional grammarians. Unlike other substitutions, this formula is complex and not well known in texts until recent times. This may be one of the reasons for its lack of reference in traditional grammatical texts.
Migrant Wife and Househusband: Transformation of Household Gender Roles with Female Migration

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Traditionally the woman's place of "work" has been confined to the so-called private sphere, namely, the household. In the household, she was expected to perform traditional women's work such as looking after the children, washing, cooking, etc. The husband was the provider of the family and his tasks were almost exclusively in the public sphere. Many women today have become providers, sometimes even as sole income earners of the family. One modern context in which this traditional division of gender roles comes into question is when women become independent migrants requiring husbands to take over traditional household tasks. Research shows that this has often resulted in displacing the husband from the traditional role of the sole decision maker in migrant households. These changes are challenging the traditional pattern of male-dominated household organization and have resulted in emergence of a new phenomenon described as migrant-wife or househusband.

This paper examines how the changing of the traditional role of the wife affects the husband's traditional role in the households of Sri Lankan women who are working in the Middle East as housemaids. The study was conducted in a migrant source community in the district of Kurunagala in the North Western Province of Sri Lanka. Ten households with husbands whose wives were abroad at the time and ten others whose wives had been abroad were selected for the study.

Migration of a woman creates a functional vacuum in the household affecting its operations. The solution to this is often in the form of adjustment to the roles and status of the existing (functional) members of the household or through infusion of new members from the kinship network. When the husband takes the responsibilities of the wife it lowers the status/social position of the husband in the eyes of the community because he is doing what is traditionally considered to be women's work. The social position of the husband is particularly affected when he is substituting for his wife doing domestic chores and there is another person, proxy and female, managing the funds remitted by the wife. There are also some changes in the gender division of labour not only in "during migration household", but also in "post migration households". It was found that there was an increase in the number of husbands sharing work in the majority of households of returned migrants.

The study showed that while the wife is abroad many husbands take up household activities traditionally performed by the wife. Although this happens out of necessity, the majority of husbands were found to be happy with this arrangement as they felt that they should contribute to running of the family as the wife is now the provider. Yet at times, they also felt that their changing gender roles negatively affected their social position (and male ego). However, household relationships led to conflicts when there was a proxy coming from outside, for example, a relative, managing the finances of the wife, as husbands do not feel comfortable with another person having control over the family budget. The social position of the husband also becomes a major issue when the proxy manager is a woman.
India’s Strategic Interests in Sri Lanka

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The regional powers and strategic framework provides a systematic method to evaluate how the relative strength and behaviour of regional powers influence small states. In this regard, scholars have acknowledged that ‘leadership’ is only one of the qualities that a regional power can display and that these countries can pursue different strategies in dealing with their smaller neighbours. This study applies the framework to India as a South Asian regional power and to Sri Lanka as a small state in the South Asian subcontinent. In this broader context, the central research problem of this study has focused its attention to analyse why India’s major strategic concern shifted to Sri Lanka’s long term peace and stability during the post-cold war period.

The research problem of the study has been examined by using the Concept of Leadership and Custodianship presented by Derrick Frazier and Robert Stewart-Ingersoll to build up a theoretical framework on regional powers’ security interests and their role in the particular region. In this study, standard research tools including descriptive and analytical methods have been used to analyse primary and secondary sources.

Being a geographically proximate state of India and because of its unique geographic position in the Indian Ocean, Sri Lanka assumes a great strategic importance to India. Some recent studies are more helpful when it comes to making sense of India’s strategic approach towards Sri Lanka. In a realistic manner, three major factors influencing India’s strategic relations with Sri Lanka are security, economy and the shared ethnicity of Tamils living in southern India and in northern and eastern Sri Lanka. The end of terrorism in Sri Lanka has given rise to new opportunities for improved strategic relationships between India and Sri Lanka. But political consolidation and growing Chinese and Pakistani presence in Sri Lanka have restricted India’s strategic leverages in Sri Lanka. The study indicates that India’s impact on Sri Lanka is limited because of its failure to play leadership and custodianship roles. Apart from this, the declining of Sri Lanka’s strategic importance to India reflects much stronger Indo-U.S. relations. During the post cold war period, India and the U.S. coordinated their respective strategic policies on Sri Lanka. In keeping with the current developments, India’s strategic interest in Sri Lanka has been enlarged to protect and project India’s security and economic interests by building strong bonds with Sri Lanka. Further, India’s strategic strength dictates that in its own interest Sri Lanka should sustain its friendly relations with India. India also appears to have realised the need to build a more positive relationship with its island neighbour for the same reasons of mutual interests. In a nutshell, after the cold war, India’s strategic interests in Sri Lanka have shifted from a geo-strategic power balance to pragmatic security considerations.
The Role of E-Governance in Curbing Corruption of the Public Sector: A Case Study of Devinuwara Divisional Secretariat Office

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Corruption is not a new phenomenon in Sri Lanka. Although deep rooted in the public sector, it does not mean that the corruption in the public sector cannot be controlled in Sri Lanka. Thus, necessary action should be taken to control corruption. The Devinuwara Divisional Secretariat Office (DDSO) has introduced several initiatives to prevent corruption that has been a major barrier in achieving its development goals and efficient service delivery. However, corruption is still one of the major issues in DDSO. Achievements in public services are far below levels of public satisfaction. According to the public, corruption is the best way to access the DDSO for information and services. Therefore, E-governance could be a solution to improve the quality of their services and provides greater opportunities for public to participate in the democratic process. In other words, E-governance could be a solution for corruption in DDSO. In view of these facts, DDSO was selected as a case study. Through this case, researchers tried to find answers to the following questions: (1) Does e-governance curb corruption in DDSO? and (2) How could e-governance be a solution for corruption in DDSO? The objectives of this study were: to analyse the role of e-governance in curbing corruption in DDSO, and to identify the e-governance initiatives in DDSO.

The study was mainly based on two types of data collection methods; survey methods and content analysis. Two types of survey methods were employed for this study, namely, structured questionnaire surveys for the public, and semi-structured interview surveys on DDSO officials such as the Divisional Secretary, Assistant Divisional Secretary, Assistant Director Planning, Accountant and Administrative Officials. Also, the interviews were extended to some selected citizens to get their insights about corrupt practices in DDSO. It helped the researchers to analyse the level of public satisfaction and to validate the data obtained from other sources. The sample size was 42 (32 randomly selected citizens and 10 DDSO officials). Besides this, content analysis was used to gather secondary data, information and facts. Data collected from different sources, as mentioned above, were analysed using qualitative and quantitative methods, and it was presented using tables, charts and figures.

The findings of this study are given below:
1. E-governance can lead to centralised data which can be used for improving audits and analyses.
2. E-governance can make decisions traceable.
3. The introduction of Information Communication Technology (ICT) can reduce corruption by improving the enforcement of rules, lessening the discretion of officials, and increasing transparency.
4. Web publishing of DDSO information builds accountability by providing documentation to citizens to substantiate their complaints against corrupt practices.
5. E-governance provides new sources of corrupt incomes for ICT professionals.
6. DDSO has still not gained significant savings or adequate efficiency through e-governance.
Employees’ Perception on Effectiveness of Performance Management System in the Non-Profit Sector in Sri Lanka: A Case Study

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Non-profit organizations play a central role in society by addressing key social problems through community and public services. One role of non-profit organizations in Sri Lanka is to overcome poverty and suffering by way of implementing emergency and long-term development programmes. The primary objective of Performance Management System (PMS) implemented by both local and international non-profit organizations in Sri Lanka is more employee-development-oriented.

PMS is considered as a tool helping organizations to achieve and sustain competitive advantage through leveraging employee capabilities. Therefore, it is an integrated system designed to meet the objectives of various stakeholders including employees, line managers, and organizations. In order to be effective, PMS needs to be aligned with other human resource strategies such as training and development and streamlined across the organization.

This study explores the effectiveness of PMS in improving employee performance in a non-profit organization in Sri Lanka as a case study. Semi-structured interviews were the main data collection method used to elicit information from employees at managerial level and their line managers on the effectiveness of the system in improving employee performance. In addition, secondary data in the form of company policies, guidelines, practices relating to performance management were also reviewed and cross-checked with primary data.

The findings indicate that there was unanimity in responses among line managers and employees with regard to the effectiveness of joint objective setting process, performance feedback, and the accuracy of self and supervisor-centred performance reviews. However, a significant number of respondents expressed dissatisfaction regarding the implementation of performance development plans and the provision of career development opportunities. In addition, this study also reveals other factors such as line managers’ attitude towards employee development, budget constraints, and lack of a proactive role of the Human Resource Division, which hinders the implementation of PMS. This study provides a set of practical recommendations to make the PMS more effective in the context of the non-profit sector.
Development of a Decision Support System for Finding the Optimal Employee-Workstation Combination for a Manufacturing Assembly Line in a Garment Manufacturing Firm: An Experimental Study

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Assembly lines are traditional and still attractive means in manufacturing processes. Lean manufacturing, which is one of the modern manufacturing concepts, seeks to make the product flow through the process and eliminates non-value-adding activities. In order to achieve this, a balanced assembly line is critical as the assembly line is at the heart of the manufacturing process. Correct task allocation to workstations and correct employee-work station combination are two of the most important factors in balancing a garment manufacturing assembly line. However, in most of the small and medium scale Sri Lankan Garment Manufacturing Firms, frequent changes in physical assembly lines are required to cater to small order quantities and the use of manual methods in arranging line layouts are found to be time consuming and tedious. Even so, most of the assembly line layouts are found to be re-adjusted several times until an optimum layout is achieved. Although many studies have been done elsewhere, the fact that there is a dearth of research in Sri Lanka in this context, led to the present study of developing a Decision Support System (DSS) for obtaining the optimal employee-work station combination for a manufacturing assembly line in a Garment Manufacturing Firm.

After a comprehensive study carried out on a manufacturing assembly line in a medium scale garment factory and some relevant literature were studied in depth, a DSS was developed using Java programming language and MySql database. The effectiveness of the DSS was experimented using two manufacturing assembly lines of the same shift which were to produce ladies skirts for the first time. The two assembly lines were recording neck-to-neck manufacturing efficiencies for the past two months with other production runs. For one line, the employee-work station combinations were found manually and for the second line, the combinations were found using the DSS. The two manufacturing assembly lines were fed at the same time and the line outputs were observed for one week.

For Line 1, the production executive took ~45 mins for deciding the workstation-employee combination of the assembly line and it took only ~7 mins for the second assembly line when the DSS was used. Therefore, the time taken for obtaining the employee-work station combination was improved by 84% when the DSS was used. The production results during the first week were observed to be on par with each other, which proved the use of the DSS was effective. Therefore, with further studies, this DSS can be improved as a day-to-day operating tool assisting managerial decision makers in Garment Manufacturing Firms. Since the DSS is very easy to run as it is platform-independent, user friendly and does not incur additional costs for installation and running, it could be a means for streamlining the manufacturing assembly line preparatory process for better efficiency.
Names of Sri Lanka as Revealed through Ancient Chinese Sources

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In the study of the development of the historical traditions of the world, China, takes a prominent place. Chinese sources are not only vital in constructing the history of China, but also valuable in studying the history of different countries in the world and their relations with China. In records related to foreign countries, various names have been found in Chinese sources to identify different countries of the world. For example, more than 34 names had been used to denote India. Quite a number of names have been used to identify Sri Lanka as well. In Chinese sources dating from the Han dynasty (206 B.C. - 220 A.D.) to the Qing dynasty (1616 - 1911 A.D.) alone, more than thirty names have been used to denote Sri Lanka.

The main focus of this research was to identify the names used for Sri Lanka in the sources from the Han dynasty to the Qing dynasty, to make a brief review of the sources and to analyse the basis on which such names were attributed.

When we examine the Chinese names used with reference to Sri Lanka, it is evident that a number of methods have been followed. For example:

1. One method has been to translate on the basis of the meaning of the word.
2. For example: "shizi guo" (师子国), "shizi zhou" (师子洲) (sihadipa)
3. Another method was based on criteria such as the main materials like gems found in Sri Lanka.
   a. For example: "bao zhu" (宝仓储), "bao zhou" (宝州) (Ratnadipa)
4. There is another category based on the pronunciation of the word denoting Sri Lanka.
   a. For example: "xilan" (锡兰) (Ceylon), "Seng jia luo" (僧伽罗) (Sihala)

This research is mainly based and focused on Chinese primary sources, which I have utilised for my postgraduate research during the last few years. It has enabled me to come across these names with reference to Sri Lanka. However, it has to be mentioned that more investigation in his area is crucial. Some names used for Sri Lanka have been established with certainty but there are other names that are still subject to controversy. Apart from this, some names which had been erroneously used to refer to Sri Lanka have now been identified and errors have been rectified. My objective is to make an initial inquiry into this important area of study in order to understand and evaluate properly the Sino-Sri Lankan relationship over the years.
A Historical Analysis of the Political Role of the Buddhist Monk in Sri Lanka during the Anuradhapura Period (3rd Century B.C. to 10th Century A.D.)

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The discourse on the political role of monks is a prominent theme in present-day social and political enquiry. Although some scholars have attempted to state that politics do not directly relate to the role of monks, others strongly point out that it is not logical to accept that Buddhist monks cannot be politically involved. Scholars who emphasise the fact that politics is entirely concerned with social issues, further attempt to highlight that their major objective is to serve the society. Therefore, they do not question the opportunity available to monks for that purpose. However, at present, Buddhist monks have emerged as a political pressure group actively involved in politics. Thus, it is timely, as well as important, to investigate: (1) the status of monks when Buddhism was introduced to Sri Lanka; and (2) the manner in which the Buddhist monks are politically integrated.

During the last few decades, more attention was paid to the social function of monks. It can clearly be seen that there was an attempt to establish the role of monks from different perspectives. Previous studies have succeeded in attempting to emphasise the social function of monks in an academic background. When attention is paid to such studies, it can be seen that Buddhist monks evolved as an organized social group. However, the political participation of the early Buddhist monk was significantly different from the present. The major objective of this study is to critically examine the above mentioned phenomenon, focusing on the primary sources related to the political and religious history of Sri Lanka.

The Anuradhapura period can be considered as the beginning of social, economic, political and cultural development in Sri Lanka. The evolution of the Sri Lankan political structure within a Buddhist framework can also be seen as a trend which emerged in this period. Within this background, the Buddhist monk was able to function as leading characters in politics as the "Buddhist State" was integrated into society. They became not only the advisers of the rulers, but also teachers to the governing elite. Moreover, since the coronation of kings, the contribution of monks was considered a highly important factor to maintain all political activities. It should be noted that monks served in a significant way in leading rulers to an ideological path that helped the well-being of the state. Thus, Buddhist monks can be identified as a community that has made strong contributions to the development of the political system of this country. It is clear that the role of the Buddhist monk was a key factor that clearly contributed to the development of the state on the one hand and the development of the Sangha community on the other hand.
Classical Athenian Family in the Limelight: Was there Affection between Athenian Spouses?

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The objective of the study is to re-examine the literary evidence in par with the vase paintings that show scenes from domestic settings in order to perceive whether any affection existed among Athenian spouses because the interpretations given with regard to some such domestic settings seem problematic.

The generally accepted view based on the conceptions of the authors of normative texts is that the Athenians considered their wives only as a machine which produce legitimate children and they looked for courtesans, prostitutes and hetaerae (respectable courtesans) for entertainment and that they bore no sentiments of affection for their spouses. Many paintings on Attic red and black figure vases are interpreted and explained following such perceptions.

Yet, information from literary sources, more precisely those from Athenian drama and law court speeches infer that the condition of Athenian families was not as stern and cold as preached and promoted by normative writers such as Plato and Aristotle. This idea is further confirmed through many domestic scenes depicted in Athenian vases such as the domestic scene shown on the Harvard hydria. The scene on it can be interpreted as demonstrating a nucleus of an Athenian family comprising a mother, father and child (with a maid).

Not everyone was ready to accept this point of view, probably, when looking at the youth with restrained thoughts of Plato, Aristotle and Xenophon, who describe the husband or the groom as twice as old as the bride which easily fits with the cold relationships they instilled into their relationships when they further asserted that the husbands spent more time outside their homes perhaps in the agora or gymnasium with their peers and not with the family at home. Yet, information from Athenian dramatists and orators pile up in favour of warm affection between spouses.

The insight we are provided with through a meticulous study of our literary sources and vase paintings is that there were positive sentiments such as warm affection between Athenian spouses as in any other normal society in antiquity or in our era. This cold and negative picture on the relationship between Athenian spouses has resulted from taking the perceptions of authors of normative texts, whose intention was to present the ideal picture they expected of their society but not the real scenario, as the ultimate characteristic of the Athenian society.
Perceptions of Host Communities towards Heritage Conservation and Tourism: The Case of the Sacred City of Anuradhapura

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Local community perception, among many other stakeholders, is a strong factor in determining successes and failures of heritage policy and plan implementation of a heritage site. In the context of a world heritage site, reconciling the balance between heritage conservation, tourism and local public aspirations is a tremendous and growing challenge. Using the Sacred City of Anuradhapura (SCA), a UNESCO world heritage site (1982) and a main religious tourist destination in Sri Lanka, as a case study from a local community perspective, this research examines the nature of the linkage between heritage resource conservation and tourism development at the particular site.

Various types of quantitative and qualitative data were analysed from three perspectives of heritage sustainability: quality of the heritage resource, quality of heritage tourism, and quality of life of the community. Majority of the community believed that they had a high sense of safeguarding the Buddhist religious heritage of SCA, but they indicated that past plans had not reflected their anticipation and neither were they clear about future plans. Villagers lack interest about being informed about resource conservation and in expressing their views. The data also provide useful information for local benefit and local engagement. Many respondents held government or private sector jobs related to heritage and tourism, but only a small proportion was satisfied with their income. Local involvement in heritage and tourism planning and management is very low and many of them felt that they did not have an effective mechanism to get their views heard. Complaints were heard constantly about the consequences on their life from implementation of projects such as relocation and resettlement. This has not been completed at the time of research, as was indicated in development plans of Anuradhapura Preservation Plan 1942, Anuradhapura Sacred Area Planning Scheme (1984) and Greater Anuradhapura Development Scheme (1998). When villagers were asked whether they were willing to move from the site, most of them were positive about the move although there were a few residents in the Citadel area who had some problems such as loss of means of living, dissatisfaction with compensation and equity issues.

Judging from the feedback, certain conclusions could be drawn. Majority of the community displayed interest and enthusiasm towards heritage conservation and tourism activities, although only a few were satisfied with the economic gains and seemed to lack motivation to take part in heritage and tourism planning and decision-making. However, overall impressions reflect both positive and negative public attitudes towards heritage conservation and tourism at SCA.

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Training Needs of University Library Assistants: Perspective of the Librarians

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Human Resource Development (HRD) is a planned effort to improve knowledge, skills and attitudes of employees. In the library context, HRD is mainly provided through education and training programmes and a clear understanding of the HRD needs is essential before directing the staff to such programmes. To fulfill this need, a study was carried out in the context of the Sri Lankan University libraries and this abstract discusses the details in brief. The broad objective of this study was to gain an insight of the training needs of the Library Assistants (LAs) in the Sri Lankan University libraries. The specific objectives were to: i). investigate the training opportunities currently available for University LAs in Sri Lanka; ii). explore the actual training needs of the LAs as perceived by them; iii). identify the problems encountered by the LAs in undergoing training; iv). examine the Librarians’ views on the training needs of the LAs and v). make recommendations to solve the identified issues. In this abstract, findings related to the fourth objective are discussed.

Twelve University libraries under the University Grants Commission (UGC) were selected for the survey. The main research instrument adopted was a self-administrated postal questionnaire consisting of structured and open ended questions administered to all twelve librarians. The response rate was 100 per cent. Descriptive statistical methods were applied to analyse the data.

The study revealed that all the University libraries have not paid adequate attention to the HR capacity development of LAs. Librarians made several observations with regard to the training of their LAs: inadequate fund allocations for training programmes; vacancies being unfilled, so that those who are in service cannot be released for training; non-availability of a training policy; non-availability of appropriate training opportunities, such as language and ICT skills; and lack of encouragement for training in the existing promotional scheme.

The study recommends the following to overcome these issues: increase funding for training; develop a training policy for the University libraries; organize appropriate training programmes by the libraries; encourage training organizations to provide more appropriate training programmes; and revise the recruitment and promotional schemes to encourage participation at suitable training programmes.
The Impact of Rabindra Sangeet on Sri Lankan Music

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In the early phase of the 20th century, Sri Lankans were seeking for a culture that could be identified as pure Sri Lankan or Eastern in order to resist British rule. Accordingly, the arrival of Rabindranath Tagore (who was an eminent poet, musician, painter, etc.) in Sri Lanka, motivated many individuals to depart to Tagore’s education institute - Shanti Nikethan, in India to learn Eastern aesthetics. Tagore's ideology and aesthetics was an excellent blend of Indian classical, Bengali and Western musical characteristics with a superior writing pattern. Hence it could motivate those Sri Lankans who studied there, to develop Sri Lankan music in a new direction.

The Rabindra Sangeet impact can be seen in several ways. The major fact is that it resisted imitation of Hindi melodies into Sinhala lyrics. Accordingly, by the influence of Tagore music characteristics, people who learnt at Shanti Nikethan composed simple lyrics and melodies with more folk-like music patterns. Ananda Samarakoon is one such important person. He created several compositions such as Wile malak pipila kadimai, podi mal ethano, etc. in the style of Rabindra Sangeet. Although it is not entirely similar to Rabindra Sangeet melodies, it follows Tagore’s ideology which is “simple” in structure. Hence, his compositions do not show complexity. Other than Ananda Samarakoon, Sunil Santa also appeared to have been influenced by Rabindra Sangeet. His Ridi Walaawa song is one such song. Creating awareness of Bengali songs among Sri Lankan musicians and listeners is another outcome of Rabindra Sangeet ideology in Sri Lanka. The reason is that, as Rabindra Sangeet is a mixture of Indian, Western and Bengali folk music patterns, people who followed Tagore’s ideology became also interested in this new music style - Bengali or rather Wanga style. As a consequence, at the request of Premakumara Epitawala, Pt. Amaradeva used the Bengali folk music style called Bhattiyali and Bondure (a Bengali song) in Premakumara Epitawala’s ballet Thiththa Batha. Moreover, both Pt. Amaradeva and Sunil Santa have sung Bengali songs in SLBC recordings such as Se yaachu de and Bondure.

Apart from the popular music stream, other musical usages also show evidence of the influences of Rabindra Sangeet. One such instance is the melody of the school song, Me siri lakbima thun Sri Pali ape thaksala dine, of Horana Sri Pali College (the school which was initiated by Tagore in 1934) which is taken from Rabindra song-Ekla cholo re. Even today, the students sing Bengali-influenced songs and Rabindra melodies written in Sinhala in their morning assembly every week. One such example is Jaya jaya sri maatha apa rejini which is similar to melody of Indian National Anthem that is also influenced from Bengali folk songs.

The effort of W.D. Makuloluwa, which can be considered as an indirect offshoot of Rabindra Sangeet and its ideology, gave considerable attention towards following a similar path to systemise our own roots in music. Hence, it is clear that there are direct and indirect influences of Rabindra Sangeet that lie underneath the context of Sri Lankan music.
Either God or Devil: Beyond Buddhism - An Anthropological View of Yakkama Ritual

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This paper focuses on an aspect of the structure of Yakkama ritual (Nanumura Mangallaya) that is particular to Laggala Pallegama Region in Mathale District. The research has two objectives: to determine how the Yakkama ritual is separately constructed within the Buddhist context; and to determine the positioning of Gods and Devils in the devotees’ court. This study employed qualitative methods including focus groups, participant observation and key informant interviews in August 2011.

Nanumura Mangallaya is the first ritual activity in the year that was introduced as Yakkama. The total structure of the ritual is embedded with worship of the great God of Rawana (Gange Bandara, Sellavi Bandara and Brahmana Bandara, etc.), God Saman, God Devatha Bandara, and they associated with eighteen Yakkas (demons) who are directly connected to their weapons cleaning ritual. They included 45 sacred weapons, such as swords, bows, arrows, knives, etc., and Goddess Paththini’s foot anklet (Salamba). The total structure of ritual idiom displaces regional guardian Gods and their pantheon of Yakkas in the community belief system. The main expectation of the ritual is protection of hunters and the community from various evil spirit and community diseases (Deyyange Leda) such as mumps, chickenpox, etc. The whole day of Nanumura Mangallaya (Yakkama), ritual villagers visit the temple ground premises and fulfill their vows to Gods and Goddesses that they have made during periods of ailments.

There is a fundamental link between Shanthikarma and Buddhism in both up-country and low-country Sinhalese societies. However, when clearly observed, the structure, rituals and practices performed in Yakkama have a non-Buddhist base and also have particular regional identities. It is also observed that the non-Buddhist element of Yakkama is a historical and culturally constructed phenomenon. On the one hand, Yakkama symbolises hunting and is a tribal community ritual. Hence, there is lack of specific evidence to link civilised religious norms to this context. On the other hand, Yakkama has been developed as a ritual contradictory to the Buddhist tradition. Shanthikarma in Sinhalese society is performed in separate spaces to get God’s benevolence and rituals are performed in common spaces to receive benevolence and prosperity.
Forecasting All Share Price Index of the Colombo Stock Exchange

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The stock market of a country plays a significant role in the economy and stock price indexes are vital pieces of information for investors. This study attempts to forecast the All Share Price Index of the Colombo Stock Exchange (CSE) using time series econometric models. The study uses daily stock price index data published by the CSE from January 2010 to June 2011. Forecasting models were constructed using univariate time series techniques with a time trend component. Optimal forecasting model was selected out of twenty five models estimated using the SIC model selection criteria (Schwarz Information Criterion). ARMA (1, 1) model (autoregressive moving average) with a quadratic time trend was selected as the optimal forecasting model. A seven-step-ahead forecast (one week) was computed using the optimal model. Residuals of the optimal forecasting model were tested for stationarity and normality using Augmented Dickey–Fuller test and Box Pierce Q-statistic, respectively. The forecasted values have relatively low deviations from the actual observations which was confirmed with a difference in means test between the actual and the forecasted values. Thus, a simple ARMA model, considering a time trend component, can be effectively used to produce a reasonably good forecast of stock price index among many other time series models. For more accurate forecasts, one should examine a fair number of models with appropriate model selection criteria.
A Contextually Informed Motivational Premise of Suicide

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A key limitation with most local studies on suicide is the failure to explain individual suicidality, even though individual vulnerabilities play a major role in the overall picture of suicide. The present research examines suicide from a psychological and contextual perspective, exploring motivation and emotions involved in the decision-making to attempt suicide. It used a qualitative methodology, using case studies as its main data collection tool. The study’s sample involved six cases (three male and three female; mean age - 21), selected from among a population of in-patients admitted to a general hospital for treatment. Data analysis was informed primarily by post-Freudian, person-centered and cognitive theories of personality development.

All cases reported two different but connected feelings in common: the feeling of ‘rejection,’ and that of ‘un-wantedness’ by significant others in his/her life. Another psychological concern was a sense of ‘unworthiness’, fuelled by the type of reasons expressed by intimate others (and in some cases, by the subjects themselves) to explain the social rejection of subject. A third concern was feelings of guilt, and shame. The final key observation was an internalised sense of self-pity and aggression, directed towards one’s own self.

The subjects showed a tendency to transform social rejection into self-defeating feelings and self-directed aggression, which ultimately motivated suicide. In most cases, subjects were convinced that their abusive experiences were wrong; yet their strong ideal images of self (whose validity is completely dependent on pleasing the authority figure), and strong feelings of vulnerability and helplessness against the abuser have stopped them from confronting the abuser. Furthermore, they have internalised and identified with the abusive system, which has created a sense of helplessness towards systemic pressures. Emotional boundlessness and enmeshed, rigid relationships have added to the complexity of the scenario. In some cases, suicide is provoked by a failure of ‘splitting’ in the face of a traumatic event. Suicide, in such an instance, has become the ultimate defense against a flood of repressed and suppressed material that surfaces, creating too much anxiety for the person to bear.

In contrast to the conventional notion on motivation of suicide as instigated by the individual, the current study showed that external, social and developmental forces play a significant role in instigating as well as maintaining subjective motivation for suicide. The findings emphasise the importance for clinicians to look beyond current psycho-socio-pathology of a suicidal client, to recognise and address deep rooted, development-related concerns, dysfunctional personality traits and cognitive explanatory styles in order to construct more effective preventive and treatment interventions for suicide.
Epigraphical Evidence of Human Rights in Ancient Sri Lanka

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Documents asserting individual rights, such as Magna Carta (1215), the English Bill of Rights (1689), the French Declaration on the Rights of Man and Citizen (1789), and the US Constitution and Bill of Rights (1791) are the written forerunners to modern concepts of human rights. These rights exist as natural rights or as legal rights, in both national and international laws. Some believe that the idea of human rights was not known in the ancient world (Freeman, 2002). Despite this idea, the Hindu Vedas, the Babylonian Code of Hammurabi, the Bible, the Quran (Koran), the Analects of Confucius, the Inca and Aztec codes of conduct and justice are some of the ancient sources which deal with duties, rights, and responsibilities of people.

Studies of human rights that existed in ancient Sri Lanka is hitherto unknown. This paper examines inscriptions that record information on the concept of human rights which prevailed in ancient Sri Lanka. Data were collected from inscriptions recorded from all over the country. The selected inscriptions were from 1st century B.C. to 13th century A.D.

Among the findings, it can be seen that the ‘right to live’ (Article 3 Universal Declaration of Human Rights - UDHR) was practiced by the time of King Kassapa IV (963-980 A.D.), for example, the Kukurumahan-Damana pillar inscription mentions that “whoever have come for refuge shall not be arrested”.

It is seen in ancient Sri Lanka where the concept of human rights began to take a greater meaning. In the Badulla pillar inscription, it is stated “for fine that has been imposed, the master of a house may be taken [in restraint]; his wife or children shall not be taken in restraint”. This meets the terms with the prevention of arbitrary persecution of Article 5 UDHR.

The Devinuwara pillar inscription of Parakaramabahu II (1236 A.D.) complies with Article 10 and 11 of UDHR, i.e., ‘fair trial and to be innocent until proven guilty’. Accordingly, it states, “punishments shall not be inflicted or caused to be inflicted, for the mere reason that a charge of guilt has arisen, without investigating in accordance with the evidence and establishing the guilt” (Paranavitana, 1953).

In fact, there are fundamental differences between human rights today and in the past. Rights that spring from natural laws have been considered as natural rights of ancient times. Ancient inscriptions clearly depict that people should have rights regardless of their race, religion, ethnicity, nationality, age, and sex. This study shows that modern concepts of dignity and of equal and inalienable rights that are the foundation of freedom, justice and peace existed in ancient Sri Lanka. Most importantly, in ancient times, society has had systems of propriety and justice in addition to ways of administering to the health and welfare of the members of the country.
Library and Archive Management: Sustainable Air-Conditioning Technologies and Compliance with BS 5454

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British Standard (BS) 5454 requires maintaining specific indoor conditions for libraries and archives. Under this, maintaining a specific moisture content and temperature is of importance with regard to providing conditions that minimise deterioration of stored materials in archives, and comfortable environments for users. The technology involved in providing and maintaining required indoor conditions, depending on the geographical location and local climate, could vary from simple passive ventilation to sophisticated air conditioning systems, where the passive systems consume hardly any energy in providing the required conditions. On the contrary, a conventional grid-connected air conditioning system incurs significant carbon emissions and running energy bills.

With increasing awareness on environmental pollution resulting from use of energy, technologies with lower levels of carbon emission and higher operating efficiencies could be considered for sustainable operation of libraries and archives. In place of conventional vapour compression refrigeration-based air-conditioning systems that use grid power, technologies such as absorption refrigeration, desiccant cooling ventilation systems and evaporative cooling systems stand among suitable candidates. However, these technologies have certain limitations when it comes to their applications under certain climatic conditions, selection and use of energy source, and efficiency of operations.

Absorption technology uses heat, instead of grid power, to produce the cooling effect, whereas evaporative cooling depends on the energy in the atmosphere to provide specific levels of moisture and temperature in delivered air, which, to some extent, depends on the moisture level and temperature of outdoor air. Desiccant technology, to some extent, enables controlling of conditions of delivered air through an evaporative system mainly focusing on varying moisture content using a heat source.

If waste heat from a process is available, an absorption system could deliver cooling and air conditioning with zero-carbon emissions. On the other hand, even with a fossil fuel based heat source, absorption systems could provide 2/3 reduction in carbon emission in comparison with a similar capacity grid-connected air conditioning and ventilation system. The reductions in carbon emissions in the use of evaporative and desiccant technologies are substantial as they use alternative energy sources and generally have very low levels of power consumptions in comparison with grid-connected air conditioning systems.

On the theme of a low carbon solution for archive and library management, this paper discusses a few selected air conditioning technologies; which are established and emerging in the light of their operational limitations in delivering specified indoor conditions, and qualitatively discusses their conformity with the indoor conditions specified in BS 5454 for libraries and archives.
A Study of the Concept of “Killa” in Sinhalese Folklore and Literature

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Birth, puberty and death are considered as the main transitional events in human life. Everywhere in the world, people make various offerings to gods and worship them during these transitional periods. As these events or occasions are universal, such behaviour is not characteristic of any particular social sector. Most of these rituals are related to women. These special events and occasions are connected with blood and therefore, believed to cause pollution. Thus, out of fear and abhorrence of blood, the concept known as ‘killa’ or ‘pollution’ has emerged. In Sri Lankan society, events such as birth, puberty, menstruation and death are identified as taints. In addition, there are some other ‘kili’ or taints such as certain foods, liquor and cobras (‘naga’) among folk beliefs. Taints of death and food are accepted as common to both males and females.

This study aims to examine the concept and practice of the ‘killa’ or taint, as it is a major aspect in the folk culture of Sri Lanka. For this purpose, this comparative research project concentrates on the beginning of the [killa] taint, its chronological evolution, folk-tales and its practice in traditional and modern society. This research was conducted in the Thumpane and Kundasale Pradeshiya Sabha divisions to find out how the rituals connected with the concept of ‘taint’ are practiced at present. Data were collected on traditional and modern knowledge through interviews, case studies, and group discussions. From the information gathered, it was clear that there is still strong evidence that the concept of ‘kili’ is believed in traditional Sinhala society. Women, in a taint or polluted state, are strictly banned from attending religious and agricultural events, healing rituals and other occult practices. Therefore, women are not allowed to participate in such events. However, it was clear from secondary sources that an environment more tolerant towards women has evolved through the belief system on super-human forces. Folk tales such as Giri Devi and Dala Kumara have provided Sinhala society with knowledge and experience for developing these kinds of attitudes. Further, as a result, in traditional societies, an individual self-control as well as an informal societal control has been developed.

Due to developments in education and advancement in technology, the concept of [kili] taint is gradually disappearing in modern society. The ancient customs and beliefs woven around the concept of birth taint etc. have been rejected by the attitudes of the modern society, which in effect has led to conflicts in the social order. Similarly, belief in taints in agriculture too is being abandoned. There is, nevertheless, a feeling among villagers that this kind of disregard for customs and traditions has been the cause of diseases and failure in crops.

When people invoke gods in modern society for attaining multiple objectives and solving personal problems, they pay excessive attention to purity. Therefore, to have or to be with taints is considered as a disqualification for participation. People refrain from associating with everything connected with taints when they engage in cultural practices and rituals. Even though people have advanced in many fields, especially in education, they are still unable to free themselves fully from conventional beliefs and concepts.
Transformation of Public Space in Kandy City: History to Present

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Transformations that occur in public space with time, within a limited area can be seen both materially and non-materially. The concept of “public space” refers to a space of collective actions and collective encountering where people can be brought in to a verity of common worlds and thus, deals with common problems.

As long as Kandy city is concerned, the notion of “public space” has become a key aspect of its landscape. Both time and space, which are common to landscaping, deserve a significant place in the current study. Thus, the transformation of public space, which is a sub-class of landscaping, demonstrates a transformation of landscape at the same time.

The theory of “landscape as a theatre” is used in the study. Actors possess a special space in that context. The public space in a town is also somewhat similar to that context. We have imposed a limitation on the present study of public space in Kandy town based on the above mentioned theory. This study attempts to focus on: (1) how public space is designed; (2) how the existing public spaces are declining; and (3) how some public spaces are transformed. This study was conducted using a case study, interviews, references to historical resources, studies based on some earlier photographs and participatory observations.

The public space in present-day Kandy city has been subjected to a complicated transformation. The public space in the city has been changed based on neo-liberal economic ideologies. The most significant factor is the City Centre. The Dialog office, banks, KFC, Keells and Cargill’s supermarkets have emerged as new public spaces. It can also be seen that all the public spaces have been centred around one area depending on economic factors.
Exclusion of the Estate Residential Communities from the Pradeshiya Sabhas’ Service Delivery System: Causes and Consequences

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The Gam Sabha was the oldest Local Government System in Sri Lanka and the present system introduced in 1987 consists of three types of local government institutions: Municipal and Urban councils for urban areas and Pradeshiya Sabhas which covers rural and estate areas. The total population of 18.3 million of the country consists of 72.2% rural, 21.5% urban, and 6.3% estate sector residents. The estate sector has the characteristics of a rural scenario but has not been mandated to Local Authorities, in this case, Pradeshiya Sabhas, to serve them. Exclusion of nearly 2200 estate settlements and 0.9 million estate residents from the administrative purview and service delivery mechanism of Local Governments throughout its history is a major political and development issue in the country.

This study attempted to analyse the legitimate issues that Pradeshiya Sabhas face in extending their administration and services to the estate sector by using their funds and the legal limitations in the system. The Pradeshiya Sabha Act No 15 of 1987 was reviewed in this study and three Pradeshiya Sabhas, namely Nuwara-Eliya, Panvilla and Udapalatha were purposely selected to collect necessary information. Interviews were conducted with Pradeshiya Sabha members, officers and estate community and political leaders.

This study highlights that the major clauses of the present Pradeshiya Sabha Act was redrafted from the previous Village Councils Act which excludes estate residents being served from public funds. Clauses 2(1), 33, 18 (xiv), 18 (xxii) and 134 (4) of the present Pradeshiya Sabha Act states that every Pradeshiya Sabha can administrate only rural areas. The estate residential areas that are part of the estate business enterprises are considered as private entities and any part of Pradeshiya Sabha funds can be spent only on village and rural development. Further, they do not have the mandate to impose rates and taxes on estate residents, residential buildings and their properties because those are considered as built-up localities of estate enterprises. These clauses limit the legitimate mandate and powers of the Pradeshiya Sabhas extending their functions to the estate sector. Hence, estate residents remain as mere voters without entitlement to any services from local authorities. Exclusion of estate settlements from public service delivery leads to social, economic and political marginalisation of all estate communities and to a non-economic form of poverty among them. Therefore, institutional arrangements are necessary to enhance the effectiveness of local authorities as local level democracies in securing the rights of the estate residents to be provided with public service deliveries.

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Sustainable Consumption and Production: Awareness among the Undergraduates - A Case Study

Sustainable Consumption and Production (SCP) is an emerging concept which answers many global environmental problems. The most important feature in SCP is that it integrates the two sides of business: production activities on the supply side, and consumption activities on the demand side. Thereby, it can give rise to a complete and integrated picture of the overall impact of business on the environment. Furthermore, it acknowledges the importance of the interrelationships between business activities, political decisions, and everyday consumer behaviour. The most important aspect of SCP thinking is that it provides relationships between resources used during the development of products and services, the energy consumed during their use, and the protection of ecosystems – during the entire Life Cycle (LC) of a product or service. It can therefore, clearly identify areas having a significant impact on the climate, and consequently, highlight key ‘hotspots’ for intervention. Maintaining sustainability in both consumption and production phases is a responsibility of both consumers and producers. In the consumption phase, consumers are supposed to consume the product ensuring minimum damages to the environment while producers have a responsibility towards the effect on the environment when the product is consumed. The results of this research can be used to link the consumers and the producers to achieve more sustainable objectives in future. In this study, consumer awareness on SCP was taken into consideration. This was done by conducting interviews on undergraduates of the University of Peradeniya who possess similar educational qualifications but are specialised in different fields of study. From the findings, it can be seen that 61% were aware of the environmental issues faced by the world but only 21% believe that their buying patterns has a link to environmental issues. However, this was changed during the consumption phase, since 41% believe that there is an impact on the environment when they consume or use different items. It was seen that 47% agreed that they have to act in a responsible manner when they dispose used items to the environment and only 27% did not consider this as an important practice. In addition, there was a clear relationship between environmental consciousness and pollution issues with awareness being higher in biological and physical science stream undergraduates than in social sciences undergraduates. This may be due to the different attitudes inculcated in them during the learning process, as a science-based background is usually necessary when analysing an environmental issue. Furthermore, it has been revealed that local producers should be educated on a number of issues, since the majority are not aware of good environmental practices to be adopted by manufacturers and that consumers are willing to select products from manufacturers who practice these over other products. The following results of the study are of relevance to producers: (i) 48% revealed that they are not aware of the producer’s commitment towards environment protection and their responsibility towards society, (ii) 64% of the consumers stated that they are ready to select products from producers who are conscious about the environment and society among other competitive brands, (iii) 86% agreed that the eco-friendly level of a product should be included in the product specification given by the producer, (iv) 46% stated that they would like to see the level of eco-friendliness on a product as a colour-rating scale and (v) 67% of the consumers stated that displaying the eco-friendly level of a product would strengthen their decision to buy a specific product. In the next phase of this research, the producer end of this concept will be investigated to correlate findings and to provide suggestions to bridge the gap between the two ends.
Friendships among University Students: A Case Study of the University of Peradeniya

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There are different types of relationships among groups of students studying together. Among many facets of their relationships, one vital relationship is the category of friends. Undergraduate university students who are young adults are expected to initiate these types of relationships during their stay in the university. The study aims to describe the non-sexual relationships between students in the university in terms of numbers of friends in each sex and to describe themes of conversations they engaged in.

The study design is a descriptive cross sectional study. Study population was undergraduate students of the University of Peradeniya. The proposal was perused by the Board of Study in Psychiatry in Postgraduate Institute of Medicine, University of Colombo, Sri Lanka. A self-administered questionnaire which was developed in English was translated to Sinhala.

The median frequency of female friends among female university students is two, whereas the median for a male student having a male friend in the university is between two and three. Males seem to have more friends than the females. Approximately 7% of the sample claims that they do not solicit a friend of the same sex. Very few students have more than four friends on campus of the same sex. The most significant finding of the study is the extremely poor inter-sex interaction. Of the study population, 70% of males claim that they do not have a female friend, while 50% of the females claim that they do not have a male friend. Only 15% of the students revealed they have friends of the opposite sex.

In analysing student conversations, there are three categories of themes. Themes which are common to all categories which transcend the barrier of sex are making jokes and politics. The second category which is exclusively spoken within the same sex friends is about private matters. Themes completely spoken within male friends are to do with substances of abuse. There are no identified exclusive themes within females. The third category is the theme exclusively spoken within the opposite sexes. They are to do with common activities such as organizing trips or religious activities. Taking the above research evidence into consideration, it transpires that there is poor interaction within the undergraduate student body in mostly a resident campus. It is appalling that about 7% of the students claim not to have any friend. This indicates that for academic and social issues the students function in relative isolation. More than 50% of the female students not having friends in the opposite sex should not be disregarded as vanity. The social learning and the maturity one expects from a university graduate which is nurtured at the university is lost if this condition prevails.
Descriptive Study of Sexual Relationships Prevalent Within a University in Sri Lanka

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Intimate reciprocal relationships, which Erikson describes, do have a sexual nature. This means that relationships will entertain some form of sexual activity. Undergraduate university students who are young adults are expected to be intimate in these types of relationships. Though there are few studies in this area, a study carried out in University of Peradeniya in 1990 has given some insight towards the situation. Due to many sociological transitions, the current situation is different from what was observed 20 years ago at Peradeniya. The aims of this study are to describe the heterosexual and homosexual relationships prevalent among undergraduates in the university and to study the prevalence of vaginal intercourse among university students.

The study is a descriptive cross-sectional study. The study population was undergraduate students of the University of Peradeniya, who understand the Sinhala language. The proposal was perused by the Board of study in Psychiatry, of the Postgraduate Institute of Medicine, University of Colombo, Sri Lanka. A self-administered questionnaire, developed in English, was translated to Sinhalese, compared and used as the data collection tool.

Out of the students who reported heterosexual relationships, more than 75% have introduced their date to their parents. This rate is high compared to the findings in a previous study done at Peradeniya, which reported a rate of only 25%. Females introduced the date to their parents more than the males, according to the current study. These findings may indicate the stability of the relationship in terms of marriage as suggested by the previous study. This may also indicate the gradual social acceptance of love marriages. In contrast to this, homosexual relationships which were observed in this study were not informed to the family. This may reflect the prevalent homophobic nature of contemporary society. The prevalence of vaginal intercourse was calculated using direct and indirect questioning. The reason for this is that due to cultural constraints, students are prone to under-report vaginal intercourse. Therefore, this study reveals a range for the rate of vaginal intercourse which is 4-32% for the male students. The rate for the female students is 4-28%. Results indicate that there are very active sexual relationships among university students.
Health Care Provider Preferences among the Adults Residing in a Rural Area of the Kurunegala District

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The objective of this study was to identify where people go for initial treatment and the reasons for preferring one type of healthcare sector over the other. A descriptive cross-sectional study was carried out in April 2011 by using an interviewer-administered questionnaire. Written consent was obtained from the chief householder and ethical clearance was obtained from the Ethical review committee of the Faculty of Allied Health Sciences.

Hundred families were selected using simple random sampling in Meddegama - West Grama Sewaka division, Kurunegala district. Respondents were asked to prioritise a given set of reasons for choosing a specific health care sector on a scale of 1-6. Preference was calculated by applying unpaired t-tests with regard to the relevant variables.

The preferred first contact health care was private care providers (64%). Reasons for choosing the private sector were given as: first priority - fewer difficulties or being user friendly (P =0.001, CI = 1.79 to 2.83) second - short distance (P = 0.001, CI = 0.37 to 1.37), third - good relationship/ better rapport (P =0.000, CI = 0.70 to1.54) and fourth - high availability (P = 0.052, CI = -0.01 to 0.90). Low cost (P =0.000, CI = -3.47 to -2.68) and safety and confidence (P =0.000, CI = -2.26 to -1.08) were reasons for choosing the government sector.

The subjects preferred the private sector for trivial ailments such as gastrointestinal and respiratory diseases while choosing the government health sector for more serious illnesses such as cardiovascular and nervous system illnesses, mental illness and snake bites as they had greater confidence in the safety of the government sector.

Chief householders with formal education of ten years and above who comprised 85% of the study population chose private healthcare providers (70.6%). Social class 1 was not represented in the study population. Those belonging to social class 2, 3 and 5 preferred the private sector (75%, 76.9% and 69.6% respectively) while social class 4 preferred the government sector (51.9%).

Although government health care is free, even the poor preferred the private sector due to convenience and better rapport with the healthcare provider. However, the government sector has won the confidence of the people as being safer for serious illnesses.
POSTERS
Assessment of Interests, Attitudes, Future Aspirations and Socio- Economic Background of First Year Students of the Faculty of Agriculture

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Students who are selected to the Faculty of Agriculture, University of Peradeniya to follow the Agriculture Technology and Management degree programme (AgTec & Mgt), may have different aspirations to reach at the end of the study period. The level of satisfaction and attitudes after getting selected to the Faculty of Agriculture, and their motivation to study can vary depending on the expectations they had when they sat for the Advanced Level examination (A/L). Students come from various regions of the country representing different socio-economic backgrounds. Under the AgTec & Mgt degree programme students need to follow the first semester at Mahailuppallama Sub Campus located in Anuradhapura District. This study was conducted to assess (i) the level of satisfaction of students on their selection to the AgTec & Mgt degree programme, (ii) their preference to stay at Mahailuppallama, (iii) socio-economic background of students and their future aspirations, and (iv) possible associations (i.e. number of times A/L attempted, level of satisfaction, and intention for migration) with gender.

Students who entered in 2010 to follow the AgTec & Mgt degree programme were selected for the study (n = 180). Data were collected using a questionnaire survey and 151 students responded.

There were more female students (62%) in the batch than male students (38%). Most of the parents of these students were A/L qualified (42%) and monthly family income of 74% was below Rs. 20,000. A significant association was found between gender and level of satisfaction after selection to the AgTec & Mgt degree program. Among male students, over 67% was ‘highly satisfied’ while 28% was ‘satisfied’ regarding selection to the AgTec & Mgt degree program. Among female students, only 41% was ‘highly satisfied’ while 56% was ‘satisfied’ for their selection. Z scores of the students at the G.C.E. A/L examination was poorly correlated with their first semester Grade Point Average (G.P.A., \( r=0.182, p<0.026 \)). Percentage of male students who entered the University through their first attempt was higher (18%) than that of female students (7%). Irrespective of gender, over 70% of the students liked the program at Mahailuppallama while the rest (~30%) had a neutral feeling. A significant association between gender and intention for migration was observed. Among male students, 66% preferred local jobs while 34% preferred to migrate. However, for female students only 25% preferred migration over local jobs. Majority of the students (59%) preferred employment in the government sector while 34% preferred the private sector and only 5% preferred self employment. Therefore; it is important to develop attitudinal changes towards the private sector employment in university students while encouraging them to acquire the necessary technical and soft skills. Since Z score of the students was poorly correlated with their first semester G.P.A. it needs further attention.
B.Sc. Nursing Students' Perception of Problem Based Learning in the Adult Nursing Module

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The most commonly used pedagogy in Department of Nursing; Faculty of Allied Health Sciences (FAHS) is the conventional lecture method. Problem Based Learning (PBL) is a student centered instructional method, which uses well-structured problems as the context for student learning. PBL pedagogy can be introduced in many ways. Adult Nursing is a subject where creative thinking and problem solving of the learners is an important outcome. Thus, an attempt was made to incorporate PBL into the teaching programme and assess its receptivity.

A selected part of the Adult Nursing module 2 was carried out as PBL sessions for 2rd year B.Sc. nursing students. An introductory session on PBL process was held, followed by four PBL sessions. Students' perception of PBL sessions were obtained by a tailor-made 16 item questionnaire, administered at the end of the four sessions. The response rate was 61% (24 out of 39). Students' perception of the PBL process was highly positive. Most of the students (92%) agreed that PBL stimulates them to learn and it is an effective way of learning. Next most highly rated item was that PBL improved their critical thinking ability (82%). Students' perceptions of tutors were also positive. However, students' perception of peers was rated less positively than the PBL process.

Results of this pilot study showed that second year B.Sc nursing students' perceptions of PBL method were very positive and they consider PBL as an effective way of learning. Therefore, it is desirable to organise more PBL sessions in the B.Sc. nursing curriculum.
Information on Meteorological Observatories in Sri Lanka

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The systematic official Meteorological station network of Sri Lanka was established in 1865. At present there are 22 main Meteorological Observatories, 38 Agro-Meteorological stations, 35 Automatic Weather Stations (AWS) including some main Meteorological Observatories, and more than 500 rain-gauges maintained by the Colombo main Meteorology Department, various Governmental Organizations (GOs) and Non Governmental Organizations (NGOs) across the country.

Many university researchers obtain climatic data from the above stations for conducting climate-related studies on Sri Lanka. The Department of Geography of the University of Peradeniya offers climate related courses for undergraduates as well as postgraduates. It is very important to obtain accurate and up-to-date climatic data (period of the climate data availability, type of climatic parameters and the observation areas) for these purposes. As there is no proper climatic data information available even in the Meteorology Department at Colombo, obtaining up-to-date climatic parameters is very difficult for students as well as staff at the University of Peradeniya when they carry out climatic studies. Therefore, the main objective of this study was to make a small pamphlet of climatic observations based on the data collected from various reports, websites, field observations, and discussions with relevant officers of the observation stations. Based on this information, and up-to date information pamphlet was prepared, fulfilling the main objectives of this project.

The prepared pamphlets will be used as teaching material for the relevant courses at the Department of Geography. Copies of the pamphlet will be distributed free of charge to Geography students, some selected Meteorological Observatories visited by the author, Main Library of the University of Peradeniya, library of the Geography Department, and researchers at the University of Peradeniya and other institutions who require this information. This information could be up-dated by the author regularly.
Animal Bites and their Management with Reference to Rabies Prevention in a Sri Lankan Rural Population: A Preliminary Survey

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Rabies is a deadly viral infection transmitted by animal bites. More than fifty deaths occur due to rabies in Sri Lanka annually while a large number of animal bites are reported daily. Anti-rabies vaccination given to animal bite victims is costly for a developing country. Therefore, the aims of this preliminary hospital survey were to describe the types of animal bites and their management with reference to rabies prevention in a rural population in Sri Lanka.

All animal bite victims presented on the same day of each week from January 6th to February 10th, 2010 (six consecutive Wednesdays) at Mahiyanganaya base hospital, a leading referral centre in Uva province of Sri Lanka, were interviewed using an interviewer-administered questionnaire. Details of wound management with reference to rabies prevention also were recorded. Frequencies and associations were determined statistically.

A total of 55 animal bite victims [32 (58%) males, 23 (42%) females] in an age range of 2 - 60 years were recorded during the study. Of them, 19 (34.5%) were below 16 years. There were 12 (22%) upper limb bites and 42 (76%) lower limb bites. One child patient had sustained a bite on the genital area. Moreover, 18 (33%) patients had past history of animal bites while 19 (34.5%) stated that at least one family member had experienced an animal bite. There were 43 (78%) dog bites and 12 (22%) cat bites accounting for 14 (25.5%) major wounds and 41 (74.5%) minor wounds. Dog bites showed an association with males (Fishers' exact test = 0.04, P = 0.05). Furthermore, 37 (67%) were provoked bites. Only 14 (25.5%) animals had been vaccinated and 44 (80%) were observable. Eleven bites (20%) were caused by stray animals. Anti-rabies vaccine (ARV) was given to 54 victims. Both ARV and anti-rabies serum (ARS) were given to 06 patients. One person was subjected to post-exposure therapy (PET) delay. Notably, 36 (65.5%) patients presented to the hospital within 24h. All had cleaned the bite wounds with soap and water.

In conclusion, males in this community are commonly affected by animal bites particularly caused by dogs. The commonest site affected by animal bites is the lower limb. Dogs and cats were the only animals that caused bites during this study. Experiencing animal bites in several occasions by the same patient and at least one family member of each patient receiving an animal bite may indicate that animal bites are a common problem in this community. In addition, many were provoked bites due to unvaccinated animals leading to ARV and ARS therapy. Although a big proportion seeks early medical treatment there are late comers. People should be educated on the importance of preventing animal bites, vaccinating animals and receiving early treatment for prevention of rabies.
Relationship between Survival and Histopathological Grading in a Group of Patients with Mucoepidermoid Carcinoma

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Mucoepidermoid carcinoma (MEC) is defined as a malignant epithelial neoplasm of salivary gland origin showing diverse clinical behaviour. Armed Force Institute of Pathology (AFIP) grading system is based on histopathological evaluation of five features. These features; namely, intra-cystic component of less than 20%, neural invasion, necrosis, four or more mitotic figures per ten high-power fields, and cellular anaplasia; are used to divide the MECs into three types: low, intermediate and high grade. Therefore, the objective of the present study was to analyse whether survival data obtained for the group of 34 patients affected with MEC correlates with the AFIP grading obtained for each patient.

The study sample consisted of thirty four patients with MEC. Hematoxylin and eosin stained slides were used to re-grade according to the criteria specified in AFIP grading. Follow-up data, namely, survival in months and the outcome i.e., whether the patient had died due to disease or whether the patient is living with or without disease was obtained by sending a questionnaire to the patients/relatives.

AFIP grading revealed 73.5% (25/34) of patients with low grade tumours. Approximately, 2.94% (1/34) and 23.52% (8/34) were intermediate and high grade tumours. The overall survival of the patients ranged from 4 to 108 months (mean = 24.11, median = 13). Recurrences were significantly more common in patients who had high grade tumours (chi-square test; p = 0.004). Overall disease specific five year survival of the patients included in the study sample was found to be 78%. At the end of the followup period (5 - 108 months) five patients had died due to the disease. Out of these patients, four patients had high grade tumours while one patient had a low grade tumour. The mean survival time for low, intermediate and high grade tumours were 27.64, 16 and 14.12 months, respectively.

In conclusion, histopathological grade was found to carry prognostic significance for patients with MEC. As low grade tumours could also rarely behave in an aggressive manner, further studies using gene expression and molecular markers may be required to predict the behaviour of MECs with 100% accuracy.
Over Expression of Manganese Superoxide Dismutase in Human Colon Cancer Cells Prevents Atpenin A5 Induced ROS Production from Mitochondrial Complex II

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Mitochondrial complex II is conventionally known to be a key enzyme in tricarboxylic acid cycle and the aerobic respiratory chain and catalyses succinate ubiquinone reductase (SQR) activity. Reactive oxygen species (ROS) produced from defective mitochondrial complex II are identified as a potential cause of carcinogenesis. In addition, ROS produced from the normal mitochondrial complex II are reported to induce hypoxia reperfusion injury. Therefore, it is important to understand the mechanisms of ROS production from mitochondrial complex II (Chen et al., 2007; Ni et al., 2008). Even though some studies have been conducted on ROS production from mitochondrial complex II in human cell lines using the complex II inhibitor theonyl trifluoro acetate (TTFA) and RNA interference (RNAi) to inhibit its activity, the results are controversial (Guzy et al., 2008; Cervera et al., 2008).

Therefore, we studied ROS production in human cell lines (colon cancer cells DLD-1 and HT-29) using a new complex II inhibitor- atpenin A5. In this study, superoxide ($O_2^-$) production from the mitochondrial complex II in intact cells was detected using Mitosox Red oxidation and verified using pharmacological ROS scavengers. Objective of the present study was to over express the specific mitochondrial $O_2^-$ scavenging enzyme- manganese superoxide dismutase (MnSOD) in human colon cancer cells before addition of atpenin A5 in order to confirm the atpenin A5 induced superoxide production from human mitochondrial complex II.

Manganese superoxide dismutase (MnSOD) cDNA was prepared from human cells, cloned into the pCMV script expression vector and MnSOD enzyme was over expressed in the mitochondria of the human colon cancer cell lines before adding atpenin A5. The results revealed that over expression of human MnSOD in colon cancer cells can abolish the atpenin A5 induced, complex II dependant Mitosox Red oxidation. Thus, atpenin A5 induced Mitosox Red oxidation in colon cancer cells is due to $O_2^-$ originating from mitochondrial complex II. This finding broadens our understanding on ROS production from human mitochondrial complex II and may provide an insight to management and treatment of diseases associated with a defective complex II.
Dental Root Transparency as an Indicator of Age Estimation in a Sri Lankan Population

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Estimation of age using dentition is an important sub-specialty of forensic sciences. In young people, the estimation of age at death can be done by the stage of development of the deciduous and permanent dentition using radiological or histological techniques or using a combination of both these techniques. Beyond young adulthood, the problem of estimation of age becomes considerably more difficult. In order to determine the age of this group a method was developed by Gustafson in 1950. The method is based on six age-related changes in dental tissues. Measurement of the translucent dentine (TD) is one of the most reliable six factors of Gustafson’s criteria. The objective of this study was to assess whether TD is a reliable factor for estimation of age in Sri Lankan Population.

The sample of teeth included 45 in total (27 males and 18 females). Teeth were collected from individuals who sought dental care at the Dental Hospital, Peradeniya and General Practices in and around Kandy city. Teeth selected belonged to individuals of Sinhala ethnic group in the age range of 24 to 81 years. Ground sections of teeth were prepared by the half tooth technique using hard tissue microtome (Leica, SP 1600). Maximum height of the TD was measured at four-time magnification (X4) with the help of a calibrated eyepiece micrometer graticule (linear) under transmitted light in both buccal and lingual side. Regression line was developed for age versus length of the TD and length percentage of TD.

When length and length percentage of TD were examined there were significant differences in the amount of TD present relative to the age ($r^2=0.309$, $P<0.001$ and $r^2=0.268$, $P<0.001$ respectively). Furthermore, the points plotted were more closely grouped around the regression line in length of TD than length percentage of the TD versus age. Therefore, the tendency of TD to increase with age was more obvious when the length of the TD than length percentage of the TD was plotted against age.

The present study concludes that both TD and percentage of TD of the root can be used for estimating the age of an individual.
Histopathological Parameters to Overcome the Diagnostic Dilemma of Oral Lichen Planus and Lichenoid Reactions: A Preliminary Study

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Oral lichen planus (OLP) and oral lichenoid reactions (OLR) are two conditions with identical clinical and histopathological features, which occur without and with known triggering factors respectively. Although, some characteristic histopathological features of either condition do exist, such features were believed to be unreliable when making a distinction between these two oral conditions. Therefore, the aim of the present study was to characterise histopathological parameters and to ascertain their value in differentiating OLP from OLR.

The study sample comprised of 51 patients with OLP and 20 patients with OLR. Clinical diagnosis of OLR was arrived at by considering the relevant drug history or identifying the presence of dental restorations (amalgam) in contact with the lesion. Patients with a history of betel chewing or smoking were excluded from the study. Known features of epithelium and connective tissue which could be used to distinguish the two lesions were evaluated using Hemotoxylin and Eosin stained sections. In addition, mast cell distribution and thickness of basement membrane were also evaluated. Statistical analyses were performed using Chi square tests and Fishers’ exact tests.

The mean age of the patients with OLP and OLR were 43.83 years and 52.5 years respectively. Approximately, 90% (45/51) of the OLP patients were females. Female: male ratio for the OLR sample was 1.2:1. Results revealed that saw tooth like rete morphology was more frequent in OLP samples compared to OLR (P<0.01). Presence of plasma cells in the inflammatory infiltrate (P<0.01), thicker inflammatory cell infiltrate (P<0.01) and perivascular inflammatory infiltrate (P<0.01) were more frequent in OLR samples than OLP. No significant differences were observed in the mast cell distribution or thickness of the basement membrane between the two groups. Other features, which are more supportive of skin LR such as focal parakeratosis or apoptotic bodies extending in to the whole thickness of the epithelium, did not show diagnostic significance for the OLP. In conclusion, the present study confirms the value of some previously known histopathological features in the differentiation of OLP from OLR. Although a previous study has indicated that increased number of sub epithelial mast cells, vascularity and basement membrane thickness as supportive of a diagnosis of OLP, similar findings could not be demonstrated in the present study.
SMS-based Home/ Industry Automation System

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Most existing home or industry automation systems are either remote controlled or task-scheduled. In such systems, IR and RF techniques are commonly used where the control distance is limited. The task-scheduled systems carry out actions that are predefined by the user at an earlier time, hence, the real-time controllability of the system is not utilised. Therefore, the requirement arises to analyse ways to build a system that has the capability to be controlled from any distance with real-time controllability.

This paper presents the design and implementation of a SMS-based remote monitoring and control system for home and industrial systems, focusing on the analysis of delays in the system to examine the capability of a real-time controllability. With this approach, communication is not limited in range except in a case where the user is out of mobile coverage. The SMS based system installed at user premises consists of a mobile phone, a main controlling unit and circuit modules designed for monitoring and controlling tasks. The user can monitor the current status of user system and control them by sending a predefined SMS.

The communication between the system and the user is achieved through the user’s mobile phone and another mobile phone stationed in the system at user premises. Therefore, only an operating mobile connection (i.e. a valid SIM card) is needed for communication. As the design is not limited to a particular commercial mobile connection the system and the user can have different mobile connections. To protect the system from unauthorised access, several authentication processes are introduced. Once the system receives a SMS from the user, it identifies the user requirement and carries out a task accordingly. Different types of sensors are stationed at user premises to get the alarms. When a predefined event occurs, the system will inform the user via SMS and any user control actions send by the user will be implemented.

The controlling cost is further reduced by embedding multiple control commands in a single message. The design is unique in its methodology that it is not limited in the number of individual devices that can be controlled. Since the operation of the system is based on a programmable microcontroller, the type of controllability and the types of alarms the user needs to receive can be configured according to the user’s choice.

The proposed methodology was tested using a commercially available mobile phone and results showed an acceptable reliability for various mobile connection vendors. The analysis on delays in receiving an alert by the user or the user system acting upon a received a control command showed some variations for different mobile connections. Modelling these errors and introducing a feedback mechanism serve the purpose of approaching a real-time controllability.
A Method for Facilitating Student – Teacher Communication

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A common problem observed in medical students is the reluctance to ask questions from lecturers/teachers in common forums like lectures and discussions. The objective of the current study was to introduce a method of communication that is both non-threatening and acceptable to the students, requires minimum infrastructure and can record students’ feedback.

A magi board was fixed in the department with an attached pen. The students were informed that this board was available for them to write any difficult words and areas that they had encountered during the teaching sessions. Answers were written by the academic staff. Feedback on the method was taken from students after five months. The initial board used proved to be inadequate for the queries written and a larger board had to be introduced within two months indicating that while students took some time to get accustomed to it, they began using it more after a while.

Written anonymous feedback taken from 2nd year students (n=30) showed the following results: 86.7% of students liked the board while 10% neither liked nor disliked it. While only 56% had made use of the board to write a question, 96.7% had learned something from it. A majority (83.3%) of students wanted the board to continue while 16.7% were not sure. However, none of the students wanted the board discontinued. The majority of the students (66.7%) found the board useful while 26.7% found it very useful.

The two most common reasons for not asking directly from a lecturer were feeling shy to ask questions (43.4%) and having no confidence in English (36.7%). The other reasons were that they had no time or that they couldn’t find the lecturer. Many students (66.7%) preferred this method of communication to direct contact while 26.6% were not sure. Only 6.7% preferred direct communication with the lecturer. Ninety percent of students indicated that they would like to have similar boards in other departments as well. While 50% of students felt that the board did not reduce communication with lecturers, 33.4% were uncertain and only 16.6% felt that it did. The suggestions for improvement are using a bigger board, using more diagrams, and explaining the difficult words and concepts at the lecture hall. Some students indicated that they were too shy to even write on the board and therefore suggested a box for students to put questions.

This simple method of communication is a useful tool from the students’ perspective. There is room for improvement and further innovation in this area as we need to adjust the tools that we use for communication to the students needs.
Help-Seeking Behaviour of Intimate Partner Violence according to Socio-Demographic Aspects in Central Province, Sri Lanka

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Intimate partner violence (IPV) occurs between a victim and perpetrator who are current or former spouses/partners. Prevalence of intimate partner violence is high in Sri Lanka. However, women’s dependence on marriage, lack of educational, occupational and financial resources and responsibility for their children limit their ability to end violent relationships. Very few studies have been conducted in a Sri Lankan context regarding help-seeking behaviour of victims of intimate partner violence. The objective of the present study is to identify help-seeking behaviour of intimate partner violence according to socio-demographic aspects in a Sri Lankan context.

Data were collected from 129 patients of IPV admitted to Teaching Hospital Peradeniya and General Hospital Kandy with informed written consent of the patients. Information was entered to a questionnaire by the authors. The data was analysed focusing on the socio-demographic factors and help-seeking behaviour.

All cases of intimate partner violence in the present study were of the female sex. Majority were married couples (90%). Thirty three percent were between the ages of 31-40 years. Twenty six percent were educated up to advanced level. Most of the victims (64%) were financially dependent on the other partner. Sixty six percent did not report a family history of spouse abuse while in 25% of accused partners and 8% of victims a family history of spouse abuse existed. Out of them, 69% had complained to the police but only 29% had undergone previous interventions. The victim’s confidence in legal authorities’ decreased with increasing number of lodged police complaints with the highest percentage of confidence (93%) reported with two police complaints. Considering the current episode, 43% stated that the reason for admission to hospital was for security. Regarding future plans, 60% stated they would accept the other partner while only 8% mentioned to wanting legal separation or divorce.

The results indicate that females are the vulnerable group in this context. Majority are married couples which may be due to the fact that living together is not culturally accepted in Sri Lanka as in western countries. Although previous studies have shown that the commonest age group involved is between 20-29 years age, this study reveals that it is between 31-40 years in a Sri Lankan context. Research in other countries points out that women’s financial dependence limit their ability to end violent relationships. This was further highlighted in our study. In western countries with mandatory arrest policies in spouse abuse, the arrest rates and victim satisfaction with the system is high. However, in Sri Lanka, the number of previous interventions was low though the frequency of police complains was high. The confidence in police decreased with higher number of complaints.

In conclusion, majority of victims were between 31-40 years, unemployed, financially dependent on their spouses. Only a minority had undergone previous interventions and many accept their partner.
The Final-Year Learning Environment at Faculty of Medicine, Peradeniya as Perceived by a Group of High-Achieving Students

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The educational climate/environment has a strong influence on effective student learning. A number of instruments are available for measuring the educational environment and Dundee Ready Education Measure, which is known as DREEM is one such instrument that has been used by many medical schools in the world.

This is an attempt to document the perceptions of a group of newly graduated students of the Faculty of Medicine, University of Peradeniya (FOMUP) about their final year learning environment. The original English version of the DREEM with minor modifications enabling better comprehension was administered to a sample of students soon after the final examination, pending results. This version consists of 50 items each scored 0-4 on a 5 point Likert scale; 0 = strongly disagree while 4 = strongly agree, resulting in a maximum score of 200. Nine items (identified to be negative statements) were marked in reverse, so that a low score on any item would indicate negativity. The sample included high achieving students and the total and subscale scores were computed and interpreted according to the DREEM interpretation guide of McAleer and Roff.

The overall mean score turned out to be 121/200 and was higher than those reported by previous Sri Lankan studies. When the item-wise mean scores were considered it was > 3 for the items: ‘I am encouraged to participate in class’; ‘The teachers are knowledgeable’; ‘I have good friends’; ‘the teaching helps to develop my competence’; ‘my social life is good’; ‘I have learned a lot of empathy in my profession’; ‘much of what I have to learn seems relevant to a career in healthcare’; and ‘my accommodation is pleasant’. The mean scores were < 3 for the following: ‘The teachers ridicule the students’; ‘the teachers are authoritarian (teacher centered)’; ‘the teachers are good at providing feedback to students’; ‘the teachers get angry in class’; ‘the students irritate the teachers’; ‘I am able to memorise all I need’; ‘the atmosphere is relaxed during ward teaching’; ‘cheating is a problem in this faculty’; ‘the enjoyment outweighs the stress of the course’; ‘this course is well timetabled’; ‘there is a good support system for students who get stressed’; ‘I am too tired to enjoy the course’. When the results were combined into subscales, their mean scores and interpretation, according to the DREEM interpretation guide were, ‘Students’ perception of learning’ (31.08/48): A more positive perception, ‘Students’ perception of teachers’ (25.31/44): Moving in the right direction, ‘Students academic self perception’ (19.02/32): Feeling more on the positive side, ‘Students’ perceptions of atmosphere’ (27.37/48): A more positive atmosphere and ‘Students’ social self perceptions’ (17.22/28): Not too bad.

It can be concluded that the final year learning environment at Faculty of Medicine, University of Peradeniya, is more positive than negative. The overall mean score as well as the mean scores of most of the inventory scales, although placed one step below the ideal score, were also higher than those reported by the previous Sri Lankan studies. The strengths of the programme are the teachers being knowledgeable and being helpful to develop competence among students. Students also endorsed that they were encouraged to participate in class, and the programme was very relevant. However, students had concerns over the conduct of teachers in relation to student teacher interactions such as giving feedback and providing a relaxed learning environment.
Spectrum of the Diagnostic Yield of Cystoscopy in the Evaluation of Haematuria: A Hospital-based Study


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Haematuria is a common condition confronting clinical urologists. Majority of patients with haematuria are found to have significant underlying pathology, with many having a urological malignancy. Cystoscopy is a valuable investigation in evaluating the lower urinary tract of such patients. The objective is to study the spectrum of the diagnostic yield of cystoscopy in the evaluation of haematuria in a local population.

This is a descriptive study of patients referred for cystoscopy in the evaluation of a lower urinary tract cause for haematuria at the Surgical Unit of Teaching Hospital Peradeniya, from August 2008 to August 2011. All were having normal renal function tests. Patients with known bladder carcinoma, upper urinary tract or systemic causes for haematuria were excluded. Patients’ clinical details and cystoscopic findings were recorded in a pre prepared data sheet.

A total of 52 patients were included in the study group with a mean age of 53 (SD=16) years. Of the study population, 76.92% (n=40) were males and 23.07% (n=12) were females. Of the sample 51.92% (n=27) had abnormal cystoscopy findings while 48.0% (n=25) had no abnormality detected in cystoscopy. Majority of patients (n=18, 72%) with normal cystoscopy findings were below 50 years of age while n=7 (28%) were above 50 years. Of the patients with normal cystoscopy findings n=20 (74.98%) were above 50 years of age while n=7 (25.02%) were below 50 years. Among them 33.32% (n=9) were having malignant lesions while 66.68% (n=18) had benign lesions. Out of male subjects, n=23 (44.2%) had abnormal cystoscopic findings while in n=17 (32.69%) were normal. Of the abnormalities n=7 (13.46%) were malignant lesions (bladder carcinoma) while n=16 (30.76%) were benign. The commonest benign lesion was prostatomegaly (n=7, 13.46%) while prostatitis was found in n=5 (21.7%) and cystitis, urethral stricture, meatal stenosis and highly vascular prostate accounted for n=1(1.9%) each. Out of female subjects n=4 (7.6%) had abnormal cystoscopic findings while in n=8 (15.38%) it was normal. Among abnormalities, bladder carcinoma and cystitis were found in n=2 (3.8%) each.

Cystoscopy yields diagnostic information in more than 50% of patients with haematuria in the assessment of lower urinary tract. These lower urinary tract pathologies were detected commonly in subjects above 50 years of age and those who were males. Eighteen percent of the study group was found to have bladder malignancies. Thus, this study reconfirms the view that cystoscopy is an essential and productive investigation for the local patients with clinical presentation of haematuria.
Turner’s Syndrome: A Case Report

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Turner’s syndrome is the most common sex chromosomal abnormality in females. This occurs due to complete/ partial absence of the second X chromosome or presence of a functionally defective second X chromosome in XX genotype due to fragmentation, deletion, ring formation, isochromosome or expression problems. In placental mammals, one functional X chromosome is maintained and any additional X chromosome is heterochromatinised randomly (Barr Body). Therefore, conventional XO genotype in Turner’s will be reflected as absent Barr Bodies. The two features that best characterise this condition are gonadal dysgenesis and short stature. However, there may be features like neck webbing and cubitiaus valgus deformity which are not constantly seen in all diagnosed Turner’s cases even though similar chromosomal defect is detected. Here, we present two sisters with proportionate short stature who were referred for sex chromatin analysis.

The two sisters were 6 and 4 years of age and both of them were well below the 3rd centile for age and sex specific height. The younger sister had neck webbing and cubitus valgus deformity where as the elder sister did not have any dysmorphic feature. Younger sister also showed some features of nutritional deficiencies and markedly delayed skeletal age with a global development delay. Ultrasonically, their uteri were normal but ovaries were poorly visualised. Barr body analysis revealed abnormally large heterochromatinised X chromosomes with a high count in both sisters.

A diagnosis of Turner’s syndrome may be suspected when there are a number of typical physical features observed. The Noonan’s syndrome too could be considered in the differential diagnosis as it has a similar phenotype. In the present study, sex chromosomal monosomy and mosaicism can be excluded with the findings in Barr body analysis and an abnormally large sex chromatin may suggest an isochromosome. The delay in the bone age too possesses a diagnostic dilemma in the younger child. Short stature in children may occur due to different reasons. However, it is important to do sex chromatin studies even though dysmorphic features are not apparent. Similarly in a Turner’s syndrome patient, it is important to investigate for other contributory causes for the clinical findings which may be treatable.
Development of an Online Assessment System

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The staff at the Information Technology Centre (ITC) is responsible for assessing a large percentage of the students of the University of Peradeniya in the subject of introductory computing. Additionally, the ITC conducts recruitment tests that aid in the employment of staff to various categories and levels of the University system. Such tests include a wide variety of subjects such as basic computer literacy, more advanced computing principles, IQ and general knowledge. Therefore, the number of assessments conducted by the ITC in a given year is very large. When considering the large number of participants undertaking some of these assessments, the burden on the limited staff at the ITC is immense. This paper investigates the design and development of an online assessment system to enhance the efficiency of the staff at the ITC when conducting such tests.

The online assessment system consists of three different front ends: the teacher interface for entering questions, the teacher interface for managing tests and the test-taker interface for the actual assessments. The interface for entering questions allows entering, modifying and deleting questions to a common question bank. These questions are classified according to category and difficulty level. The interface for managing tests can be used to automatically or manually select test questions for a particular assessment based on the categories and difficulty levels. It also allows managing the test takers and storing their final marks into a Microsoft Excel file. The test-taker interface is a simple web interface where the correct answer for each question can be selected before finally submitting the test.

The online testing system has been used in many tests at the ITC and attempts have been made to correct any identified limitations. This system of conducting online tests has increased the reliability and functionality since it has made test generation to suit the intended audience, it is very convenient and very efficient in processing results as grading is fully automated. The reliability of the testing system has been very good apart from hardware and networking-related technical issues that may temporarily exist in general purpose networked computer systems. Overall, it has proved to be of great value to the Information Technology Centre of the University of Peradeniya in order to help the staff members conduct a large number of tests in a very efficient manner.
Synthesis, Investigation of Acid Base Properties and Carbon Dioxide Trapping Capability of Nickel-1,2-diaminobenzene-2,4-pentanedione Complex

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Nickel-1,2-diaminobenzene-2,4-pentanedione complex was synthesised by the template synthesis method. It was characterised by UV-visible spectroscopy, cyclic voltammetry and FT-IR techniques. The CO₂ trapping capability of this complex was studied by VenireLabPro CO₂ Gas Sensor by measuring the amount of CO₂ transmitted through the Ni complex and the starting material, nickel acetate, in an ethanolic solution. Sixty percent CO₂ was absorbed by the complex as compared to the starting material. The UV-Visible spectrum of the Ni(II) complex in ethanol showed bands at 269 nm, 393 nm and 583 nm. These bands disappeared and new bands were formed giving isobestic points around 625 nm, 240 nm, 260 nm and 290 nm on the stepwise addition of H⁺ to the solution. Cyclic voltammetry analysis was carried out to understand the catalytic activity of the Ni(II) complex towards CO₂. Under N₂ atmosphere, the Ni(II) complex showed a reversible band corresponding to the Ni(II)/Ni(I) redox couple. This band was shifted towards the positive direction in the presence of CO₂.
Synthesis of Copper(II) Complex of [5,12-dioxa-7,14, dimethyl-1,4,8,11-tetraazacyclotetradeca-1,8-diene(L)] and Determination of its CO₂ Binding Properties

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Copper(II) complex of [5,12-dioxa-7,14, dimethyl-1,4,8,11-tetraazacyclotetradeca-1,8-diene(L)] was synthesised using template synthesis and characterised by UV-visible spectroscopy, X-ray fluorescence spectrometry, cyclic voltammetry and FT-IR techniques. CO₂ trapping capacity was studied with Vernier CO₂ gas sensor, which was capable of measuring the amount of CO₂ emitted from the sample. The solid Cu(II) complex shows higher CO₂ absorbance as compared with the solid starting material CuCl₂. In the UV analysis, intense blue aqueous solution of the copper complex turns green with dropwise addition of 0.10 M HCl. Addition of 0.10 M NaOH to the same solution turns back to the original color gradually. The intensity of the peak at 250 nm decreases with the addition of acid. This behaviour is reversed with the addition of 0.10 M NaOH. The spectral changes with an isobestic point at 350 nm imply the protonation and deprotonation of the tetraazamacrocycle without distorting the geometry of the complex.

When comparing the FT-IR spectra of Cu(II) solid samples, IR data for the complex are similar to the reported data for similar complexes. The shifts of the complex compound for C=N and N-H modes are found in the regions of 1590-1600 cm⁻¹ and 3250-3280 cm⁻¹ respectively. The shift in the N-H mode along with the appearance of new bonds in the region 450-470 cm⁻¹ assignable to Cu-N vibrations, suggests that imides nitrogen is coordinated to the metal ions. The Cu-O bond, which appears in 500-550 cm⁻¹, indicates that the imides oxygen is non-coordinating. Cyclic voltammetric studies were carried out to reveal the catalytic activity. Under N₂ atmosphere, CV of the Cu(II) complex showed a reversible band corresponding to Cu(II)/Cu(I) redox couple. When the DMSO solution of the complex is saturated with CO₂, the current intensity of the oxidation peak disappeared. The reappearance of the original reversible redox band with passing N₂ may be indicative of its catalytic activity towards CO₂.
Spectroscopic Evidence for the pH Sensitivity, Anion Trapping and CO₂ Binding Properties of N, N’-ethylenebis (acetylacetoniminato) Nickel(II) hemihydrate Complex

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N,N-ethylenebis (acetylacetoneiminato) nickel (II) hemihydrate complex was synthesised using template synthesis and characterised using UV-visible spectroscopy, cyclic voltammetry and FT-IR techniques. CO₂ trapping capacity was studied with Vernier CO₂ gas sensor which is capable of measuring the transmitted amount of CO₂ (in ppm) from a sample within specific period of time (in seconds). The solid Ni(II) complex shows about 50% more CO₂ absorbance compared with the solid starting material Ni(CH₃COO)₂ at a level of 1×10⁻⁴ moles of each solid sample. Ni(II) complex in methanol shows bands between 200-900 nm with the extinction coefficients ranging from 1.84 × 10⁴ M⁻¹ cm⁻¹ to 104 M⁻¹ cm⁻¹. The band at 267 nm shows a red shift with the addition of 0.05 M HCl acid and disappears with the addition of 0.05 M NaOH. With continuous addition of acid and the base, an intensity decrease was observed for the band at 235 nm while an intensity increase was observed for the band at 307 nm giving isobestic points at 278 nm and 339 nm. This is observed when a chromophoric precursor is quantitatively converted into a single product.

When comparing the FT-IR spectra of Ni(II) solid samples, the sample exposed to CO₂ for 5 hours shows a new band which arises around 2900 cm⁻¹. Though the interpretation of this mode is not that straightforward, it may be due to the vibrational changes of the CO₂ molecule, after association with the Ni(II) complex.

Cyclic Voltammetric studies were carried out to reveal the catalytic activity of Ni(II) complex towards CO₂. Under N₂ atmosphere CV of the Ni(II) complex showed a reversible band corresponding to Ni(II)/Ni(I) redox couple. When the DMF solution of the complex is saturated with CO₂, the current intensity of the oxidation peak disappeared with increasing current intensity of the reduction band. The reappearance of the original reversible redox band corresponding to Ni(II)/Ni(I) redox couple by passing N₂ may be indicative of its catalytic activity towards CO₂.
Determination Of CO$_2$ and SCN$^-$ Binding Capacities of [5,12-dioxa-7,14,dimethyl-1,4,8,11-tetraazacyclotetradeca-1,8 diene(L)] Co(II) Complex

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Cobalt(II) complex of [5,12-dioxa-7,14,dimethyl-1,4,8,11-tetraazacyclotetradeca-1,8-diene(L)] was synthesised using a template synthesis and characterised using UV-visible spectroscopy, cyclic voltammetry (CV) and FT-IR techniques. CO$_2$ trapping capacity was studied with a Vernier CO$_2$ gas sensor capable of measuring the transmitted amount of CO$_2$. The solid Co(II) complex shows more CO$_2$ absorption than that of solid starting material, CoCl$_2$.

In UV-visible spectroscopic analysis, the intensity of the orange colour in an aqueous solution of the complex increases with the addition of 0.1 M potassium thiocyanate solution to the metal complex. The intensity of the d-d band at 500 nm decreases while the intensity of CT band around 210 nm increases. This occurs through an isobestic point at 260 nm indicating a SCN$^-$ association to the complex and FT-IR data confirm the presence of the desired complex.

Cyclic voltammetric studies of the Co(II) complex shows a reversible band corresponding to the Co(II)/Co(I) redox couple. When the DMSO solution of the complex is saturated with CO$_2$, the current intensity of the oxidation peak disappears and that of the reduction peak slightly increases. The reappearance of the original reversible redox band after passing N$_2$ may be indicative of its affinity towards CO$_2$. Reduced Co(I) centre of the complex may coordinate with CO$_2$, and the coordinated complex may not be easily oxidised back to the original compound.
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