

01

PHYLOGENETIC RELATIONSHIPS IN SELECTED MONOCOTS AND BASAL ANGIOSPERMS: MORPHOMETRICS AND FLAVONOID DISTRIBUTION

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Phylogenetic systems, introduced by Dahlgren in 1981 and Angiosperm Phylogenetic Group II System in 2003 had stated that there is a close relationship between basal angiosperms and some monocot taxa. Basal angiosperms are the evolutionary early angiosperms that diverge from the ancestral angiosperms. Therefore, the objective of this study was to interpret phylogenetic relationships of selected monocot taxa with basal angiosperms with respect to the morphometrics and flavonoid distribution.

Nymphaea stellata, *Piper betle*, *P nigrum*, *P longum*, *Aristolochia indica*, *Apama siliquosa* and *Annona muricata* were selected as basal angiosperms and *Anthurium undraeanum*, *Alocasia macrorrhiza*, *Aponogeton crispus* and *Dioscorea alata* were selected as monocot taxa for the present study. Fifty seven morphological, anatomical, flavonoid glycoside and pollen characters were analysed using SYNTAX 2000 to interpret phylogenetic relationships.

The phylogenetic relationships were reasonably represented in the analysis of combination of both morphological and flavonoid characters. This indicates that basal angiosperms are closely related with the monocots taxa used in the present study. Therefore, the splitting of angiosperms into main two groups as dicots and monocots as sister groups in the early phylogenetic systems is not in agreement with the present findings. Further, it supported the view of both systems; Dahlgren in 1981 and Angiosperm Phylogenetic Group II in 2003, which have identified that some monocot taxa shared common characters with basal angiosperms such as reticulate venation in monocot taxon *Dioscorea alata*, *Anthurium undraeanum* and *Alocasia macrorrhiza*; scattered vascular arrangement in basal angiosperm taxa *Nymphaea stellata*; circular vascular arrangement in monocot taxon *Dioscorea alata*.

Further, it demonstrated that family Piperaceae displays a closer phylogenetic relationship compared to the other selected basal angiosperms. A multi-access key was constructed using DELTA (Description Language for Taxonomy) software that can be used for future taxonomic purposes.

02

FLORAL AND VEGETATIVE MORPHOMETRICS AND PHENOLIC CONTENTS OF SELECTED *PIPER NIGRUM* L. CULTIVARS: CORRELATION WITH TAXONOMY

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Piper nigrum (Black pepper) which is known as the “King of spices” is one of the major spice crops of Sri Lanka. The Department of Export Agriculture, Matale is the centre for recommending *P. nigrum* cultivars to the farmers. Until now, the Department has recommended 10 cultivars, but it has records of 45 *P. nigrum* accessions (accession number 1-45) which have never being taxonomically evaluated.

The present study was carried out to infer the phenetic relationships among twelve accessions of *P. nigrum* cultivars and to determine the potential of these accessions to be introduced as recommended cultivars for the farmers.

Five vines from each accession were selected from the germplasm site of *P. nigrum*, Department of Export Agriculture, Matale and their morphometric characteristics ie. variation in leaves, spikes, fruits, vines and nodes and phenolic constituents were determined. Paper chromatography was used to separate and identify the phenolics present in leaves of the twelve *P. nigrum* accessions. The results obtained were analyzed by cluster analysis using MINITAB 14 software package.

The twelve *P. nigrum* accessions were found to be taxonomically different from each other in terms of morphometrics and phenolic constituents according to the dendrograms obtained from cluster analysis. The most related accessions were accession numbers 03 and 05 (BD/MW₂₃ and BD/NK₂₇). The accession number 26 (KW.W-12) was found to be the most potent cultivar that can be introduced as a new cultivar. In addition, the accession numbers 05, 08, 12, 36 and 44 (BD/NK₂₇, BD/GM₂₈, BD/WA₃, BD/MN₄₁ and BD/MN₄₂) were found to be moderately potent.

03

EVALUATION OF GROWTH OF *RHIZOPHORA MUCRONATA* IN RELATION TO WATER AND SOIL QUALITY IN SELECTED SITES IN KALPITIYA, PUTTALAM LAGOON, NORTHWEST SRI LANKA

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The largest patch of mangroves in Sri Lanka occur in Puttalam Lagoon which is about 3210 ha. *Rhizophora mucronata* (Rhizophoraceae) and *Avicennia marina* (Avicenniaceae) are the most predominant true mangrove species observed in this area. The mangroves which surrounds the lagoon have been extensively exploited by the coastal communities for various purposes such as fuelwood, timber for construction and fencing, dyes and tannins for fish nets and sails and to a lesser extent brush piles in fishing. The Turtle Conservation Project (TCP) has initiated a mangrove rehabilitation program in Kalpitiya area in the Puttalam Lagoon using *Rhizophora mucronata*. The planting had been done primarily on two occasions and therefore the plants are 5 years and 6 months old. The plant growth shows a visual variation even among the same ages.

The study was conducted with the objective of assessing the comparative growth performance of similar aged planted mangrove, *Rhizophora mucronata* in the different planted sites in Kalpitiya with regard to some water and soil parameters as much variation had been observed among them visually.

Six sites having 5 years old plants and 4 sites having 6 months old plants were selected for the study. Total height, stem diameter at the bottom (bottom diameter) and stem diameter just above the root level (top diameter) were taken as growth parameters. 5m x 5m plots were established along belt transects aligned perpendicular to the land. The distance between two such transects was 15m while the distance between two plots in one transect was 5m. All the *R. mucronata* trees in the 5 x 5m plots were measured for above parameters. Water samples were collected at both low tide and high tide situations from all the sampling sites. Soil samples were taken from both 30cm and 60cm depths in each plot. Minitab statistical package was used to analyse the statistical variation of growth parameters as well as soil and water parameters between sites. Pearson Correlation was used to identify any statistically significant correlations between growth parameters and soil and water parameters tested.

The results showed that the variation of the growth parameters differed significantly ($p < 0.05$) between sites in 5 years old plants. Both the diameter (bottom) and total height were highest in the mangroves in Eththala site followed by Palakuda and Palliwasathurai. The differences among the sites were non significant in sites with 6 months old plants. Statistically significant ($p < 0.05$) correlations were observed between plant growth and salinity and BOD in waters and carbon content in soils. The optimum pH and salinity levels for growth of *Rhizophora mucronata* were between 8.5 to 8.7 and 38 – 42 $\mu\text{g/L}$ respectively.

04

HISTOCHEMICAL ASPECTS AND *IN-VITRO* GERMINATION OF POLLEN OF *RHIZOPHORA* SPECIES

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In-vitro germination of pollen has been used as a powerful tool for genetical, physiological, biochemical and cytochemical studies and it is a prerequisite for crop improvement and plant breeding programmes. The present study was conducted to investigate some histochemical aspects and *in-vitro* germination of pollen of two common mangrove species ie. *Rhizophora mucronata* Poir. and *Rhizophora apiculata* Blume. Pollen morphology was studied by observing randomly selected 25-50 pollen grains of each species under Triocular Labomed research microscope ($\times 400$). Iodine test and Sudan III test were performed to determine the presence of carbohydrate and lipid in pollen. Randomly selected 50 pollens of each species were observed for colour changes after the test. For *in-vitro* pollen germination, pollen grains were grown in two media containing different concentrations of sucrose (0 %, 10 %, 15 %, and 20 %), a liquid medium containing 0.001 % boric acid and semi-solid medium containing 0.5 % agar and 0.005 % boric acid. Numbers of germinated and non germinated pollen grains were counted under mid power of the microscope with 5 replicates for each sucrose concentration. Statistical analysis was done by One Way ANOVA using Minitab R.14.

Pollen grains of both species were light green, spherical, smooth walled, and tricolporate. Very low intense blue colour developed with Iodine test revealed that starch contents in pollen grains of both species were low. However, Sudan III test indicated abundance of lipids in pollen grains of both species. The percentage germination of pollen grains was significantly increased with the increase of sucrose in the semi-solid and liquid medium especially from 15 % to 20 % in *R. mucronata* ($p < 0.05$). In *R. apiculata* the highest percentage germination of pollen grains were observed in liquid and semi-solid media containing 15 % and 20 % sucrose concentrations. None of the pollens of two species germinated in control (0 % sucrose) and 10 % sucrose solution in semi solid media. Bursting of pollens was observed in 10 % sucrose concentration in both media tested in two species. However, no pollen bursts were observed at both media containing 15 % and 20 % sucrose concentrations for the two *Rhizophora* species studied. Twenty percent sucrose concentration was most effective for germination of pollen and pollen tube growth of both *Rhizophora* species. The information collected in this study revealed that the optimum sucrose concentration and reserved nutrients in pollen are important factors influencing the germination of pollens of both *Rhizophora* species.

05

LUPIN (*LUPINUS* SPP.): A NEW CASH CROP FOR SRI LANKA

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Lupin (*Lupinus* spp.) is a pulse crop which is rapidly gaining popularity throughout the world as a protein rich healthy human and animal food. Several varieties of *Lupinus luteus* (Yellow-Lupin), *Lupinus albus* (White-Lupin) and *Lupinus angustifolius* (Sweet-Lupin) are commercially cultivated. Lupin flour is commonly used as a major ingredient in bread, noodles, pasta, cookies, lupin coffee and in some vegetarian instant meals. *Lupinus angustifolius* varieties are very popular due to the sweetness of flour. At present, Lupins are cultivated in many areas including Australia, South America, and Mediterranean countries and in South African countries. Sri Lanka has diverse climatic conditions with reasonably fertile soil in many parts of the country. Therefore, there is a high potential for introducing commercially developed Lupin varieties as a new cash crop to Sri Lanka.

An experiment was conducted with ten commercially cultivated *Lupinus* genotypes comprising of *L. albus* (var. Kiev mutant), *L. luteus* (var. Wodjil and Pootalong) and *L. angustifolius* (var. Ganguru, Tanjil, Walan, Belara, Donja, Kalya and Mandelup). The study was conducted with three objectives in mind i.e. to evaluate the possibilities of introducing Lupins into Sri Lanka, to select suitable varieties and to identify the potential growing areas. Eight morphological and yield characters (plant height at 4 weeks, time to flowering, number of leaves/leaf nodes on the main stem, number of main branches, plant height at flowering, plant height at maturity, number of seeds/plant and whole plant biomass) were measured to assess growth and yield performance of Lupin varieties grown in pots in Colombo, Kandy, Matale, Bandarawela and Nuwara Eliya Districts representing different climatic conditions. Ten replicates representing each Lupin variety were grown in each site.

Morphological and yield characters have shown that all Lupin varieties performed better in Nuwara Eliya and Bandarawela Districts. *L. luteus* and *L. albus* varieties required longer period to flower than that of *L. angustifolius*, however, no considerable difference was observed in flowering time among the four sites. None of the Lupin varieties flowered in the site in Colombo District, probably due to the high temperature (30-32 °C) prevailed during flowering which resulted in aborted flowers. Comparatively, the stem height, number of leaves and number of branches at flowering of plants grown in Nuwara Eliya District performed best. Similarly, plant biomass and seed yield of Lupin varieties were higher in sites in Nuwara Eliya District followed by those in Bandarawela District. Out of the seven varieties of *L. angustifolius*, Tanjil, Mandelup and Walan were better adapted to Districts of Nuwara Eliya and Bandarawela. The growth performance of *L. luteus* and *L. albus* varieties were similar. However, it is necessary to conduct field studies with all Lupin varieties to evaluate their growth performance under different eco-climatic conditions.

SSR MARKERS REVEALED HIGHLY HOMOZYGOUS TALL COCONUT ACCESSIONS FROM SRI LANKA

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Coconut, the most widely grown plantation crop in Sri Lanka taxonomically falls into three groups designated as varieties of coconut in Sri Lanka. They are tall or *typica*, dwarf or *nana* and thembili or *aurantiaca* (Liyanage, 1958). The tall varieties are predominantly out breeding in nature and as a result are inherently heterozygous. They are hardy palms with a tall stature with better adaptability to withstand harsh climatic conditions. They are high producers of copra than dwarf and thembili but with less number of nuts produced. Sri Lanka tall is extensively used in breeding programs for production of coconut hybrids. The inherent heterozygosity of tall coconut is an obstacle to producing true coconut hybrids because of the variability that arise within the hybrid due to heterozygosity of the tall parent. Dwarf coconuts in contrast are inherently homozygous as they are naturally inbreeding. Therefore quantifying the homozygosity of tall in coconut germplasm repositories of the country is of great significance.

A representation of coconuts established in *ex-situ* gene banks of the Coconut Research Institute of Sri Lanka were assessed by selecting 13 tall (bodiri, kamandala, gon thembili, nawasi, porapol and ran thembili), dwarf (dwarf green, dwarf yellow, dwarf red and dwarf brown) and aurantiaca (king coconut, rathran thembili, nawasi thembili) varieties including two San Ramon like forms (Margret and Indian) and three tall forms collected from ancient villages (Damana, Uhana and Deegawapi). Tender leaves sampled from 13 coconut forms were subjected for screening SSRs after extracting DNA using a cTAB based protocol modified from Doyle & Doyle (1990). Sixteen SSR primers constructed by Perera *et al.*, (1999) and Rivera *et al.*, (1999) were used in the PCR. The PCR products were electrophoresed in denaturing 6 % polyacrylamide gels and visualized by staining with silver nitrate staining. Amplified alleles of each locus were recorded and the number of homozygous loci of each accession was determined.

Almost all dwarf and aurantiaca forms investigated were homozygous for all the 16 loci except Nawasi thembili, which had only 2 heterozygous loci out of the 16. Among tall coconuts, five (bodiri, porapol, ran thembili, Damana and Uhana) were heterozygous for only one locus. San Ramon-like accessions, Margaret and Indian were heterozygous for 12 and 11 loci respectively. The high homozygosity of dwarf and aurantiaca reflected their inherent inbreeding (autogamous) habit while moderate level of heterozygosity of tall accessions emulated their out crossing nature (allogamous). The extremely low heterozygosity in Sri Lanka tall forms bodiri, porapol and ran thembili and two Sri Lanka tall ecotypes Damana and Uhana is noteworthy. Studies based on RAPD, SSRP and AFLP markers have clearly demonstrated close resemblance of Damana and Uhana and Deegawapi collected from very old coconut palm populations in the Ampara District. The high homozygosity of these two accessions and their proven hardiness suggests them as worthwhile candidates for testing as pollen parents in hybridization programs for developing coconut hybrids with lessened heterozygosity.

07

ANTIGLYCATION ACTIVITY OF *SALACIA RETICULATA* L. (KOTHALA HIMBUTU) ROOT, STEM, LEAF, TWIG AND FRUIT EXTRACTS

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In living organisms, proteins may be susceptible to modification by glucose and other reducing sugars through non-enzymatic glycation. This reaction finally produces Advanced Glycation End products (AGEs). Accumulation of AGEs in the body contributes to pathogenesis in chronic diabetes. Oxidative reactions are known to participate in AGEs formation and antioxidants/radical scavengers may inhibit this process. *Salacia reticulata*, a scientifically well documented, traditional anti-diabetic plant has not been tested on blocking of AGE formation, although it has been tested for other anti-diabetic properties. In this study, we report the *in vitro* antiglycation activity of *Salacia reticulata* root, stem, leaf, twig and fruit extracts.

Freeze dried hot water extracts of *Salacia reticulata* root, stem, leaf, twig and fruit (n=3 each) at 6 different concentrations (7.8, 15.6, 31.2, 62.5, 125.0 and 250.0 µg/ml) were used in this study. Reaction volume of 1 ml containing 800 µg bovine serum albumin (BSA), 400 mM glucose and different extracts of *Salacia reticulata* in 50 mM phosphate buffer (pH 7.4) containing 0.02 % (w/v) sodium azide were incubated at 60 °C for 40 h and aliquots of 600 µl were treated with trichloroacetic acid to obtain AGEs-BSA precipitate. The precipitate was then dissolved in phosphate buffer saline (pH 10) and fluorescence of the samples was measured at an excitation wave length of 370 nm and emission wave length of 440 nm. Control samples representing 100 % glycation were conducted in an identical way replacing *Salacia reticulata* extracts with same amount of buffer.

Root, stem, leaf, twig and fruit extracts of *Salacia reticulata* showed significant antiglycation activity in a dose dependent manner. Antiglycation activity varied significantly among different extracts (P<0.05). IC₅₀ values of root, stem, leaf and twig extracts were 13.06±0.69, 27.29±0.93, 144.53±1.12 and 171.90±0.88 µg/ml respectively. Fruit extract had the lowest antiglycation activity representing IC₅₀ of 562.44±9.91 µg/ml.

It is concluded that, all parts of *Salacia reticulata* possess antiglycation activity. Root and stem of *Salacia reticulata* will be good natural sources with potent antiglycation activity to manage diabetes. Even though the antidiabetic activity of this plant is well documented, this is the first report of its antiglycation activity. However, the therapeutic usages of *Salacia reticulata* in human subjects on controlling glycation have to be investigated.

COMPARISON OF PHYSICO-CHEMICAL PARAMETERS AND BERBERINE CONTENT IN *BERBERIS CEYLANICA* AND *BERBERIS ARISTATA* (DARUHARIDRA)

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Berberis Linn. (Family: Berberidaceae), a genus of shrubs or small trees, is distributed in the temperate and sub tropical parts of Asia, Europe and America. The genus consists of species which are commonly used in many traditional systems of medicines. *Berberis aristata* DC commonly known as Daruharidra is native to mountainous parts of North India and Nepal. *Berberis ceylanica* Schneider is endemic to Sri Lanka and is distributed in mountain forests and forest borders up to about 2200 m height. Berberine is one of the important alkaloidal active principles of this genus. The present study was carried out to (a) determine physico-chemical parameters and (b) to quantify the berberine content in *B. ceylanica* and market samples of Daruharidra. Three samples from each species were used for analysis. Statistical comparisons were made using one way ANOVA followed by Duncans Multiple Range Test.

Physico-chemical parameters such as moisture content, total ash, acid insoluble ash, water soluble ash, ethanol and water extractable matter were determined using WHO guidelines for *B. ceylanica* and market samples of Daruharidra. Detection and quantification of berberine were performed by TLC densitometry at the wavelength of 366 nm. The percentages of moisture content, total ash, acid insoluble ash, water soluble ash, ethanol extractable matter and water extractable matter in *Berberis ceylanica* samples (n = 3) were 6.6 – 7.2, 0.80 – 0.81, 0.21 – 0.24, 0.32 – 0.33, 6.4 – 6.5, 7.2 – 7.8 and for Daruharidra samples (n=3) these were 7.2 – 8.1, 1.5 – 1.6, 0.27 – 0.31, 0.36 – 0.49, 3.7- 5.4, 4.9 – 8.9 respectively. The berberine content in methanol extracts of Daruharidra and *B. ceylanica* were in the range of 1.5 – 2.72 % and 1.58 – 1.78 % respectively. On the other hand, very low berberine content was present in the methanol:dichloromethane (1:1) extracts of Daruharidra (0.20 %) and *B. ceylanica* (0.22 – 0.25%). However, berberine content of *B. ceylanica* and Daruharidra were not significantly different (p>0.05) from each other either in methanol extracts or methanol: dichloromethane extracts respectively.

In conclusion, this study has indicated similarities of *B. ceylanica* and market samples of Daruharidra in terms of physico – chemical parameters and of berberine content and hence possibility of using *B. ceylanica* as a substitute for Daruharidra.

09

EVALUATION OF EFFECTS OF DIFFERENT ORGANIC AMENDMENTS ON GROWTH OF RICE (*ORYZA SATIVA* L.) IN NORTH-WESTERN PROVINCE OF SRI LANKA

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Improvement of soil health in paddy fields through organic amendments is one of the important practices that farmers could simply manage. There is scarcity of information on field scale differences in growth responses under different organic fertilizer amendments at field level and there is poor awareness among farmers on this. This study was conducted to investigate the growth response of local paddy variety BG- 352 at the field site in Kaudulla at “Maha” season. Soil samples were analyzed for cation exchange capacity, base saturation, pH, organic matter content, electrical conductivity and major and micro nutrients using the standard protocols. Seven fertilizer treatments were tested with four replicates in a randomized block design; *Gliricidia* leaves (T₁), *Gliricidia* leaves + rice straw (T₂), rice straw (T₃), rice straw + 50 g of Urea (T₄), rice straw + 100 g of Urea (T₅), recommended rate of chemical fertilizer (T₆), and control without fertilizer (T₇). The plot size was 2 m². The recommended rate of chemical fertilizer was applied to all plots except for the control plots (T₇). The standard cultivation practices were adopted for management of the plots. Height of plant, length of flag leaf and root, width of flag leaves and base of the stem, number of tillers/plant, shoot and root biomass were measured (6 individuals/ treatment) two months after sowing. All data were analyzed for statistical significance using ANOVA at $p < 0.05$.

Soil analysis revealed that the soil was deficient in nutrients N, P, K, S, B, and Zn. Mean number of tillers/ individual was significantly higher in all the other treatments than T₇ plots except for T₃. The height of the plants and length of the flag leaves were significantly longer in all the treatments than T₃ and T₇. While length of plant roots of T₇ was short (15.1 cm) all the other treatments showed longer root length (> 18 cm). The biomass of the shoot was significantly higher in all the other treatments (> 2.0 g) than T₇ (0.8 g). The root biomass of plants was significantly higher in T₄, T₅ and T₆ (> 0.6 g) than the T₇ (0.2 g). The maximum shoot biomass, height of plants, length of flag leaves, and number of tillers were recorded under T₅. Most of the measurements of T₁ showed more or less close values to that of T₅ for most of the parameters, but that of T₃ and T₇ showed significantly low values. Rice cultivation with integrated fertilizer management would be a better practice for net high rice plant growth in nutrient deficient soils of dry zone of Sri Lanka.

10

**AN INVESTIGATION OF SOIL TRANSMITTED INTESTINAL PARASITIC STAGES
IN SOIL AND HUMAN POPULATIONS IN THREE SITES OF SEDAWATTA IN
COLOMBO MUNICIPAL AREA**

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This study was designed to investigate the presence of soil transmitted intestinal parasite (STIP) stages in soil, faecal matter of children and domesticated animals in three sites of Sedawatta, a low line area along the bank of Kelani river in Colombo Municipal Area. Toxocara and strongyle type ova were found in soil (150 samples) of all three sites tested and also in the faecal matter of dogs and cats collected from the same sites. STIP ova of *Ascaris* and *Trichuris* were found in the faecal matter collected from a total of 52 children but these eggs were not found in soil in any of the tested sites. *Ascaris* and *Trichuris* eggs were found in the faecal matter of children tested as having 13.3% in Site A (Kelani Nadeegama), 36.6% in Site B (Nawa Kelanipura) and 44.4% in Site C (Oliyamulla) of Sedawatta area. The inhabitants of Site A had their own latrines compared to Site B and C where the public toilets are utilized. There was also a significant association ($P < 0.05$) between the prevalence of *Ascaris* and *Trichuris* eggs in faecal matter of tested children and the use of public latrines. Moreover, the prevalence of STIP eggs found in faecal matter of children was associated only with the income level of the people ($P < 0.05$) out of other several socioeconomic parameters tested. Thus the use of public latrines by children and their hygienic practices may be a source for the higher prevalence of these infections among children. The absence of *Ascaris* and *Trichuris* ova in soil may be due to the usage of either public or private latrines by the inhabitants. The contamination of soil with geohelminth ova of animal origin in these low line areas would also generate a potential risk for humans in gaining zoonotic infections.

11

AN INVESTIGATION OF CERCARIAL DERMATITIS CAUSING FURCOCERCOUS CERCARIAE IN SNAIL INTERMEDIATE HOSTS IN THE ANAVILUNDAWA SANCTUARY OF SRI LANKA

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Cercarial dermatitis is an allergic disease condition of humans caused by the penetration of skin by non-human schistosome Furcocercous cercariae released by snail intermediate hosts present in fresh water bodies. People (n= 38) in Anavilundawa area, Chilaw who had constant contact with fresh water bodies were found to have cercarial dermatitis when studied by a questionnaire survey as carried out in this study. The presence of itching and red colour micropapules were considered as the predominant symptoms for this allergic disease condition in humans. This study investigated the cercariae types released by snail intermediate hosts in fresh water reservoirs of Anavilundawa Sanctuary area in the dry zone of Sri Lanka. Snails (of the genera of *Lymnaea*, *Indorplanobis*, *Pila* and *Paludomus*) were collected and they were allowed to release cercariae in to water and cercariae types were identified by morphologically and PCR assay (to amplify ITS2 genetic locus of Ribosomal DNA) followed by sequence analysis.

The results indicated two out of four genera of fresh water snails *Lymnaea*, *Indorplanobis* as infected with Furcocercous cercariae. *Pila* and *Paludomus* didn't release any Furcocercous cercaria. Eight cercariae types which were morphologically different were identified. All these cercariae were of the type Furcocercous cercariae which was known to cause the cercarial dermatitis allergic condition in humans. Thus the presence of Furcocercous cercariae types in the water bodies in Anavilundawa may be responsible for the cercarial dermatitis condition prevailing in the study area. The sequence and genetic analysis done on five cercariae types showed that they were of three distinctly different genetic groups (clades) and two cercariae types (species belonging to the family Shistosomatidae) were found to be aligned in their sequences tested, as detected by a blast search. Furcocercous cercariae belonging to genera of *Diplostomum*, *Clinostomum* and *Shistosoma* were found through this phylogenetic study. This preliminary study showed that a limited genetic diversity prevails among the non-human cercariae types collected from snail intermediate hosts of Anavilundawa area. This genetic diversity may be helpful for the cercariae to find their specific snail intermediate hosts.

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AN INVESTIGATION OF THE ANTIMALARIAL ACTIVITY OF ARTEMISIA VULGARIS LEAF EXTRACT IN A RODENT MALARIAL MODEL

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Artemisinin, isolated from the Chinese plant *Artemisia annua*, and its derivatives are effective against both chloroquine resistant and sensitive strains of *Plasmodium falciparum*. According to available data the only plant species representative of this genus in Sri Lanka is *A. vulgaris*. A study was undertaken for the first time to investigate the antimalarial activity of a leaf extract of *A. vulgaris*.

Antimalarial activity of an organic extract of *A. vulgaris* was evaluated in terms of both anti-parasitic and anti-disease activities. Anti-parasitic activity of the extract at three doses (250, 500, 1000 mg/kg) was assessed *in vivo* using the *Plasmodium yoelii* rodent malaria model, using distilled water (DW) as the negative control and Coartem as the positive control. Oral administration of the extract in the 4-day suppressive assay at 500 mg/kg and 1000 mg/kg significantly ($P < 0.01$) inhibited parasitaemia by 65.16% and 51.46%, respectively. Curative assay carried out for the 500 mg/kg dose of the extract did not show efficacious anti-parasitic results.

Significant ($P < 0.05$) antinociceptive activity was observed for the extract in the hot plate test, indicating a central, supra-spinally mediated response in relieving pain. Anti-disease activity was further corroborated by increased survival of infected mice treated with the 500 mg/kg dose.

The *A. vulgaris* extract was tolerated well by mice over a period of 14 days (assay of sub-chronic toxicity), showing no overt signs of toxicity or stress. Hepatotoxicity (evaluated in terms of serum GOT and GPT levels), renotoxicity (in terms of serum urea and creatinine) and haematotoxicity were also ruled out.

In conclusion, the results demonstrated that *A. vulgaris* leaf extract is orally active with moderate anti-parasitic and anti-disease activity and is non-toxic, and has the potential to be a source of plant-based antimalarial agent in the future.

THRIP INFESTATIONS ON EGGPLANTS (*SOLANUM MELONGENA*) IN RUHUNU-RIDIYAGAMA IN SOUTHERN SRI LANKA

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Eggplants (*Solanum melongena*) are one of the most important vegetable crops widely grown in Southern Sri Lanka. Recently, fruits of eggplants have been seriously damaged by causing formation of discolored, i.e., brown colour patches, and malformed fruits. In the present study, species composition, nature of infestation, distribution and population density of Thrip pests on eggplants were investigated. The study was carried out at six localities namely, Thuduamulla, Karambagalmulla (2 localities), Habaraththawela, Bolana, and "Hathara Kanuwa" at Ruhuna Ridiyagama in the Divisional Secretariat Division of Ambalanthota, during May 2009 to April. At each location, infestation was assessed on 10 randomly selected Eggplants. At least three randomly picked flowers/buds were collected per plant. Total number of fruits and infested fruits per plant were recorded at each sampling occasion. The flowers were dissected and number of larvae and the adult were recorded. The adult were identified up to the species level using Lucid keys developed by Moritz *et al.* (2001).

All the eggplant fields sampled were infested by . The highest flower infestation (67%) was detected at Habaraththawela. At four locations the flower infestation exceeded 25%. Hundred percent fruit infestation was detected at Thuduamulla, Karambagalmulla (1st location), Habaraththawela and "Hathara Kanuwa". No fruit infestation was found at the two remaining localities. High density per flower was recorded at Habaraththawela and Thuduamulla. No significant difference was found between the bud and flower infestation. Three Thrip species, *Pezo dianthi* Priener, *setosus* Moulton and *Frankliniella schultzei* (Trybom) (Thysanoptera: Thripidae) were detected. All the eggplant fields sampled were infested by *P. dianthi* and showed the highest frequency of occurrence, i.e., 58%. *setosus* and *F. schultzei* are of minor importance. *setosus* was prevalent at four localities (67%). *Frankliniella schultzei* showed low prevalence. At Habaraththawela *P. dianthi* was detected as the only Thrip species. larvae were only detected at Karambagalmulla (1st location), Habaraththawela, Bolana and in low numbers, i.e., < 1 per flower. The finding of this research indicated that the infestation on eggplants is widespread in Ruhunu-Ridiyagama and the *P. dianthi* was considered as the destructive Thrip species. infestations are initiated in flowers and subsequently invade the fruits. Hence, control measures should be applied with the onset of flowers.

BREEDING OF THE ENDANGERED SEAHORSE, *HIPPOCAMPUS KUDA* AND CONSTRAINTS FOR LARVAL DEVELOPMENT UNDER CAPTIVITY

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Sea horses are among the first commercially important, marine fishes to be listed in the CITES. They are traded world wide for use in traditional medicine as aquarium pets and as curios. Captive breeding of sea horses have been widely accepted as the major option to address the present market demand for seahorses while conserving the wild endangered stocks. However captive breeding of sea horses is not widely practiced due to limited information available on breeding and rearing technologies. This study was conducted to investigate the breeding of wild caught *Hippocampus kuda* and to rear the larvae to marketable size under captivity.

Wild caught adult seahorses were stocked in brood stock tanks at a density of 5m⁻² at a male: female ratio of 3:4. The average total length of female: male was 11.1±0.3cm and 10.5±0.5cm respectively. The average weight of females: males were 7.9±0.9g and 9.4±1.1g respectively. They were fed with *Acetes* shrimp twice a day. Sea horse larvae were counted just after hatching to determine fecundity. Total length and corresponding wet weights of larvae were measured at fortnight intervals. Larvae were fed with *Artemia* until they reached the marketable size (4 months period). Moribund larvae were observed for any abnormalities and external signs of pathological conditions.

Male sea horse released 250±30 individuals a time and new born larvae measured 0.98±0.02cm in length. The mean growth rates at the three growth inflexion points observed at the 2nd, 3rd, 16th weeks were 1.16, 1.06, 1.02 cm/week. Growth rates observed were comparatively better than studies done in the countries for the same species. The condition factor ranged from 0.39 ±0.10 to 1.03 ±0.37 gcm³. 80% of the larvae died within first two weeks of hatching and the final survival rate at the marketable size was only 3% from 13th week onwards.

Larvae showed lethargy, loss of appetite, erratic swimming, rotational swimming, reddening on the skin and blisters in the tail region. 90% of the moribund larvae were infected with fungi and bacteria. Water quality parameters in the tank were within the optimum range for *H. kuda* larvae. Disease causing agents such as bacteria, fungus, and external fouling organisms are suggested to be the major cause for low survival rates. Further research to identify disease causing agents and their control is warranted.

EFFECTS OF DIFFERENT LAND USE PATTERNS ON WATER QUALITY ALONG DAMBAGASTALAWA OYA IN AMBEWELA – TALAWAKELLE AREA

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Scientific evidence on water quality changes due to anthropogenic activities in the hill country of Sri Lanka is sparse. The present study was performed to investigate the effects of different land use patterns especially the agricultural practices on the water quality of the Dambagastalawa Oya in Ambewela and Thalawakelle area.

Six sampling stations were selected for the study ie. at the beginning of the Oya, at the end of Ambewela cattle farm, at the end of the Elgin forest, at the end of tea estates, at the end of vegetable farms and in a location of home gardens. The parameters studied were pH, DO, salinity, conductivity, concentrations of Ca (II), Mg(II), Cd (II), Zn(II), Na, K, Total N, Total P and BOD.

When compared with the WHO potable water standards it was evident that the Ambewela cattle farm highly contribute to the pollution of the Oya (pH = 6.3, DO = 1.1 mg/l, Salinity = 96.00 ppt, Conductivity = 81.70 μ S/cm, Ca = 9.9 μ g/ml, Mg = 12.5 μ g/ml, Na = 13.0 ppm, K = 6.4 ppm, N = 0.008 μ g/l, P = 0.15 μ g/l, BOD = 8.9 mg/l). Furthermore, it was observed that the water which get polluted at the cattle farm gets purified while flowing through the Elgin forest. This could be due to natural processes as no anthropogenic activities are found in this forest area. Compared to the other stations, tea estates showed high Zn level in water and this could be due to the usage of Zn based fertilizers in the tea estates. However, Zn level in this station never exceeded the WHO potable water standards. Presence of Cd(II) was also evident at all the sampling stations including the springs and Elgin forest (1.0 μ g/l and 4.0 μ g/l) which shows that presence of Cd(II) could not be due to any anthropogenic activities but could be due to natural dissolution. As the presence of Cd(II) even in the springs is evident from the study, it is essential to determine the levels of Cd(II) in bottled water and milk products from hill country. Ambewela cattle farm was found to be the major contributor of the pollution of the Dambagastalawa Oya. The contribution towards pollution of the Oya due to the tea plantations, vegetable farms and human settlements in this area were below the significant levels of pollution (according to WHO standards.). Therefore, it is recommended strongly that the cattle farm should maintain proper quality in waste water with appropriate treatment mechanisms before any serious environmental hazard crops up.

**DETERMINATION OF TOXIC CYANOBACTERIA DOMINANCE USING
IMPORTANT VALUE INDEX (IVI) IN SOME SELECTED WATER BODIES IN SRI
LANKA**

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Cyanobacteria are a group of prokaryotes that found in fresh, brackish and marine waters all over the world. Some bloom forming cyanobacteria species of *Microcystis*, *Anabaena*, *Cylindrospermopsis*, *Lynbya*, *Nosotc*, *Nodulaira* and *Oscillatoria* produce bio toxins which affect the human health. The present study refers the Important value Index (IVI) to categorize the dominance level of cyanobacteria to evaluate health risk in some selected drinking (Labugama, Kalatuwawa, Kondawatuwana) irrigation (Parakramasamudraya, Minneriya, Kantale, Neelapola, Nuwarawewa, Tissa wewa, Ranna, Kattakaduwwa) and recreational (Kesbewa, Boralessgamuwa) water bodies for a period of one year from April 2009 to April 2010. Immediately after collection of water, a 100 ml portion was fixed with acidified Lugol's solution at final concentration of 1% and enumerated. Screening of Microcystin-LR was done at the site itself using immunostrips. Relative phytoplankton abundance, frequency and bio volume of each species were considered and determined the IVI (Important Value Index).

Results of the study showed that *M. aeruginosa* was the dominant cyanobacteria species in more than 50% of water bodies tested. Based on the dominance of *M. aeruginosa*, four ranks; 1-10; 11-25; 26-60; > 60 were established to determine the effect of *M.aeruginosa* on water quality with special emphasis on cyanotoxin contamination possibility. The IVI values of Labugama, Kalautwawa, and Minneriya were in the ranks 1-10 and 11-25 respectively. IVI value of Neelapola, Kantale, and Parakramasamudraya were with in 26-60. IVI values greater than 60 were recorded at Kondawatuwana, Boralessgamuwa, Kesbewa, Ranna, Nuwara wewa and Tissa wewa. Having low IVI values of *M. aeruginosa* in Labugama and Kalautwawa reservoirs indicate that the water bodies can be used exclusively for drinking purposes and the heath risk would be minimal. Opposite was true for Kondawatuwana tank and Boralessgamuwa lake which are having high IVI values of *M. aeruignosa* with greater than 10 µg l⁻¹ of microcystin-LR contamination.

EFFECTS OF CADMIUM ON THE HAEMATOLOGICAL PARAMETERS OF THE MOZAMBIQUE TILAPIA, *OREOCHROMIS MOSSAMBICUS* (PETERS, 1852)

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Haematological profiles have been frequently used to assess the health status of fish subject to metallic stress. The present study, which examined the effects of exposure to environmentally relevant concentrations of Cd, aimed to ascertain the potential of this heavy metal to induce changes in the haematological profile of the Mozambique Tilapia (*Oreochromis mossambicus*). Adult female fish (112 ± 5.3 g and 3-5 months of age) collected from the National Aquatic Agency, Colombo, were housed in glass tanks containing 30 L of water and repeatedly exposed (twice) to three concentrations (0.2, 2 and 10 mg l⁻¹) of CdCl₂ for five days. Both treatment tanks and controls (without Cd) were maintained in triplicate. At the end of the trial fish were sacrificed to obtain blood. Five primary haematological parameters i.e. clotting time, erythrocyte (RBC) count, lymphocyte (WBC) count, packed cell volume (PCV) and the haemoglobin concentration (Hb) and three secondary indices i.e. the mean cell haemoglobin (MCH), mean cell haemoglobin concentration (MCHC) and mean cell volume (MCV) were determined.

The study revealed that Cd exposure induced alterations in some of the haematological parameters of the adult tilapia. Exposure to Cd caused significant increases in RBC and WBC counts, Hb concentration, MCV and MCH, whereas the PCV, MCHC and clotting time remained unaltered. The alterations in haematological parameters were only evident at the low (0.2 mg l⁻¹) and high (10 mg l⁻¹) concentrations. The lack of an apparent response at mid concentrations, nevertheless, warrants further investigation. These results are particularly alarming since the lowest test concentration, which was capable of inducing changes in the blood parameters, falls within the ranges recorded in the water bodies of Sri Lanka.

**EFFECTS OF CADMIUM ON LARVAE OF THE COMMON ASIAN TOAD
DUTTAPHRYNUS MELANOSTICTUS (SCHNEIDER, 1799): EVIDENCE FROM
EMPIRICAL TRIALS**

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The contamination of water bodies with heavy metals, in recent times, has gained the attention of toxicologists due to the harmful impacts these compounds manifests on aquatic species. In the present study we investigated the toxicity of one of the most common heavy metal contaminants, Cadmium (Cd), to larvae of the Common Asian Toad *Duttaphrynus melanostictus*. Tadpoles (n = 54) were collected from three uncontaminated sources and repeatedly exposed for 10 days to five environmentally relevant concentrations of Cd (0.002, 0.02, 0.20, 1.0 and 2.0 mg/l). Treatment and control tanks (without Cd) were maintained in triplicate. Mortality levels were recorded daily, whilst growth, development and activity of the tadpoles were monitored at two day intervals.

The results revealed that mortality was enhanced by the repeated exposure to Cd, at 0.20 mg/l and above, with mortality levels in those exposed to 1.0 and 2.0 mg/l reaching a 100 %. Mortality increased in a dose-dependent manner ($r = 0.89$, $p < 0.01$). The LC₅₀_{2-10 day} values for *D. melanostictus* ranged from 0.05 – 0.35 mg/l¹. Growth impairment was also apparent in surviving larvae with tadpoles exposed to 0.20 mg/l being 20 % smaller than those of the control. Development was also impaired i.e. even after the lapse of 40 days none of those exposed to 0.2 mg/l progressed beyond the hind limb stage, while 80 % of those in controls completed metamorphosis. Furthermore, Cd at concentrations of 0.02 mg/l and above negatively affected the swimming activity of the tadpoles. These results affirm that exposure to the field levels of Cd recorded in Sri Lanka (0.02 – 0.2 mg/l) is detrimental to the young stages of *D. melanostictus* due to the negative impacts on growth, development and activity. These findings highlight the necessity to have strict measures for the discharge of heavy metal contaminants into natural water bodies of the Sri Lanka.

A PILOT STUDY ON THE IMPACTS OF SELECTED HEAVY METALS ON THE IMMUNE SYSTEM AND REPRODUCTIVE BIOLOGY OF *EUPHLYCTIS HEXADACTYLUS* (RANIDAE: RANINAE) UNDER NATURAL CONDITIONS

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Exposure to high concentrations of metal ions, identified as toxic xenobiotics, that cause immunotoxic effects by means of immunosuppression may render amphibians more susceptible to novel diseases. This may contribute towards adverse impacts on the local amphibian populations as a part of global amphibian decline.

The present study, for the first time, investigated effects of metal ion toxicity on the immune system of the six-toed frog, *Euphlyctis hexadactylus*, in a site reported to be highly polluted with domestic sewage, industrial effluents and agricultural runoff compared to a reference site (N=10 females per site), in Sri Lanka. The study was based in the main canal of the Bellanwila-Attidiya Sanctuary which was found to be polluted with low levels of aquatic metal ions; cadmium (0.019 ppm), lead (0.955 ppm), copper (0.04 ppm) and zinc (2.71 ppm), compared to the reference site in the Kolabada-Thalpitiya area in the Bolgoda wetland area where the metal ions were undetectable. The metal ions were detected in samples using Atomic Absorption Spectrophotometry. Non-functional (based on total white blood cell counts, spleen weight/body weight ratio, spleenocyte count and basal immunoglobulin level), and functional (in terms of phagocytic capacity of peritoneal macrophages) immunotoxic tests carried out using standard methodology.

Significantly lower values ($P < 0.05$) were recorded for the above parameters for frogs of the Bellanwila site compared to those of the reference site, indicative of immune impairment of frogs in the polluted site. On the contrary, reproductive biological parameters (egg volume, estimated egg count, egg count/volume ratio) of frogs of the Bellanwila site were found to be significantly higher ($P < 0.05$) than those of the reference site.

In conclusion, the clear impairment of the immune system of frogs of the polluted Bellanwila site compared to those of the reference site in Bolgoda, may be due to metal ion pollution. The reproductive capacity of frogs from the Bellanwila site may have increased as an evolutionary trade off to withstand the risk of getting extinct from disease outbreaks. This preliminary investigative eco immunotoxicology study provides a baseline for future studies in Sri Lanka.

CARBOFURAN-INDUCED HISTOLOGICAL ALTERATIONS IN *DUTTAPHRYNUS MELANOSTICTUS* (SCHNEIDER, 1799) TADPOLES

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This study investigated the histological alterations in liver and tail muscle tissue of tadpoles of the Asian Common Toad, *Duttaphrynus melanostictus* Schneider, 1799 caused by exposure to a commonly used carbamate pesticide, carbofuran. It was specifically intended to ascertain sublethal damage in tadpoles surviving exposure to this pesticide. Larvae (Gosner stages 24-25) were continuously exposed to 250 and 500 $\mu\text{g l}^{-1}$ of carbofuran (Curaterr 3G) for one week. Treatments and controls (without pesticides) were maintained in triplicate (n=10 per treatment or control). At the end of the exposure, tadpoles were sacrificed for the examination of histological alterations in the selected tissues. The standard H and E staining process was used to prepare slides.

Observations revealed that exposure to carbofuran caused alterations in the structure of both the liver and tail muscle tissues of the exposed tadpoles of *D. melanostictus*, but to varying degrees. In the liver, the presence of cytoplasmic vacuolations, sinusoidal dilations and the formation of bile plugs were the most notable aberrations in the exposed larvae, which were not evident in those of the control. The muscle tissues were severely affected due to atrophy caused by the architectural alterations resulting from the degeneration of myotomes. In both tissues the damage at 250 $\mu\text{g l}^{-1}$ was greater than that observed at 500 $\mu\text{g l}^{-1}$ very likely due to a hermetic response. These results suggest that, although tadpoles may survive exposure to carbofuran in the short term, the organisms may be subject to sublethal damage such as histological alterations in vital tissues, which might ultimately be detrimental to the survival of the entire population.

**GROWTH AND REPRODUCTIVE BIOLOGY OF *GERRES ABBREVIATES*
(BLEAKER, 1850) (PERCIFORMES:GERREDAE) IN THE JAFFNA LAGOON, SRI
LANKA**

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Gerres abbreviatus [Bleeker, 1850], ‘deep body silver biddy’ a bony fish with silvery scales and protrusible mouth is an edible fish caught in Jaffna lagoon fishery. Random weekly samples of 190 fishes (Males – 96, females – 65 and unsexed immature fish - 29) collected from fishermen during February to September, 2004 were analyzed in the Department of Zoology of the University of Jaffna, Sri Lanka.

Growth biology by length-weight relationship and reproductive biology by Condition Factor (K), fecundity, and tissue indices (gonadosomatic index –GSI and hepatosomatic index - HSI) were analysed.

The sampling mean values of total, fork, and standard fish body lengths were 15.772 ± 3.708 , 13.468 ± 3.279 , and 11.955 ± 3.006 respectively.

The increases in morphometric lengths, the total length and fork length were directly proportional to the increase in standard length indicated by the linear regression biometry with R² values (coefficient of determination) of 1.2303 and 1.0884 respectively. The Length-Weight relationship revealed a typical biometric growth pattern, the “parabolic curve” in *G. abbreviatus*.

The average Condition Factor variations in females and males at maturity was at standard length intervals 14.1 – 16.0 cm and 12.1 – 14.0 cm respectively. The monthly variations of average Condition Factor, GSI and HSI indicated 3 spawning periods of *G. abbreviatus* in March, May, and August, and distinctly the primary spawning month as in March 2004 during the study period.

NICHE OCCUPANCY OF THE RUFIOUS BABBLER *TURDOIDES RUFESCENS* (BLYTH, 1847) IN MIXED-SPECIES FEEDING FLOCKS OF SINHARAJA WORLD HERITAGE SITE

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Rufous babblers are well known as the nuclear species of the mixed-species feeding flocks in Sinharaja World Heritage Site. Niche occupancy height and the feeding niche of Rufous babblers in and outside the mixed species feeding flocks were studied in Sinharaja World Heritage Site from February to April of 2010. Five study stations, approximately 0.75 km apart, were selected in the main skid trail between Heen Dola and West main area. The mean niche occupancy height of the Rufous babblers outside the mixed species flock was 6.18 m ($\square 3.13$, $p < 0.05$). Mean niche occupancy height of the Rufous babbler inside the mixed species flocks was 9.3 m ($\square 3.6$, $p < 0.005$). Horizontal niche breath of the Rufous babbler outside the mixed species flock was 1.1 m ($\square 1.0$, $p < 0.05$) and it was 1.3 m ($\square 1.0$, $p < 0.005$) when inside the mixed species flocks.

Both the niche height and horizontal niche breath of the Rufous babblers, showed a significant difference between in and outside the mixed species flocks. Six out of the seven vegetative characteristics measured (GBH, tree height, light intensity, sapling density, canopy openness and over story tree density), were not significantly different among five stations, occupied by the Rufous babblers in and outside the mixed species flocks. Understory tree density showed a significant difference ($p = 0.028$) between the areas occupied by the Rufous babblers, with a mean of 1886.7 ± 573.0 trees/ha outside the mixed-species flock and 2706.7 ± 1029.89 trees/ha inside the mixed-species feeding flock.

Considering the feeding ecology of the Rufous babbler inside the mixed species feeding flock, it was observed that foliage is the most frequent feeding substrate (72.9%) used and horizontal postures are more favored (74.3%) by the Rufous babbler. Therefore it can be concluded that the Rufous babblers expand their feeding occupancy niche both vertically and horizontally and use denser vegetation inside the mixed species feeding flock. Foliage was the most preferred feeding substrate and horizontal posture was the most favoured when inside the mixed species flocks.

FOOD RESOURCE PARTITIONING AMONG THREE KINGFISHER SPECIES AT THE BELLANWILLA-ATTIDIYA WETLAND

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Three species of kingfishers; the Common Kingfisher (*Alcedo atthis*), the White-throated Kingfisher (*Halcyon smyrnensis*) and the Pied Kingfisher (*Ceryle rudis*) occur sympatrically in most wetlands in Sri Lanka. The three species differ in body size, with the common kingfisher being the smallest and the white-breasted kingfisher being the largest of the species. Since food is the primary factor affecting resource-use patterns in sympatric bird species, the foraging behavior of the kingfishers was studied to understand the potential mechanisms that enable stable co-existence of the three species. The study was conducted over ten months from May 2009 to February 2010 at the Bellanwila-Attidiya urban wetland. Three trails were selected bisecting four different microhabitats and observations on feeding behavior were conducted between 0600 and 1700 hrs. Focal animal sampling was also conducted in the morning, afternoon and evening to record prey type and foraging frequency.

Results showed that there were interspecific differences in foraging sites with the common kingfisher more frequently capturing prey from streams (56 %), the pied kingfisher from open water areas (61 %) and the white-throated kingfisher from swamps (44 %). Preferred prey types were also identifiable with both the Common and Pied Kingfishers preferring fish, whereas the White-throated Kingfisher fed on both insects and fish. Significant interspecific differences were evident in the foraging times with the common and pied kingfishers recording the highest feeding frequency in the morning and evening, whilst the White-throated Kingfisher fed throughout the day. These results imply that the mechanism of coexistence among the three kingfishers is to a large extent related to their feeding habits.

STAKEHOLDERS, MANAGEMENT PROBLEMS AND PROSPECTS FOR COLLABORATIVE MANAGEMENT OF THE MADURU OYA NATIONAL PARK

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The Maduru-oya National Park (MONP) is the third largest national park of Sri Lanka. Despite rich biodiversity and scenic splendor, MONP has been neglected for decades due to uncertain security conditions. Park is surrounded by rural communities including two resettlements of indigenous *Veddhas*.

This study was carried out from June 2007 to June 2009, to identify; key stakeholders and their interactions with the Park, current management problems and their causes in order to give recommendations for park management. Data was gathered from potential stakeholders using structured interviews and Participatory Rural Appraisal. Transect walking across representative habitats was done to witness management issues. Matrix Ranking, Pair-wise Ranking, Problem Analysis, Impact Diagrams, Network/ Flow Diagrams, Participatory Mapping, Wealth and Wellbeing Charts, Seasonality Charts, Daily Routine Charts and Livelihood Profiles were employed as information generation tools.

Matrix Ranking indicated that key stakeholders are the Department of Wildlife Conservation (DWC), Army Special Forces (ASF), Army Training School (ATS), *Veddhas*, Fishermen, Timber-fellers and Peripheral Villagers. Major management problems prioritized by Pair-wise Ranking were illegal timber-felling, human-elephant conflict, over-fishing, military activities, illegal poaching, excavation of treasure sites and collection of firewood and other non-timber products among which interactions of *Veddhas* are exclusive to MONP. Illegal activities were minimal in the areas utilized for military training. Adverse impact of ATS on park resources was remarkable. Major causes for these management problems were lack of funding and labour for maintenance, poor staff motivation, lack of staff and vehicles for patrolling, inadequate road-network, poor visitor interactions, lack of awareness and mutual trust between stakeholders and poverty of the peripheral communities.

In contrary to the current institutional provisions for a centralized management structure, the study stipulated that a participatory management approach which is a partnership by which various stakeholders agree on sharing among themselves the management functions, rights and responsibilities would be suitable. DWC officials already work in collaboration with ASF in apprehending illegal entrants in an informal manner. Due to poor facilities prevail with DWC it is wise to methodically collaborate with ASF. A zonation plan is essential to demarcate core, visitor and buffer zones. Military activities should be prohibited in the core area. Activities of villagers should be restricted to the buffer zone. Eco-development including ecotourism should be introduced to alleviate poverty of marginal communities. Community participation in park management activities and Conservation education programmes should be introduced to make stakeholders aware about their responsibility to conserve the natural asset they use.