

D 158	D 166	D 174	D 182	D 190	D 198	D 206
D 159	D 167	D 175	D 183	D 191	D 199	D 207
D 160	D 168	D 176	D 184	D 192	D 200	D 208
D 161	D 169	D 177	D 185	D 193	D 201	D 209
D 162	D 170	D 178	D 186	D 194	D 202	
D 163	D 171	D 179	D 187	D 195	D 203	
D 164	D 172	D 180	D 188	D 196	D 204	
D 165	D 173	D 181	D 189	D 197	D 205	

D 158

Diuretic effect of *Anisomeles indica* kuntze

Anisomeles indica (Lamiaceae), [Sinhala: Yakwanassa, Tamil:Peyameratti] is a perennial herb grown in the wild in Sri Lanka. A decoction of leaves and stems of this plant is claimed to possess diuretic activity. However, such activity and the growth stage of the plant having the activity have not been verified through a controlled scientific investigation. The aim of the study were to scientifically investigate the diuretic activity an the growth stage of the plant which is effective using rats. Freeze -dried decoctions of leaves and stems of plant at pre-flowering (E1) and flowering (e2) stages were orally treated separately on rates and they were orally hydrated with 50 mL/kg body weight of normal saline. The tested doses were 250 and 500 mg/kg body weight of E1 and 500 mg/kg body weight of E1 and 500 mg/kg body weight of E2 in 1mL of water. Frusemide (13 mg/kg) was used as the reference drug. The urine out put of these rats were measured after 6 h of treatment. The rats treated with 500 mg/kg of E1 significantly ($P<0.01$) increased the urine output (by 124%) while frusemide significantly ($P<0.05$) reduced the urine out put by 61%. However, 250 mg/kg of E1 and 500 mg/kg of E2 failed significantly to alter the urine out put. The treatment of E1 also significantly ($P<0.01$) decreased the sodium and potassium ion excretion. The mechanism of the diuretic action of aldosterone. These observations reveal that *A. indica* has a powerful diuretic action and scientifically justify the diuretic claimed in the traditional medicine of Sri Lanka. However, the present study showed that only the plant at pre-flowering stage is effective.

D 159

Antifungal properties of *Cinnamomum zeylanicum* and *Carrophyllus aromaticus* against *Colletotrichum musae* and *Lasiodiplodia theobromae*

Storage of banana is made difficult by post -harvest fungal diseases such as anthracnose and crown rot. Approximately 20%-30% of the annual production of banana is lost due to post-harvest diseases and malpractices during handling, storage and transport. Benzimidazole fungicides such as Benomyl (Benlate) have been used on banana for effective control of post harvest disease in several countries, including Sri Lanka. Anthracnose and crown rot are two most common post-harvest diseases reported in Sri Lanka. Crown rot is caused by *Colletotrichum musae*, *Fusarium moniliforme*, *Verticillium theobroma* and *Lasiodiplodia theobromae* while anthracnose is caused by *Colletotrichum musae*.

The primary objective of this study was to develop an effective post harvest treatment system against *C. musae*, *L. theobromae* and *F. moniliformae*. The isolated and identified organisms associated with anthracnose and crown rots were treated in vitro with volatile extracts of cinnamon bark (*Cinnamomum zeylanicum*), cinnamon leaf and buds of clove (*Carrophiilus aromaticus*) in a liquid medium. The extracts showed high fungicidal activity even at low concentrations against the growth of *C. musae* and *L. theobromae*.

Cinnamon bark, cinnamon leaf and clove oils were fungistatic against *Colletotrichum musae* & *Lasiodiplodia theobromae* between arrange of 0.03%-0.05% and 0.035%-0.06% respectively and were fungicidal at 0.04%-0.007%, and 0.045%-0.08% respectively.

D 160

Bioactivity of the essential oil of *Cymbopogon citratus* (Lemongrass) on *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) [Rice Weevil]

Sitophilus oryzae is the most destructive and common insect pest in rice and paddy. At present, Phosphine and pirimiphos methyl, are used to control this pest. Synthetic pesticides cause various problems and to overcome them, it is necessary to look into alternative methods.

The objective of the present study was to evaluate the insecticidal and / or repellent action of essential oil of *C. citrates* against *S. oryzae*. The essential oil of *C. citrates* was used for the choice testes and toxicity bioassays.

The repellent activity of the essential oil of lemongrass was studied using the olfactometer and Choice Chamber bioassays. The olfactometer bioassay showed a significantly higher repellent activity of test insect at doses higher than 75 mg of essential oil, whereas the results obtained from the Choice Chamber bioassay showed no significant repellence when compared to the control. The fumigant toxicity test showed about 90% mortality at 2.5 g/L concentration of essential oil and in the contact toxicity bioassay more than 80% mortality was observed at the concentration of 26 g/m². The LC₅₀ values of the essential oil due to the fumigant and the contact effects were 1.14 g/L and 7.8 g/m² respectively. These two studies showed that the contact toxicity is more effective than fumigant toxicity.

All four bioassays revealed the repellent and fumigant potential of *C. citraus*. The test oil cold be developed as a biopesticide to control *S. oryzae* in stored rice and paddy.

D 161

Insecticidal and repellent activity of volatile leaf constituents of - *Azadirachta indica* (A-juss) [Neem] against *Callosobruchus maculatus* (L) inhabiting stored cowpea

Bioassays were carried out to assess the efficacy of neem leaf volatiles compounds using fumigant toxicity, contact toxicity and Choice Tests to mange *C. maculates* in cowpea. The results of fumigant toxicity and the contact toxicity of neem leaf volatiles showed that 100% mortality could be achieved at contact higher than 0.52 g/L and 1.98 g/m² respectively on 3rd after treatment. The LC₅₀ value of neem leaf volatile due to fumigant toxicity and contact toxicity were 0.35 g/L and 1.07 g/m² respectively.

The repellent activity of neem leaf volatiles was investigated using Choice testes. The results obtained from the Olfactometer test revealed percentage of bruchid responded was significantly low (less than 27%) at doses higher than 80 mg when compared to control (73 %). During the Choice Chamber test insects in all treated samples showed repellent activity against neem leaf volatiles. In cowpea seeds treated with neem leaf volatile at dose of 160-40 mg, the mean number of bruchid moved was 0-3 ($p < 0.001$) where as control and ethanol treated samples showed the movement of 36 and 29 mean numbers of bruchids respectively. At the higher doses (160 - 80 mg) the number of eggs laid was zero. Significantly higher number eggs (< 80) was laid in control and ethanol treated samples.

D 162

Evaluation of the efficacy of Bird Chili (*Capsicum frutescens var longum* L., *Capsicum frutescens var conid* L) and Green Chili (*Capsicum annum var fasciculatum*) against Black been aphid (*Aphis fabae* Scop.) of Long bean (*Vigna sesquipedalis* L.)

Water extracts of fresh pods of *Capsicum frutescens var longum* L, *Capsicum frutescens var conid* and *Capsicum annum var fasciculatum* were tested against *Aphis fabae* on long bean. Under the laboratory conditions, effective concentrations of these varieties were made using 500 g/L of *C.f. var fasciculatum*, 600 g/L of *C.f. var. conid* 700 g/L of *C. f. var longum*. Each test plant was allowed to infest 50 aphids prior to start the experiment all treatments were applied in same amount. (5ml for each plant) the two control treatments were also carried out by spraying water and without water. Population densities of aphids on test plants were counted at 24, 48, and 72 h intervals after 1st application. It was clear that the population densities on the plants treated with these three treatments were significantly lower from two control treatments. ($p, 05$). Though there were no significant difference among these three varieties, when the aqueous extractions of *C. a. var. fasciculatum* was applied aphids population density on long bean declined rapidly than the other treatments that the best out of these three varieties.

D 163

Host selection and host acceptance by *Anisopteromalus calandrae* (Howard), a hymenopteran parasitoid of *Callosobruchus chinensis* (L.)

Mung bean (*Vigna radiata*) is an excellent protein source and considered as one of the important legumes in Sri Lanka. *Callosobruchus chinensis* is a serious pest of stored mung seeds and *Anisopteromalus calandrae* is a well-known cosmopolitan parasitoid of *C. chinensis*. Information on the host selection and acceptance strategies of *A. calandrae* is useful for the development of a successful biological control of *C. chinensis* using this parasitoid. Therefore two laboratory experiments were carried out to study the host selection and acceptance strategies of *A. calandrae*. In the first experiment egg, larval and pupal stages of *C. chinensis* were offered for oviposition of *A. calandrae*. It was revealed that the parasitoid oviposited only in the larval and pupal stage of the pest. Percentages of parasitization were 73 and 80 respectively. To study the exact age of the host, accepted by *A. calandrae*, different host groups aged from day 0 to 18th days (from the day of the eggs deposited) were separately offered for oviposition by *A. calandrae*. It was clear that parasitoids accepts only 12th to 17th days old hosts which contains mature

larvae and pre pupal stages of host for oviposition. Percentages of adults, emerged from 11 to 16 days old, larvae, were 70, 78, 73, 80, 81 and 68 respectively.

D 164

Malpractice in pest management strategies adopted by farmers in Weligama area

In Sri Lanka rural agriculture sector plays a key role in rice and vegetable cultivation and insect pest problem, which causes yield loss is a major issue. Most pesticides used by farmers are highly toxic. There is evidence that use of such chemicals cause major environmental problems as well as health hazards in man. Unawareness and ignorance of effective pest management strategies in insect pest management programs has become a major constraint in implementation of Integrated Pest Management Programs. Objective of this study was to find out farmers' knowledge on pest controlling practices and to find out major constraints in Integrated Pest Management. In our study a questionnaire was prepared to estimate the awareness of crop protection and pest management strategies adopted. Farmers in Weligama area were surveyed. Results clearly showed the over dependence on pesticides by farmers. Unawareness of their effects on environment, target species, non-target species and human health were major issues identified. It was revealed that over 60% of farmers use prophylactic treatments even before appearance of any pest. Seventy-percent of people have no knowledge on Economic Injury Level. Though 60% of farmers are aware of pesticides prepared from plants, they are reluctant to use them in pest management programs due to long preparation methods and late action. This has been a major constraint in implementation of biological methods in Integrated Pest Management programs. Most farmers are unaware of pesticide toxicity and pesticide safety. It is clear that to promote and popularize Integrated Pest Management practices, farmer knowledge and attitude on safety of environment and other organisms should be improved.

D 165

Effect of soil nutrient status on the invasion of *Prosopis juliflora* and *Opuntia dillenii* at Bundala National Park

Prosopis juliflora and *Opuntia dillenii* have invaded the thorn scrub forests in the southern dry forests of Sri Lanka. This study was conducted to identify soil nutrient status that may have influenced the successful invasion of the two alien species.

Soil pH and macronutrients including nitrogen, phosphorus, potassium, calcium, magnesium & sodium were examined in four 40 m diameter circular plots at Bundala National Park. Foliar nutrient contents were estimated in the selected dominant species and in two invasive species to find out nutrient absorption relationships.

Results showed that the concentrations of potassium, calcium, magnesium and sodium in the soils of pure invasive plant stands are significantly higher than that of natural forest soil (Pooled t test: $p < 0$, <0.004 , <0 , <0 respectively). Studied invasive species had high contents of potassium and calcium in their foliage when they grew in places where the alkali cation concentrations were high. No differences were observed in the pH, nitrogen, and phosphorus contents of different soils and they may not affect the successful invasion of two alien species.

The invasion of *P. juliflora* and *O. dilleni* in the study area is strongly influenced by the concentration of alkali cations in the soil and these species can absorb and store high potassium and calcium concentrations when they grow on soils where potassium and calcium concentrations are high. It may be one reason for their adaptation to grow successfully in such habitats.

D 166

A study of the effects of *Parthenium hysterophorus* on the species diversity of local habitats

Parthenium hysterophorus is a noxious exotic weed that believed to have been introduced into Sri Lanka through the goats imported for IPKF in the late eighties. Within a brief period it has invaded various other parts of Sri Lanka, including Jaffna Peninsula. Its invasive and noxious potentialities have been highlighted in many reports.

Its invasion may lead to the elimination of some local species affecting the species diversity of the local habitats. In order to evaluate this a quantitative survey was performed using the random sampling quadrat method.

Where *Parthenium* was present, the number of species other than *Parthenium*, ranged from 0-17. Where *Parthenium* was absent, the number of species other than *Parthenium* ranged from 6-36. From the t-test ($p=0.05$) indicates that there seems to be a correlation between the presence of *Parthenium* and species diversity.

It is evident from the results that *Parthenium* has definite ill effects on the floral diversity of the habitat where it is present. This may lead to serious damage to the ecology of such habitats, and also the natural balance of these habitats.

D 167

Differences in seedling growth of tree species in relation to simulated light environments in a Sri Lankan lowland rain forest

Differences in seedling growth of five species belonging to genera *Mesua*, *calophyllum*, *Garcinia* (Clusiaceae) and eight species of *Shorea* (Dipterocarpaceae) under different light levels in shade houses were investigated over a period of one year from January 2000 to January 2001 at the Sinharaja field research station.

Seedlings were grown under four light environments ($1200 \mu\text{mol m}^{-2}\text{s}^{-1}$, $800 \mu\text{mol m}^{-2}\text{s}^{-1}$, $350 \mu\text{mol m}^{-2}\text{s}^{-1}$, $50 \mu\text{mol m}^{-2}\text{s}^{-1}$) that represented a range of PPFD (photosynthetic photon flux density) found within the forest. Five seedlings of each species were grown in each light environment, which was replicated three times. At the end of one year the height increments and percentage survival of seedlings were measured.

The study revealed that *Garcinia*, *Calophyllum*, and *Mesua* species showing the lowest height increments when grown in $50 \mu\text{mol m}^{-2}\text{s}^{-1}$ light level. The greatest relative height growth was observed in $350 \mu\text{mol m}^{-2}\text{s}^{-1}$. Plasticity (ratio between highest and lowest values among light treatments) measurement of height increment was greatest in *Garcinia hermonii* (18.59), lower in *Calophyllum trapezifolium* (4.63) compared to *Calophyllum bracteatum* and lower in *Mesua nagassarium* (6.109) than *Mesua ferrea* (7.39). Percentage seedling survival of *Garcinia hermonii* ($50, 350, 800 \mu\text{mol m}^{-2}\text{s}^{-1}$, 86.61%; $350 \mu\text{mol m}^{-2}\text{s}^{-1}$, 93.4%) was lower than that of the other four species (100%) in all four different light treatments. The mean relative height increments of all eight *Shorea* species were higher at $350 \mu\text{mol m}^{-2}\text{s}^{-1}$ except *Shorea congestiflora* and *Shorea disticha* compared to that in each of the three light treatments. The greatest mean height increment was observed in $800 \mu\text{mol m}^{-2}\text{s}^{-1}$ light level in *Shorea congestiflora* and *Shorea disticha*. *Shorea cordifolia* exhibited the greatest (12.81) plasticity in height among different light levels. Percentage seedling survival of *Shorea megistophylla* was higher (100%) than that of the other species in all light treatments.

The results suggest that $350 \mu\text{mol m}^{-2}\text{s}^{-1}$ light level favours growth of all species in the Clusiaceae except *Mesua ferrea* and in Dipterocarpaceae except *Shorea congestiflora* and *Shorea disticha* in seedling stage.

D 168

Effect of light seedling growth and survival of nine late - successional tree species growth across topographic positions within Sinharaja rain forest

Light, and moisture availability are key factors, determining seedling establishment in tropical rain forests. Growth and survival of tropical forest tree seedlings are dependent on the total daily photosynthetic photon flux density in the canopy gap and forest understory. The radiation regime in the canopy gap is strongly dependent on the size, location and aspect of the canopy gap.

In this study we have investigated the influence of light for seedling growth and survival of nine late-successional tree species planted in the canopy gap and forest understory on different topographic positions; valley, mid-slope and ridge-top. At the end of every six months height and mortality were recorded and total daily photosynthetic photon flux density was recorded on full sunny days.

The largest amount of photosynthetic photon flux density (PPFD) 29.9 mol/m^2 /day was recorded in the ridgetop and the lowest PPFD 2.3 mol/m^2 /day was recorded in the centre of valley site. The respective PPFD of full sun were 75% and 32.6%. The PPFD received by the centre of midslope site was 18.9 mol/m^2 / day and it was 48% of PPFD of the full sun.

After three years, survival and growth performance of seedlings planted in gap and understory plots in the valley, midslope and ridgetop sites were compared. Results

showed that clear differences in survival and growth of seedlings among sites. Growth and survival of seedlings were greater on the gap site than all understories in all locations and *Shorea disticha* exhibit high growth performance than other species on each topographic position in each site. Survival of these in the understory decline progressively from valley to ridgetop and Seedlings of *Mesua Ferrea* had a higher survival than other species in the canopy opening and understory conditions of the topographic position. These differences are related to the available amount of daily total photosynthetic photon flux density and soil moisture.

D 169

Measurement of light quantity and air temperature variation within Sinharaja rain forest

The amount of light quantity in a canopy gap is strongly dependent on the size, location and aspect of the canopy gap. Larger the gap, the amount of light quantity that may reach in the forest floor will be higher. For this reason different size of gaps may have different microclimates.

Objective of this study was to determine the variations of light quantity and air temperature in canopy gaps and forest understories of three different topographic positions, valley, midslope and ridgetop within the Sinharaja rain forest.

The largest amount of photosynthetic photon flux density (PPFD) 29.9 mol/m²/day was recorded in the ridgetop and the lowest PPFD 12.3 mol/m²/day was recorded in the centre of valley site. The centres of the ridgetop gaps were exposed for a long duration of full sun due to its aspect and the centre of valley site gaps were exposed for a shorter duration of full sun. The respective PPFD of full sun were 75% and 32.6%. The PPFD of the full sun. On a sunny day the light quantities received valley, midslope, and ridgetop forest understories were between 0.60 – 2.50 mol/m²/day, 0.63 – 1.90 mol/m²/day and 0.35 -2.00 mol/m²/day, respectively. IN the forest understorey the effect of the dynamics of light is mainly due to the contribution of sun flecks.

Diurnal temperature range was wider in the centre of gaps than adjacent forest understories. On sunny days the highest temperature observed was 29 °C and it the gap centre of ridgetop. The lowest temperature observed 26 °C was in the centre of the valley site.

D 170

Potential for a community based management system for four selected non-timber forest (NTF) species in the buffer zone of Sinharaja MAB reserve

Caryota urens (kithul), *Calamus ovoideus* (cane), *Cosinium fenestratum* (weniwel) and *Elettaria cardamomum* (wild cardamom) are four widely used non-timber forest (NTF) species around Sinharaja. Two peripheral villages (kudawa and Pitakle) of the Sinharaja were surveyed to gather information on a suitable community based buffer zone management system using these species.

Tea is the major cash crop of both villages. There is a considerable dependency of villagers on the forest for fuel wood and medicinal plants but not the above NTF species. In each village, more than 25% of the households tapped kithul and more than 1/3 of the households use *Coscinium fenestratum* for its medicinal value. With respect to cane only 6% of the households in Kudawa used it for basketry. None of the surveyed households in either village collected the wild cardamom on a commercial scale. More than 85% of the households in each village responded positively to develop a community of the households in both villages were willing to obtain renewable permits for harvesting these NTF species. The proportion of households interested in cultivating cardamom or kithul in the buffer zone was 80% in Pitakele and 37% in Kudawa.

The results suggest that a community management project using these NTF species will be successful in the buffer zone of Sinharaja forest and that it could be developed using indigenous knowledge to combine biodiversity conservation with economic benefits.

D 171

Studies on propagation and growth conditions of *Piper longum* (L.) in Sri Lanka

Piper longum (L.) of family Piperaceae is a perennial herb with a branched rootstock and an ascending or prostrate stem. Almost all its parts are used for medicinal purposes.

Three separate experiments were carried out to determine the best type of cuttings/s, best substratum and optimum shade level for its growth.

Selection of the best type of cutting for propagation was investigated by planting five different types of stem cuttings (comprising the one, two and three uppermost node/s, and 2 and 3 nodes without the uppermost node). 96% of cuttings comprising the two uppermost nodes rooted. This result was significantly higher ($p < 0.01$) than the results obtained from the other types of cuttings, which ranged between 86 – 92%. *Piper longum* did not require hormonal application to enhance rooting.

The most suitable substratum was examined by growing plants in sand, top soil (Reddish Brown Latosolic) and farm yard manure mixed in the ratio of 2:1:1: (A), 3:1:0; (B) and 1:1:1 (C). The performance of *P. longum* grown in substratum C was significantly higher ($p < 0.01$) than that in the other substrata.

To evaluate the optimum shade requirement, *P. Longum* plants were grown in shelters under three shade levels (25%, 50% and 75% shades), obtained by using 1-2 layers of coir mesh combine with UV treated polythene. Light intensities were measured using quantum sensors (LI -190Z, LiCor and a data logger (LI-1000, LiCor). The means of plant height, leaf number and chlorophyll content were all significantly higher ($p < 0.01$) in plants grown in 50% shade compared to that in each of the remaining shelters.

D 172

A preliminary investigation on the species delimitation of the genus *Stemonoporus*

Stemonoporus is an endemic genus of the Dipterocarpaceae family in Sri Lanka. Most recent taxonomic treatments towards species limits of *Stemonoporus* are not in agreement with each other. Therefore an attempt was made to carry out a numerical analysis using morphological data to determine the species limits of *Stemonoporus*. All data for the analysis except for the stamen number were extracted from herbarium specimens. The data matrix consisted of 18 characters and 95 operational taxonomic units (OUT). The results of the analysis were in agreement with the recognition of *S.wightii*, *S. elegans*, *S.lanceolatus*, *S. oblongifolius*, *S. affinis*, *S. kanneliyensis*, *S. gardneri*, *S. scalariformis* of Kostermans's and Sahnton's. the OUT's of the taxa that were in disagreement with each others classifications tend to show heterogenic groupings in the present analysis as well. The results support Kostermans views in splitting taxa but it does not fully agree with his groupings. Although a preliminary investigation, the study strengthens the position of the taxa recognized by both treatments and provides a valuable base for further study. It also stresses the need of an in depth study for other taxa which showed heterogenic groupings with taxonomically more informative characters such as floral characters as well as using anatomy, photochemistry and molecular biology related characters.

D 173

A comparative study of seed amino acid content, pollen germination and drought tolerance of two grain legumes and their tentative wild relative

The majority of pulse grain belonging to the tribe *Phaseoleae* of the sub family *Papilionoideae*, are an important source of protein for human diets in the tropics. Wild relatives of pulse grains had proven to possess many desirable characters, such as, high nutritive value, resistant to diseases and pests, insecticidal properties, delayed dehiscence of pods.

One of the identified potential wild species that can be used to improve the pulse grains is *Macroptilium lathyroides* (L.) urban. In this study *Macroptilium lathyroides* was compared with two *Vigna* spp.

The findings revealed that the total free amino acid content in seeds was high in *Macroptilium lathyroides* (48.11 ± 2.13 mg/g) when compared with that of *Vigna radiata* (44.22 ± 1.23 mg/g) and *Vigna mungo* (41.78 ± 0.96).

The germination percentage of pollen samples was done to assess the pollen viability. It indicated that there was no significant difference ($p > 0.05$) between *Vigna mungo* (74.3 ± 2.49) and *Macroptilium lathyroides* ($70.0\% \pm 4.78$), whereas, a comparatively low germination percentage was recorded in *Vigna radiata* ($57.7\% \pm 3.74$). to study tolerance to water stress, two parameters were taken into account. Percentage survival of seedlings revealed that wild species had the highest resistance to the drought condition (90%) and this was followed in decreasing order by *Vigna radiata* (80%) and *Vigna mungo* (75%). This was confirmed by the study of stomatal index, where the wild species showed the lowest stomatal index (19.405 ± 0.9990) and this was followed by *Vigna radiata* (22.565 ± 0.588) and *Vigna mungo* (23.613 ± 0.956) in increasing order.

As *Macroptilim lathyroides* is closely related to the species belong to the genus *Vigna*, it can be used to improve these species through conventional or molecular breeding methods.

D 174

Protein nutritional quality of processed *Canavalia gladiata* (Awara)

The bean *Canavalia gladiata* though categorised as an unconventional legume, has agro-economical features suitable for growth in tropical climate and a high yield. Since chemical composition studies indicated a high protein content (29%), the intention of this study was to find out effect of household processing methods on the nutritional quality of protein by biological evaluation.

Evaluation of true digestibility (TD), biological value (BV) and net protein utilization (NPU) of diets made with mature *Canavalia* seed flour (40-60 μ m) grits (1mm² < grits < 2 mm²) were carried out with male Sprague-Dawley rats. The processing methods included, soaking, boiling, soaking and boiling, autoclaving, roasting of grits and roasting of flour. The NPU of all the processed samples were significantly lower than the reference ($p \leq 0.05$). The NPU of boiled only (38.6) and soaked and boiled grits (37.6) were significantly higher ($p \leq 0.05$) than the other processed samples [autoclaved grits (31.0), roasted grits (15.1) and flour (10.8) and soaked (1.6) grits]. TD of heat the processed samples (boiled (84.8), soaked and boiled (76.2) autoclaved (82.0) roasted (64.5) grits and roasted flour (61.2)] increased significantly ($p \leq 0.05$) when compared to the raw (51.4) and soaked samples (35.8). The BV of boiled only and soaked and boiled grits were significantly higher than the other heat processed samples though lower than the reference ($p \leq 0.05$). The lower nutritional parameters of the soaked grits indicate that soaking give rise to some adverse components that lower the digestibility. This is also confirmed by the low digestibility of soaked and then boiled grits. Boiling of the grits gives the best nutritional parameters for protein quality.

D 175

Systematics of the worker ants collected from the premises of Kelaniya University

Ants (Order: Hymenoptera; Family: Formicidae) are widely distributed and widely distributed and ecologically important insects but little is known about the systematics of Sri Lankan ants. Two hundred and eighty six samples of worker ants were collected by baited trap method and manually from bare ground, leaf litter, buildings, bushes, trees and grass in the premises of Kelaniya university and the samples were preserved in 85% ethanol. A light microscopic study of the morphology and systematics of the ants in each sample was carried out. Ants belong to the Dolichoderinae, Formicinae, Myrmicinae, Pseudomyrmecine and Ponerinae subfamilies were observed in this collection. *Technomyrmex* Mayr and *Tapinoma melanocephalum* Fabricius were present among the dolichoderines whereas *Oecophylla smaragdina* Fabricius, *Camponotus* Mayr, *Paratrechina* Motchoulsky, *Paratrechiina longicornis* Latrielle, *Anoplolepis* Santschi, *A. gracilipes* Emery, and *Polyrhachis* Swains and Shuck were found among the formicines. Among the mymicines *Monomorium* Mayr, *M. pharonis* L., *M. destructor* (Jerdon), *M. floricola* (Jerdon), *Pheidologeton* Mayr, *P. diversus* Fred Smith, *Crematogaster* Lund, *Pheidole*

Westwood, *P. spathifera* Forel, *Meranoplus* Smith, *M. bicolor* Guerin, *Solenopsis geminate* Fabricius, *Tetraopnera rufonigra* Jerdon was the only species present among the Pseudomyrmecines. The ponerines *Odontomachus* Latrielle, *Odontomachus simillimus* Fred Smith, and *Diacamma* Mayr were also identified in the collection.

D 176

Preliminary studies in Esterase Related resistance and taxonomic status of *Rhynchophorus ferrugineus* Oliv. (Coleopters:Curculionidae) populations collected from the areas of the coconut triangle in Sri Lanka

Rhynchophorus ferrugineus, the only reported species of the genus *Rhynchophorus* in Sri Lanka, is one of the major pests of coconut (*Cocos Nucifera*) in Southeast Asia. It has been reported that different individuals exhibit varying morphological characters and the possibility of having more than one species or populations among these weevils. Organophosphates are the main insecticides used in controlling these insects in Sri Lanka. The main objective of this study was to verify the taxonomic status of *Rhynchophorus* in Sri Lanka and to determine the insecticide resistance among the populations.

The weevils (61 individuals) were collected from five different areas namely, Kaduwela, Wadduwa, Madurankuliya, Mirigama and Dankotuwa; representing the coconut triangle of Sri Lanka and which had been exposed to different regimes of organophosphate spraying over the last ten years. The colour of all the collected individuals were reddish brown and displayed a male to female sex ratio of 1:2 and their mean total length was 33.3 mm \pm 0.016. A majority of individuals (55.73%) had even spots, while in other individuals spot number varies from six to three on their thorax. However the number of spots documented has been either four or six. The mitochondrial DNA analysis was carried out using the universal primer pair designed from the 5' end of the 12S gene in mitochondrial DNA of insects. In each study site at least six individuals were sequenced in both directions. A 355 dp sequence of 30 insects was obtained. Molecular differences were not present in the four populations except a one base pair change in two of the individuals (7% difference). Amino acid sequences reveal that, both changes are silent. The comparison of sequence data obtained for 12S ribosomal sequence with DNA database BLAST suggest the closest relative available is *Chrysolina varians* (63%).

The mean specific activity value of the esterases assay was 0.1328 μ moles/min/mg in the field populations. Native PAGE gels run and stained for esterase enzyme showed individual variations among and between populations. Studies suggest that *Rhynchophorus ferrugineus* is the only species of this genus present in Sri Lankan coconut plantations. However, to identify the genetic variations and resistance status among populations more studies are necessary.

D 177

Insecticide resistance of the malaria vector *Anopheles culicifacies* collected from four districts in Sri Lanka

Insecticide resistance status and underlying mechanisms were studied in the major vector of malaria *Anopheles culicifacies* collected from four high malaria transmission districts, namely Anuradhapura, Moneragala, Puttalam and Trincomalee during 199 Sept.- 2001 March. Adults were tested for the World Health Organization (WHO) recommended discriminative dosage of DDT, Malathion, propoxur, lambda-cyhalothrin, deltamethrin, cypermethrin, permethrin and etofenprox. Preparation of insecticide impregnated papers and the test procedure were according to the WHO standard methods.

An. Culicifacies from all four districts were highly resistant to organophosphate malathion, but highly susceptible to carbamate propoxur. Out of the pyrethroids tested, all populations gave 100% mortality to lambda-cyhalothrin and cypermethrin. 3.3% of Moneragala and Trincomalee populations showed resistance to deltamethrin. Resistant percentages to permethrin were 50%, 35%, 13% and 77% for Anuradhapura, Moneragala, Puttalam and Trincomalee populations respectively. For etofenprox, resistance percentages varied from 5%-15%.

Activity levels of insecticide detoxifying enzymes were also investigated. Carboxylesterase activity was measured with the substrate para-nitrophenylacetate. Highest mean specific activity was from Moneragala ($1.01 \pm 5.55 \mu \text{mol min}^{-1} \text{mg}^{-1}$). Native polyacrylamide gel electrophoresis resolved one elevated esterase isozyme, with high affinity to activity levels of glutathione S-transferases for the substrate reduced glutathione/chlorodinitrobenzene were observed from all populations. High oxidase levels were reported from Trincomalee ($1.09 \pm 3.39 \mu \text{mol min}^{-1} \text{mg}^{-1}$) and Moneragala ($0.99 \pm 2.20 \mu \text{mol min}^{-1} \text{mg}^{-1}$). Inhibition of the organophosphate and carbamate target-site, acetylcholinesterase (AChE), indicated the presence of altered AChE mechanism in 1.8 - 6.5% of these populations. Carbamates and some pyrethroids can be used successfully in vector control programmes.

D 178

Status and mechanisms of insecticide resistance in three rice insect pests and two of their natural enemies

Insecticide resistance of three rice insect pests (i.e. green leafhopper *Nephotettix virescens*, white planthopper *Cofana spectra*, Paddy bug *Leptocorisa sp.*) and two of their natural enemies (i.e. ladybird beetle *Micraspis discolor* and ground beetle *Ophionea indica*) was studied using insects collected from a rice field at Batalagoda. Adults were subjected to insecticide bioassays by topical application using a microapplicator. Different dosages of insecticide bioassays by topical application using a microapplicator; carbamate carbosulfan and BPMC; and pyrethroid permethrin were used. Mortalities were recorded after 24h and LD₅₀s and LD₉₀s were obtained using log-probit mortality curves. Higher organophosphate, pyrethroid and carbamate tolerance was shown by *N. virescens* and *M. discolor* (respective LD₅₀ $\mu\text{g/g}$ values for dimethoate, chlorpyrifos, permethrin,

carbosulfan and BPMC were 1.875, 5.125, 0.625, 0.25 and 0.9, 10.1, 0.2, 1.2, 4.6). Predatory insects showed higher tolerance for a fixed DDT (organochlorine) dosage.

Highest insect carboxylesterase activity was shown by *N. vireacens* (1.1346 ± 0.7763 $\mu\text{mol}/\text{min}/\text{mg}$). Native polyacrylamide-gel electrophoresis revealed elevated carboxylesterases in all except *O. indica*. High glutathione-S-transferase activities were observed in *O. indica* and *M. discolor* (0.5447 ± 0.5671 and 0.4949 ± 0.3526 $\mu\text{mol}/\text{min}/\text{mg}$ respectively). Oxidase levels were high in *M. discolor* (0.3737 ± 0.4999 OD/mg). Inhibition of the insecticide target site, acetylcholinesterase, by propoxur indicated the presence of insecticide-insensitive target sites in predator populations. Malathion carboxylesterase mechanism was absent in all populations.

Carboxylesterases cause high organophosphate and carbamate resistance in *N. virescens*, *C. spector*, *Leptocoris* sp. and *M. discolor*. Glutathione-S-transferases are responsible for high DDT resistance in predators.

D 179

Wasps associated with a rice field ecosystem

The study on trap-nesting and other wasps was conducted in a rice field in Siyambalapitiya in the Kegalle District, during a single cultivation cycle. Wasps that frequent the rice plants, the bund and peripheral vegetation were collected using a sweep net. Stem-nesting wasps were studied using trap nests of different diameter [2.0 - 6.4 mm], texture [wooden/bamboo] and colour [natural/yellow/green]. A bundle of 12 traps were placed at each of 7 selected locations in the paddy field/. Traps were checked every fortnight for occupancy.

The nests yielded 19 wasps belonging to 3 species. Their duration of development ranged from 18 - 23 days and their nest architecture was similar. *Rhynchium brunneum* [F.] [Eumenidae] nested in wooden traps of natural colour with a diameter of 6.4 mm. *Trypoxylon thaianum* Tsuneki [Larridae] nested in similar traps of diameter of 3.2 mm. *Auplopus mutabilis* [Sm.] [Pompilidae] nested in bamboo traps having a diameter of 5.0 mm. Sweep net collection yielded 13 species of wasps belonging to 7 families [Chrysididae, Eumenidae, Larridae, Nyssonidae, Pompilidae, Sphecidae and Vespidae]. Thus, a total of 13 species of wasps in 11 genera belonging to 7 families were collected and identified during the study. The presence of wasps was especially evident during the reproductive and grain ripening stages of the rice plant. This preliminary study reflects the diversity and abundance of predatory wasps in a paddy field ecosystem that may help in the control of paddy pests.

D 180

A community participatory approach for seed production of *Oreochromis niloticus* (Nile Tilapia) *Oreochromis niloticus* in Rice-fish integration systems

Oreochromis niloticus (tilapia) has a unique place in aquaculture in Sri Lanka and their natural reproduction is an advantage. But both rice and fish farmers have a little knowledge on seed production of tilapia. Rice farmers in dry zone could produce tilapia

seeds in their field, which is known as rice-fish integrated farming. Farmers in Sri Lanka do not practice rice-fish integrated aquaculture and especially the fish seed production in paddy fields. Tilapia produced in paddy fields could be stocked in reservoirs, seasonal tanks or home garden ponds as they show good growth in these 3 aquatic systems.

The trial was carried out in triplicate in Tunkama area. Areas of the rice fields used were 198 m² and 90 m². The culture period was 55 days starting with tillering stage up to beginning of ripening stage of rice. These fields were selected after a thorough examination for its suitability with respect to water supply and mud content. These fields were supplied with irrigated water only during the farming season. Water exchange was carried out once a week. A single trench was prepared in each paddy field and the size of the trench did not exceed 10% of the paddy field. Supporting canals however, were connected with this trench. Height of the bunds of paddy fields were increased and strengthened.

Stocking density and sex ratio used were 0.3 KG m⁻² and 3:1 (female: male) respectively. First fry were observed 25 days after stocking of the brooders. Total number of fry produced were 950 within 55 days. Farmers have observed an improvement of tillering, rice yield and pest control in these fields.

D 181

Performance of a trickling filter constructed with locally available materials for fresh water ornamental fish aquaria

A trickling filter that could be mounted on the outer surface of an aquarium wall was designed and constructed using PVC pipes and pieces of plastic straws as the filter medium for small ornamental fish aquaria. Performance of this trickling filter was evaluated in relation to a conventional under gravel filter by monitoring selected water quality parameters while maintaining an equal biomass of goldfish on a commercially available feed at an equal ration. Three replicates using glass aquaria (60 cm 38 cm 30 cm) were arranged for each filter system and for the control which had no filter.

Void ratio, surface area and volume of the trickling filter were 0.96, 32 cm² and 643 mL while those of under gravel filter were 0.54, 784 cm² and 4000 mL respectively. There was no significant difference between the trickling filter and under gravel filter in converting ammonia to nitrite and then to nitrate ($p > 0.05$). Concentration of dissolved oxygen was significantly higher and water temperature was significantly lower in aquaria with trickling filters ($p < 0.05$) than those of aquaria with under gravel filters. However, pH of water in aquaria with trickling filter dropped to 4.2 towards the end of the experiment (63 days).

Void ratio of trickling filter, which was closer to one, would allow the free flow of water compared to the under gravel filter which could clog rapidly and develop anaerobic conditions in it due to low void ratio. Similarly, use of trickling filters offer more occupy a considerable space within an aquarium. Therefore this trickling filter could be recommended for small scale ornamental fish industry and it should be accompanied with a buffering agent in order to maintain pH.

D 182

Effects of Chloropyriphos on gills of *Rasbora daniconius*

Fish are one of the major components of aquatic ecosystems and their gills are delicate structures directly involved as sites of respiration, osmotic regulation, acid base balance and nitrogen waste excretion. Variety of pollutants including pesticides cause different types of gill lesions that would exert difficulties in the normal functions and behaviors making them vulnerable to predation, less competitive, more susceptible to adverse environmental conditions and finally decline in populations.

Present study is focused on sublethal effects of a widely used Organo - phosphate pesticide foe pests of paddy - Chloropyriphos on the gills of *Rasbora daniconius* commonly found in fresh water habitats.

LC₅₀ value of Chlorpyriphos for *Rasbora daniconius* for 72 h was found to be 0.22 mg/L. *Rasbora* were subjected to different doses (0.0005 mg/L, 0.00125 mg/L, 0.005 mg/L, 0.0075 mg/l and 0.6 mg/L) of Chloropyriphos. Comparative study of types of gill lesions and their severity were performed using histological sections of the gills obtained from the exposed fish.

Eleven different gill lesion types were observed and only 3 -4 lesion types were found in a single individual. Number of severe lesion types increased with the higher doses. The results also revealed that *Rasbora* gills were very sensitive even to a 100 folds dilution of value LC₅₀ and sublethal concentrations could also exert mortality if continuously exposed to the pesticide.

D 183

Establishment of *Poecilia ewticulata* (guppy) as a model toxicokinetic system using parental to offspring effects of Chlorpyrifos (Lorsban)

Toxic effects of Chlorpyrifos on reproduction of fish are little known. In present study Guppy, a viviparous fish with a short reproductive period was selected to investigate guppy as a suitable laboratory model for toxicity tests and to understand reproductive effects of Lorsban (chlorpyrifos) on this fish. Male and female guppy were selected with proven fertility from our own colony and the groups of fish (n=12x6groups) were exposed to pre-determined concentrations of Chlorpyrifos (2 µg/L, 0.002 µg/L) for 14 days based on the 96 h LC₅₀ (7.17 µg/L) for guppy. Mating behaviour of pairs was recorded on the 2nd day of exposure. Offspring were counted and survival recorded on the 14th day. Results showed that number of gonopodial thrusts by male was significantly decreased with the increasing concentrations of Chlorpyrifos in comparison to controls. Gonopodial thrusts /15 minutes: 4, 8 and 11 in fish exposed to 2 µg/L, 0.002 µg/L and control respectively. Live birth reduced significantly to 8/female in fish exposed to 2 µg/L compared to 27/female in the control group. Survival of offspring at the 14 days was reduced to 66% in fish exposed to 2 µg/L of Chlorpyrifos. Results revealed that low concentrations of Chlorpyrifos could impair reproductive behaviour and capabilities of guppy to a significant and reduce their survival. Our study confirmed that Chlorpyrifos could potentially alter mating behaviour, live birth and F₁ survival of

guppy. Guppy is a suitable laboratory model for toxicity tests and could be used for further toxicokinetic studies.

D 184

Influence of water quality and substrate characteristics on the distribution of fish species in some selected tributaries of Nilwala river basin

River Nilwala located in the Southern part of Sri Lanka, with a catchment area of 960 Km², consists of a complex tributary system draining through human settlements and natural forest areas. Considering the enormous natural and anthropogenic effects on these tributaries, the fish fauna of selected tributaries representing different altitudes and habitat types along the river course from Ahalakanda to Malimbada, was studied from September 1999 to May 2000 at eight selected sites.

Physicochemical parameters such as temperature, conductivity, DO, BOD, pH salinity, water depth, flow rate, NO₃⁻ and PO₄³⁻ concentrations were determined. A checklist of the fish fauna was prepared. The relationships between the species distribution to water quality parameters and the substrate type have been established.

A total of 42 fish species were recorded from all sites. Out of these, 4 species namely *Amblyharyngodon melettinus*, *Esomus thermoicos*, *Eleotris fusca*, *Pseudosphromenus cupanus* were not recorded from Nilwala basin in previous studies. The sites located on upper tributaries were of high standard water quality and were associated with substrates consisted of boulders, pebbles, gravel (>60%) and both these criteria were highly correlated to the species composition. Changing water quality of intermediate sites did not show any significant correlation with species composition but associated with specific substrates. As river flows to lowland areas the substrate is replaced by silt. Immediate changes of the water quality from upper tributaries to lowland areas were reflected by the downstream species composition, which is different from that of upland tributaries.

D 185

Species characterization using mitochondrial DNA sequences: a preliminary study using fishes of family Myctophidae

Mitochondrial DNA polymorphism is a widely used tool in population differentiation, species identification, and phylogenetic studies. Development of molecular markers for characterization of morphologically close fish species is immensely important, especially for identification of early life stages. In the present study, the suitability of DNA sequences of a conserved using three morphologically close, widely distributed Myctophid species, namely *Benthoosema glaciale*, *glaciale*, *Notoscopelus kroeyerii* and *Diaphus dumerilii* collected from the Atlantic Ocean.

About 516 base long segment (approximately one third of 16S rRNA gene from fish was amplified by polymerase chain reaction (PCR) and DNA sequences were obtained by cycle sequencing using dye-labelled dideoxynucleotide terminators. The sequence comparison displayed considerable sequence variation among three species and the

pair-wise interspecific sequence divergence varied between 5.1% and 10.5%. This suggests that the mt-16S rRNA gene is a useful marker to distinguish these three species. The sequences were further compared with those from six other Myctophid species (morphologically close). It revealed interspecific sequence divergence between 4.5% and 18.9%. These results show that despite the mt-16S rRNA gene is an evolutionarily conserved gene even among distantly related species, it provides a useful tool in species identification among closely related fishes of the family Myctophidae.

The present analyses also found several sites variable among the species, at which sequences consisted of recognition sites for nine restriction enzymes. Prior knowledge of available restriction sites in the selected gene is a prerequisite for an indirect, yet less expensive method of studying genetic differences, i.e. PCR-based restriction fragment length polymorphism (PCR-RFLP) analysis. Restriction site information revealed in this study can be deployed to develop the above method for Myctophid fishes so that a targeted restriction may generate species-specific fragment profiles making the species characterization much easier.

D 186

Correlation between atmosphere SO₂ content and epiphytic lichen diversity in Colombo and suburbs

Lichens have found to be highly sensitive to disturbances of nature, particularly to air pollution. Sensitivity of lichens, especially to SO₂ in the atmosphere allows them to be used as indicators of air quality.

The present study was carried out to determine whether a correlation exists between the diversity of lichen flora and the SO₂ concentration in the atmospheric air at six different sites within the same climatic zone. Epiphytic lichens on trunks of common trees were recorded using 250 cm² -graduated quadrat. To determine the diversity of lichen flora Shannon's Diversity Index was used. Sulphation rate method using PbO₂ candle was used to determine the SO₂ levels according to the present study there is a strong negative correlation between lichen diversity and SO₂ levels in the atmosphere. ($r = -0.93$, $P < 0.05$, $P < 0.01$; turbidimetric method and $r = -0.95$, $P < 0.05$, $P < 0.01$ gravimetric method).

The diversity of lichen flora was highest in Waga ($H=1.904$) and lowest in Fort ($H=1.268$) while the SO₂ level lowest in Waga (0.01 mg SO₂ / m² / day) and highest in Fort (0.49 mg SO₂ / m² / day). The percentage lichen cover was also highest (49.3%) at Waga and lowest in Fort (16.0%). The relative number of dying lichens was highest in Fort and in Waga such dying colonies were not recorded.

Bark pH and light intensity could influence the distribution and diversity of lichens. However, in this study these parameters were not found to be significantly different among different trees whether they were in the same or different sites. As a significant negative correlation between SO₂ content in the atmosphere and epiphytic lichen diversity was observed in this study, it could be concluded that SO₂ level in the atmosphere has an influence on the diversity of lichens.

Variation in species composition of lichen communities among different sites with in a climatic zone

Epiphytic lichens were studied on selected substrates in sites on a transect from Colombo to Waga, and at Sapugaskanda in order to compare the diversity and species composition of lichen communities at those sites. Common trees having dbh values greater than 30 cm in a 100-sq. meter quadrat were selected for the study. Three trees belonging to the same species were used to register lichens. A 250 cm² quadrat was placed randomly between 0.5 and up to 1.5 m height from the ground on each tree trunk at four different places. Lichen taxa, number of individuals and percentage cover of each lichen taxon were recorded on all substrates. Identification was done using different keys, after studying the characters of different lichens collected. Light intensity; bark pH of trees and relative humidity was also recorded in each site. Shannon index was used in diversity analysis.

Higher lichen diversities were recorded in Waga and Sri Jayewardenepura sites with values of 1.904 and 1.873 respectively, while the lowest value (1.268) was recorded in Fort. Commonest lichens included photophilous genera such as *Pyxine*, *Buellia* and *Pyrenula*. *Pyxine* had higher percentage coverage in all sites except Fort (3.5%) and Waga (1.3%) while; genus *Pyrenula* had moderate cover in all sites. Light, bark pH and moisture are the major environmental factors that determine the species composition of lichen communities that exist in different sites in the same climatic zone. *Leptogium*, a genus with a Cyanobacterial photobiont was recorded only in Waga, which had a higher relative humidity when compared to other sites. However, bark pH values and the exposure of the trees were not found to be significantly different among different trees whether they were in the same or in different sites. *Roccella*, which is a coastal lichen, could be a pollution sensitive species as it was absent in all sites in Colombo except in Sri Jayewardenepura site.

Biodegradation of petroleum hydrocarbons by some marine bacteria

As a consequence of identifying limitations of traditional cleanup techniques, the concept of bioremediation of oil pollution has emerged as a highly effective alternative. The present study was aimed at isolation and identification of petroleum hydrocarbon degrading bacteria from marine environments, and evaluation of their biodegradation potential. Using the enrichment culture technique, ten bacterial species capable of utilizing petroleum hydrocarbons were isolated and identified as *Micrococcus* sp, *Pseudomonas picketti*, *Beneckea harveyi*, *Alcaligenes cupidus* and *Beneckea natrigenes*. In evaluating the biodegradation potential of petroleum hydrocarbons, the isolated bacterial species were experimented as monocultures as well as mixed cultures. As petroleum hydrocarbons, crude oil (Iranian Light) was used and degradation was analyzed by Gas-Liquid Chromatography. When crude oil is the sole source of carbon and energy available for bacteria, it will be attacked and assimilated at the expense of *n*-alkanes. Therefore, the rate of biodegradation of crude oil was estimated by analyzing and quantifying residual *n*-alkanes.

Monoculture of *Alcaligenes aestu* degraded medium and long chain alkanes extensively. But, *Pseudomonas picketti* was unable to show degradation to any extent. As a mixed culture, *Pseudomonas picketti*, *Beneckea harveyi* together with *Alcaligenes* sp. were most effective when compared with other culture combinations. The isolated *Corynebacteriu* sp. showed more than 50% degradation of crude oil as a monoculture but, when it is present in mixed culture combinations, above such of degradation was not observed. All the bacterial cultures biodegraded medium chain n-alkane fraction more readily and the long chain alkane fraction to a lesser extent. The elimination of the short chain n-alknes below C12 was mainly due to the volatile nature of those hydrocarbons. In the presence of glucose as an alternative carbon source, the degradation of alkanes was elevated, but the commencement of the biodgradation was delayed for fourteen days. The degradation of petroleum hydrocarbons was depended on exogenous sources of nitrogen and phosphorous.

D 189

Survey on the distribution of subterranean entomopathogenic fungi in Southern part of Sri Lanka

The soil is a excellent habitat for microorganism and Arthropods. The majority of arthropods live exclusively in the soil, but such as many pterygote insects spend only a part of their life cycle in the soil, usually the larval stage or the pupal stage. The interactions between the soil micro flora and athropods are numerous and greatly influenced by the physicochemical parameters of the soil.

During the present study, distribution pattern of possible soil mycopathogens of insects in the southern part of Sri Lanka was studied. Soil samples were collected from four major sampling sites along the southern coastal belt. Entomopathogenic fungi (EPF) were extracted using the bait insect, *Galleria mellonella* (Greater wax moth) larvae. The physicochemical parameter of the soil was also measured using the standard soil analysis methods. Pathogenicity of the extracted fungi was confirmed by the reinfection of *G. melloneella* larvae using the extracted fungal spores.

Abundance of Entomopathogenic fungi was higher in the wet zone compared to that of the dry zone. Soil temperature and organic contents were negatively related to the abundance of EPF. High salinity favours the abundance of these mycopathogens and the samples collected from coastal zone had more EPF than in samples collected from the inner sites.

D 190

Population structure of the coconut palm population in Sri Lanka as revealed by Randomly Amplified Polymorpjic DNA (RAPD)

RAPD markers were used to assess the population structure of the coconut pal in Sri Lanka by screening 43 out of the 100 ex-situ conserved germplasm at gene banks of the Coconut Research Institute (CRI) these accessions comprised 19 distinct phenotypes [7 tall (typical), 9 dwarf (nana) and 3 aurantiaca (thembili) forms], 7 Philippine-tall-like ecotypes and 17 Sri Lanka tall ecotypes. Twenty pre-tested 10-mar primers were used to

screen the accessions. A total of 186 amplification products (4-13 fragments per primer) with 166 polymorphic fragments were observed. The distance matrix constructed on Nei and Li pair-wise genetic distances ranging from 0.1-0.4. The resultant dendrogram unveiled the population structure of the coconut as an assemblage of two major groups presumably of African and South East / Pacific origin with dwarf types in a single subgroup in the latter, the Sri Lankan tall ecotypes resembling very much the African tall coconut ecotypes, appeared as a single cluster in spite of a few distinct phenotypes identified on clearly contrasting states of morphological descriptors. Interestingly, although unknowingly the CRI has already exploited the heterosis of the above three distinct groups by production of the hybrid cultivars, CRIC65 and CRISL98. The results thus indicate that further exploration of germplasm within the country for capturing more genetic variation of the palm's biodiversity as a futile exercise and suggest enrichment of germplasm by exotic introductions as a better alternative for further genetic improvement of the palm.

D 191

A study of culture conditions, growth rate and manganese absorption potential of the aquatic weed *Lemna major* under laboratory conditions

Lemna major is a free- floating aquatic monocot that commonly occurs in both fresh water and brackish water stagnating ponds and sluggish streams in tropical countries. It can grow into dense aggregations in nutrient rich water bodies.

Aquatic plants possess tremendous potential to bio-concentrate metals relative to their environment. This study undertaken to study the culture conditions and optimal growth rates of *Lemna* under laboratory conditions and also to investigate its absorption potential of manganese.

A known number of mature plants were placed in a concentration series of Hoaglands solution ranging from 20% to 100% in 200 mL. Glass vessels under artificial light with 12 hours of intermittent light and dark periods. After every 24 hours the numbers of fronds or entire plants were counted. For the study of manganese concentrations ranging from 0 to 4 mg/L. Plants were harvested at 48, 72, 96, 120, 144, and 168 hours and analysed using atomic absorption Spectrometer.

30% Hoaglands solution provided the medium for shortest doubling time and eventually the optimal growth. The doubling time of *Lemna* ranged from 4-6 days. Uptake of manganese depended on the concentration of the ion in the medium and duration of exposure. The maximum accumulation occurred at 120-h exposure at 4mg concentration per mL beyond which plants showed signs of toxicity. The rate of accumulation was 2.2 mg manganese ion per g fresh weight of *Lemna*. With the increase of manganese accumulation in *Lemna* there was decrease of manganese concentration in the medium relative to the absorption indicating manganese accumulation in the plant.

If wastewater is not heavily loaded with metal ions, *Lemna* mat can be used in wastewater pond systems for removal of manganese ions as *Lemna* has both high rate of growth and high absorption potential.

D 192

Detection of some organo-chlorine pesticide residues in the waters of Walawe river in Sri Lanka

River Walawe is the most important water source in the South Eastern region of Sri Lanka. With a length of about 100 km and a catchment of 2442 km. it has an extensive tributary system. It feeds water to the irrigationally important Uda Walawe reservoir and to a number of other tanks. Some parts of the catchment and the river basin are predominantly agriculture lands with tea, paddy, sugar cane, banana and dry zone vegetables. Two major agro-based industries located in the region, the sugar factory at Sewanagala, the Pulp and Paper Mills at Embilitiya, the effluent of which know as black liquor, affects the water quality of the river significantly specially during certain times of the year. Use of large quantities of agrochemicals is prevalent in the basin throughout the year. The main rainy season in the basin is from October to January with an average of 568 mm with significant rains during April to June as well.

This investigation was carried out to detect the presence of organo-chlorine pesticides in the water as they are commonly used in the catchment areas. Water samples were collected at 5 sites along the river during April to September 2000, and extracted using n-heptane for organo-chlorines and subjected to gas-chromatographic analysis for 16 organo-chlorine pesticides. Only three major pesticides were detected out of the 16 tested which are Heptachlor (conc. Range from 3.1 - 60.8 ng/L, ± 0.34) Dieldrin (conc. Range from 0-97.3 ng/L, ± 7.0), and Endrin, (conc, range from 0.8-9.3 \pm ng/L, ± 8.2). All three are well known insecticides, which are used in agriculture in Sri Lanka. Highest concentrations are detected during April and September/October periods, which coincide with onset of rains after dry spells and cultivation periods in the basin.

D 193

A preliminary survey on some anthropogenic impacts on the distribution pattern of algae (Chlorophycean) on the Southern coast of Sri Lanka

This paper reports on observations made during to years on the seasonal variations in the distribution pattern of algae with special reference to chloophyceaen algae inhabits the reef, predominantly on the shoreline side. A total of 36 Chlorophyceae species were identified. Out of the total algal species in the study area, 31% belonged to Chlorophyceae while the rest comprised of Rhodophyceae (58%) and Phaeophyceae, (11%). However of the total biomass, only 20% is attributed to Cholorophyceae, while 70% was Rhodophyceae and 10% Phaeophyceae. The highest number of Chlorophyceae species (10-20) were found during May to June when the reef is less exposed to dryness due to Southwest monsoonal effects while from September to November and February to March, the number of species (10-15) have decreased as a result of higher exposure times of the reef to dryness. With reference to biomass, the highest was in January to February indicating high growth rates of those resistant to dryness, while the lowest was in April to May indicating that many of those which are resistant to dryness are sensitive to high wave forces of the Southwest monsoons.

The wave height varied between 0.5 m and 2.0 m, the maximum being between the months April to June and the minimum between November to February. The flow rate

of the waves (0.75-1.6 m per second) varied with a positive correlation with wave height. The wave frequency (4-5 waves per minute) also showed a positive correlation with wave height, the highest being during the Southwest monsoons. Coral mining and construction of groynes for fishery harbors are major factors that lead to increasing wave forces could reduce biodiversity among all natural factors. The results indicate that such factors could reduce biodiversity among all algae but specially among the Chlorophycean algae. Another observation made was that sea grasses and certain algal species such as *Ulva fasciata* grow luxuriously throughout the year at sites which are subjected to nutrient rich effluents and suppress the growth of many other Chlorophyceae reducing the biodiversity.

D 194

Effect of crude extract of toxic and non-toxin *Microcystis aeruginosa* on the yield of *Oryza sativa*, cultivated under flood irrigation

Beneficial effects of algalization on the yield of rice have been well documented. But the recent findings on the toxic effects of microcystins, the most common cyanobacterial toxins on plants have given a second thought on plants have given a second thought on algalization. However a few studies have been done on the subject and even those were with purified toxins, under spray irrigation. This paper focuses on effects of degraded toxic and non-toxic *Microcystis aeruginosa* blooms on *Oryza sativa*, cultivated under flood irrigation.

Plastic pots were filled with 0.0033 m³ of muddy soil and two weeks old *Oryza sativa* seedling were planted at the rate of six seedling per pot. Surface of each pot was covered with black polythene, to prevent the growth of cyanobacteria on the soil. After establishment of plants, 4 pots per each treatment were randomly assigned to seven treatments (a control and three concentrations from crude extraction of each of toxic and non-toxic *M. aeruginosa*). Each pot was fed every other day with 25 mL of the relevant extract. Each single dose of high, medium and low toxic *M. aeruginosa* extracts contained 9.4, 4.7 and 1.35 mg of microcystin mL⁻¹ respectively. Treatments were continued until one week before harvesting.

Dry weight of roots, straw yield and grain yield of *Oryza sativa* irrigated with extracts of toxic *M. aeruginosa* showed significantly lowest values. Roots were the most affected. Dry weights of roots and straw yield of the plants irrigated with extractions of non-toxic *M. aeruginosa* were also low compared to those of the control, but its grain yield was not affected, indicating non-toxic *M. aeruginosa* may affect the partitioning to grain in rice by altering coefficient.

D 195

Some comments over misguiding reports on the species composition of mangroves in Sri Lanka

The species richness of mangroves in many geographical areas is decreasing with time as a result of the destruction of mangrove forests and exposure to various anthropogenic stresses. In contrast, some recent reports on the number of mangrove species in Sri Lanka have extended the list of mangroves by 13 newly added species. This raises

questions on the reliability of such reports and prompted us to undertake the present study. All mangrove communities along the coastal belt from Puttalam to Palatupana were visited and species composition was recorded along band transects selected through floristically more diverse areas of each mangrove community and other areas of those mangroves were also thoroughly examined. Reported localities of newly added species were especially checked for the presence of those particular specie(s).

Certainly, the number of species of mangroves depends on the definition of mangroves. In the present study, the criteria given in Tomlinson (1986) were used to distinguish mangrove and non-mangrove plants (*e.g.* mangrove associates). According to that list, this study reports 21 species of mangroves but other recent reports have increased this number up to 38, possibly as a result of misidentifications and deliberate additions.

This study highlights the possible causes of misidentification of mangrove species in these questionable reports, while providing an objective and realistic revision of the mangrove species actually present in Sri Lanka today.

It is highlighted that additions to the list of mangrove species should be done correct and proper scientific justification.

D 196

A composition of the relative efficiencies between artificial substrate samplers and conventional sampler in sampling macroinvertebrates for biomonitoring of water quality

Techniques adopted for macroinvertebrate sampling in quality assessment of running water is vitally important. The validity and accuracy of any biomonitoring program depends crucially upon the sampling methods. In the present study, for sites in upper and middle catchment area of Nilwala River Basin in Matara district were sampled using two types of artificial substrate samplers (ASS) and a conventional sampler (CS) from July 199 to May 2000 to compare their relative efficiencies. Wire mesh cages (WMC) filled with stones and wooden boxes (WB) were used as ASS, while surbur sampler was used as a CS. ASS were set in different microhabitats *i.e.* pools, riffles and cascades comprising natural substrate types such as leaf litter, sand and bedrock respectively and surber sampler was also operated on the same comparable natural substrate types.

Results revealed that abundance and the number of taxa of macroinvertebrates collected from WMC, WB and CS were significantly different ($p < 0.05$) irrespective to sites. When compared, the number of taxa sampled was higher in WMC (average 14 taxa) than WB sampler (average 06 taxa) and conventional sampler (average 08 taxa), while WB sampler showed the highest abundance of macroinvertebrates. Chironomids, annelids and molluscs were the dominant taxa found in WB sampler and cased caddish fly, Simulium and plecopteran larvae preferred to colonize in WMC sampler. Macroinvertebrates collected from different natural substrate types showed significant difference in terms of the number of taxa and their abundance. The number of taxa and their abundance were highest in leaf litter and lowest in sand. Dipteran and coleopteran larvae were more abundant in leaf litter. As the number of taxa (which can be used as

indicators of water quality) sampled by the ASS was higher than that by CS, the ASS is more effective in sampling macroinvertebrates in biomonitoring studies.

D 197

Analysis of confectionery industrial wastewater and evaluation of the performance of a wastewater treatment plant: A case study

The study was conducted to analyse Confectionery Wastewater and to evaluate the efficiency of a wastewater treatment plant in a leading confectionery manufacturing industry. The secondary treatment operation units of the wastewater treatment plant comprise of an anaerobic and two modified RBC systems. The maximum daily flow rate was 18m³.

Physiochemical parameters analysed were Biological Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and pH. In addition to qualitative analysis of carbohydrates, microorganisms from the effluent were isolated and identified using standard identification methods. Grab samples from each treatment unit were used for the analysis.

The values of BOD₅ and COD of the influent ranged from 3,721.29 mg/L to 16,458.79 mg/L and, 12,420 mg/L to 23,187.20 mg/L respectively. The influent had a SS range of 0.21 mg/L to 8.62 mg/L, TDS range of 2.06 mg/L to 4.80 mg/L and PH range of 4.10 to 6.72. After anaerobic treatment, the BOD₅ ranged from 343.55 mg/L to 781.73 mg/L and the COD ranged from 4,215.00 to 9,593.60 mg/L. Anaerobic treatment unit had a SS ranged of 0.05 to 4.01 mg/L, TDS range of 1.11 to 3.65 and PH range of 5.16 to 7.15. End of aerobic treatment the BOD₅ value ranged from 200.12 to 601.41 mg/L, whilst the COD ranged from 2,120.80 to 6,307.30 mg/L. The SS value ranged from 0.03 to 2.57 mg/L and TDS range of 1.01 mg/L to 3.02 mg/L and a pH value range of 7.12 to 8.70. The final discharge had BOD₅ and COD values ranging from 164.78 to 382.47 mg/L and 908.0 to 2,854.56 mg/L. The SS TDS and pH value ranges of the final discharge were 0.05 to 3.67 mg/L, 1.00 to 3.67 and 6.01 to 8.36 mg/L. Although in general terms the BOD value is lesser than that of COD, it was observed that in certain instances the BOD₅ was higher. Among thirty-seven isolates, there were thirty-five Bacteria and two Yeast species. Present study indicated the overall efficiency of the Wastewater Treatment Plant ranged from 98% to 9% and 52% to 92% in terms of its reduction of BOD and COD, although the actual values of the treated effluent did not fall within the stipulated standards of CEA.

D 198

Mixed species of birds flocks of two attitudes in the northern flank of the Knuckles region, Central Province of Sri Lanka

Mixed species flocks of birds were investigated in two altitudes [Riverstan (1350m altitude and 6km²) and Pitawalapatana area (750m altitude and 5 km²)] at Knuckles Region in Central Province of Sri Lanka with the objectives of studying the flocking behavior and composition in the same geographical location but different altitudes. Monthly transect (1 km) counts were made between April and October 1998. A total of 25 and 20 Mixed Species Flocks were encountered at Riverstan and Pitawalapatana area respectively during the study period. The composition of mixed species flocks were

different at the two sites, the percentage of flock species contributing to the flocks being higher at Riverstan and Pitawalapatana area (31%). The number of bird species in flocks at Riverstan and Pitawalapatana area was 18 and 21 respectively. The flock size varied between 3-15 species with a mean value 7.41 ± 1.49 , and 3-17 species with a mean value 9.35 ± 4.87 at Riverstan and Pitawalapatana area respectively. The number of individuals in flocks in Pitawalapatana area, but not in Riverstan. The calculated Shannon Weiner diversity index in Pitawalapatana area ($H' = 3.091$) was higher than Riverstan ($H' = 2.89$). The Grey-headed Canary Flycatcher and Sri Lanka Hill White-eye were nuclear species at Riverstan while Tickle's Blue Flycatcher were regular species at Riverstan and in Pitawalapatana area the Black-crested Bulbul, Sri Lanka Dull-blue Flycatcher, Blue-winged Leaf bird and Yellow-fronted Barbet acted as regular species. The Greenish Warbler and Dark-fronted Babbler were occasional species in both sites. The cluster analysis of different flocks revealed that there were two and four main associations found in Riverstan and Pitawalapatana area respectively.

D 199

Post-breeding territoriality of *Saxicoloides fulicata leucoptera* (black robin) in Buttale; Intermediate zone of Sri Lanka

Eight black robin territories were demarcated within an area of about 17.5 ha in Buttala, just after their breeding season (July - October in 2000). Some birds were captured and banded using coloured plastic rings. All black robin sighting locations were mapped and their territories were demarcated using a territory mapping method.

A population of 29.2 ± 4.76 birds was estimated at a population density of 1.667 individuals per hectare. 30 birds were recorded to occupy 8 territories. Black robin territories had an average size of 1.18 ± 0.34 ha, with an activity centre of 22.57 3% of the total area in average. Territories were distributed in open or sparse woodlands and grass or scrub-land. The key features of distributed of the black robin territories were the density of the undergrowth (Mainly high *Panicum* grasses), and human maintenance of the habitat. It prefers habitats with less undergrowth density and with close proximity to human habitations.

The number of black robins occupying a post-breeding territory varied between two to six, and there was no correlation between the territory size and the number occupied.

The territories overlapped at their boundaries with an overlapping area of 8.96 4% of the total area in average. There was a very poor negative correlation between the territory size and size of the overlapping area.

Six territorial behaviour patterns were documented during the study. They are named as territorial song, Territorial display which is peculiar to this species, territorial attack, look out at the territory boundary, tail show and territory investigation.

D 200

Behaviour and diurnal activity of *Saxicoloides fulicata leucoptera* (black robin)

Ad-libitum and focal-animal behaviour sampling was used to construct an ethogram for the behaviour of black robin. The study was done during July through October 2000, in a selected intermediate zone habitat at Buttala.

Present study recorded a total of 65 behaviour types or events, which categorised in to 12 categories of major behaviour patterns. These behaviour patterns included maintenance activities such as locomotion, ingestion (feeding), elimination, shelter-seeking and resting, cleaning, communication, and thermoregulation patterns, agonistic behaviours such as intra specific agonistic patterns and interactions with other species, reproductive behaviour patterns, including the territorial display which is peculiar to it. Some reproductive behaviour such as courtship and mating behaviour patterns could not be studied since the research was done in the post-breeding season.

Time budget and diurnal activity of black robin were studied using 84 instantaneous behaviour samples. Time budget studies show that the order of the percentage time spent on major behaviour patterns as highest in locomotion then on perching feeding, resting, cleaning and other patterns. Activity of black robin was low in midday than that of morning and evening. The peak activity and least activity were recorded around 17:30h and 1:30 h respectively. Its activity had an inverse relationship with the environmental temperature and a direct relationship with the relative humidity.

It was determined that there was no significant difference between the activity of male and female of black robins except for perching in the evening where the female spent much time than the male.

D 201

Physico-chemical and biological environment of Malala lagoon at Bundala National Park under overwhelming fresh water influence

Bundala National Park situated in Southern Sri Lanka is the only Ramsar wetland system in the country. Malala lagoon, the largest water body in Bundala National Park is a very productive ecosystem that is demarcated by a sand bar on east adjacent to sea and a narrow canal to Embillakala water body. The main objectives of this study were to investigate some of physico-chemical parameters, variation of the biological component and investigation of biological indicators dictating the lagoon status due to fresh water input. Two transects (3000 m) were studied. Each transect was divided to ten sites separated each other by 300m. Study was carried out from November, 2000 to mid March, 2001 with 7 sampling visits. Measured salinity levels (from 1.06 ± 0.01 g/L towards sand bar) along the transects were low and indicated fresh water conditions. Fresh water rotifer (*Brachionis plicatilis*) distribution (From 0 to 131 ± 13 /L towards sand bar), fresh water jelly fish distribution (From 5 ± 0.8 to 22 ± 4 / L towards sand bar) clearly indicated the fresh water influence. Nutrient loading such as nitrate (ranged from 147.0 ± 3.8 to 189.4 ± 3.8 $\mu\text{g/L}$) and phosphate (from 75.0 ± 2.3 to 121.3 ± 28 $\mu\text{g/L}$ towards sand bar) was much higher indicating fresh water back up. Freshwater input via Embillakala to Malala lagoon was overwhelming especially June to February. This increased water input in to lagoons may result in an increase in the area of wetland. Long-term exposure to fresh water may change habitat characteristics to maintain the lagoon conditions.

D 202

Analysis of Socio-ecological factors affecting Bundala National Park

Bundala National Park (BNP) is the only Ramsar wetland in Sri Lanka, which is reputed for its rich biological influence of people living in and near the Park. Questionnaires were prepared for the general community, occupational information and usage of park resources. According to the findings inhabitants were using the park resources to a considerable extent. Our results revealed this might be due to settlement of people close to the national park boundary. Over 90% of people knew that the BNP is a National Park but only a few that it is a Ramsar wetland. Similarly bird migration is a know factor (80% of people) but not the importance of the habitat for such birds. Income level of people was poor and over 90% percent of the people did not have a permanent income. In the fishing community 50% families had 4-6 family members than the other families (3-4 members per family). Fuel wood collection, killing wild life for economic purposes, over-fishing with disturbing aquatic environments, usage of water bodies as a dumping ground, unsuitable land use practices and agricultural practices were identified harmful to the park ecosystem balance. Data independent. Most families engaged in paddy cultivation (70%) and a few families engaged in chena cultivation (30%). Over 30% families used forests for fuel wood collection and hunting wild life. The study revealed that poor living conditions and some occupational practices might have profound effects on the Park environment and water bodies. Proper management plans are required to secure the future of BNP ecosystem to provide the people better livelihoods. Community participation in management and conservation practices could be proposed as a tool in BNP.

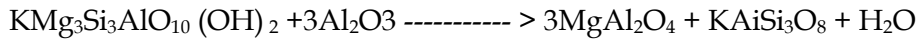
D 203

Corundum / Spinel reaction textures in metamorphosed carbonates rocks of Sri Lanka

Corundum and Spinel are considered the most abundant and most important of gem minerals of Sri Lanka. There are instances where corundum and spinel co-exist within the source rock exhibiting a characteristic relationship between the two minerals. These source rocks are mostly carbonate rocks such as skarn, marble and dolomite. This study was undertaken to find the probable reactions considering these macroscopic scale reaction textures and their relations to the source rock.

Corundum crystal with spinel crust is a common occurrence in Sri Lanka. A unique feature of the fresh source rock is the uniform thickness of the spinel crust over the corundum crystal. In this first instance source rock contain both spinel, corundum and phlogopite. In the same rock there are protions with phlogopite in abundance and others with no phlogopite (mica exhausted). A significant feature exists within the areas where thee is no mica. In this case spinel rim around the corundum crystal is not uniform (not perfectly hexagonal) indicating a reaction. Therefore the observations suggest that there is a reaction between corundum and phlogopite to form spinel as the final product. This reaction continuous until all the mica is exhausted. The reaction is as follows.

Reaction- 1- Phlogopite + corundum -----> spinel + K-feldspar



In the second case hexagonal shape corundum crystals were observed in the carbonate rock consisting of a higher amount of plagioclase (31%), therefore corundum/spinel mixtures and finally spinel confined to a hexagonal outline in the same rock were observed. The reaction textures and the thin section studies suggest the following reaction.

Reaction-2_Corundum ----->Spinel + phlogopite

The first reaction, unravel a mode of formation of corundum/spinel, where the reaction is a balanced one. Second reaction encountered also happens to be a sequence of formation of corundum/spinel but in this case it is not a balance one because it may have been a open system. Some reaction products have been expelled from the system as fluid or gas. Although both these reactions seem to be very similar, there are differences. In the first case the crystals need not be perfect hexagonals and there is no plagioclase present in the system, while in the second case there is a very high percentage of plagioclase present in the system, while in the second case there is a very high percentage of plagioclase (31%) and all most all the crystals are perfect hexagonals.

D 204

Spoilage pattern and keeping quality of Tilapia species stored in iced chilled and frozen condition

The cultured Tilapia production in Sri Lanka has increased during the past. The International trade in Tilapia is growing steadily in Taiwan, Indonesia, Thailand, USA and Japan. Tilapia is mainly exported in the whole frozen form and as frozen fillets. Fish yields in reservoirs in Sri Lanka have increased dramatically after the introduction of Tilapia. The keeping quality of Tilapia was assessed in iced (0 °C), Chilled (-5°0) and frozen conditions (-18 °C).

The Tilapia used for storage studies were collected from Udawalewa reservoir into pre sterilized bags and transported to the laboratory. Samples were analyzed within 24 hours interval after collection. Shelf life was determined by evaluating TBC (Total Bacterial Counts), TVN (Total Volatile Nitrogen), and TMA (try Methyl Ammonoa), and PH. Overall acceptability was evaluated using characteristics with the help of trained taste panelists.

Tilapia showed a shelflife of 19 days in ice, 15 days in chilled condition and more than six months in frozen condition. According to the quality parameters monitored, at the time of rejection TBC counts reached $9.8 \times 10^6/\text{g}$ and $9.6 \times 10^6/\text{g}$ in iced and chilled condition respectively. The TVN values recorded were 8.9 mg/100 g and 55.36 mg/100g in iced and chilled respectively and organoleptic quality score was around 2 for both. In the frozen Tilapia, TBC was $3 \times 10^3/\text{g}$ and TVN was 56mg/100g after 169 days. Frozen condition delayed the multiplication of bacteria to reach the rejection level (10^6) by 150 & 157 days when compared to iced and chilled condition respectively. The initial TBC counts were 2×10^2 .

D 205

Plagioclase as a protective rim around corundum in metamorphosed carbonate rocks of Sri Lanka

Sri Lanka produces the finest quality corundum. Most of the source rocks of the corundum are considered to be metamorphosed carbonate rocks.

Most of the source rocks of corundum in Sri Lanka are considered to be carbonate rocks but most of them have flaws or are opaque. This type of corundum bearing source rocks are found as thin bands in various parts such as Balangada, Elahera, Bakamuna, Polonnaruwa, Okkampitiya ect.

It was found that corundum bearing carbonate crystal completely enclosed by the plagioclase. The crystal seems to be complete with perfect edges without any damage from the mineral reactions. When corundum is partially rimmed around by plagioclase, the unprotected areas are fractured and some of these fractures contain the totally damaged by the reactions and the spaces formed thus were filled with the reaction product of phlogopite mica.

These observations suggest that plagioclase acts as a shield for corundum to protect it from the damage resulting from the reactions of mica formation. This effect is observed only in micro scale (thin sections) where plagioclase was not present as an inclusion. In Sri Lanka this phenomenon could not be observed in macro scale (thin sections) where plagioclase was not present as an inclusion. In Sri Lanka this phenomenon could not be observed in macro scale but in countries like Australia and south-west Rwanda it was observed in macro scale associated with alkali basaltic rocks

In Sri Lanka alkali basaltic rocks are not found and corundum bearing pegmatite is also rare. But according to the plagioclase phenomena (plagioclase shielding effect) the existence of intermediate characteristics between those of 'magmatic' and 'metamorphic' origin in the corundum bearing carbonate rocks of Sri Lanka were found.

D 206

Damages of Paraquat exposure to male reproductive system and affect on spermatogenesis in rats and mice

Paraquat is one of the most widely used herbicidal chemicals in the world. Even the lowest dose of Paraquat is reported to cause measurable adverse effects on growth, survival and reproduction. Target organ exposure technique was used to investigate specific effects in rats and mice male reproductive system. Wistar rats (6 groups, n = 10) were treated with 1 mg/kg body weight of Paraquat by inter-dermal exposure to scrotal sac for a week on every other day. The treatment groups were sacrificed. Reproductive parameters including fertilization potential end points were analyzed. Mice (5 groups, n = 10) were exposed with four concentrations [8(T6), 4(T7), 2(T8), 1(T9) mg/kg bodyweight] of Paraquat as previously and sacrificed on the day 14th. Testicular and epididymal sperm parameters were measured. DNA integrity of epididymal sperm was assessed using acridine orange staining.

No behavioral or pathological changes were seen for either experiment. There was a significant reduction in testicular weights but reduced testicular counts were seen in T4

&T5. Total epididymal sperm count and motility has been significantly reduced. There was a marked increase in epididymal weight among treatment groups (mice) and significant ($P, 0.05$) in T7. Testicular weights did not show changes in mice, indicating reduced effects on testicular endocrine motility decreased and DNA damages were increased significantly for treated groups T6, T7 and T8 ($P<0.055$). In rats reduction of embryo measurements and increased in pre- and post-implantation loss and DNA damages and abnormalities were higher markedly. Effects of Paraquat did not recover until 42 days post treatments, showed persistent effects. However, we observed that the effects in the rat are not exactly similar to those in mice with a similar exposure method. We can conclude that Paraquat damages, which were persistent at least until 42 days to rat male reproductive system is severe that extends from spermatogenesis to fertilization process.

D 207

An investigation of the effects of low concentrations of Chlorpyrifos on epididymal sperm malnutrition in rats

The present study investigated effects of extremely low concentrations of Chlorpyrifos (Primec) to reproductive structure and function of male rats. First, a group of animals (4 groups; $n=10$) were given oral dose of -0.6 (T1), 0.25(T2), 0.125(T3) mg/kg/body weight, every other day for 14 days. They were sacrificed on the 14th day, testicular and epididymal sperm number and motility were recorded. Second, a group of male rats (4 group, $n =6$) were gavaged either Chlorpyrifos (3.2 mg/kg/BW) or distilled water only (control animals). Treated animals were sacrificed at 7-day intervals post-treatment until 21st day. Testicular and epididymal sperm count and motility was recorded.

Results showed total sperm counts of treated groups were significantly reduced than those of control group. Although caput total sperm count was not significantly different in treatment groups T1 and T2 it was significantly reduced in treatment group T3 ($P<0.05$). Proximal and distal cauda sperm counts were significantly different to those of control group for all treated groups ($P<0.001$). From distal corpus to distal cauda sperm motility parameters were decreased. In the second group of study, testicular sperm count showed a significant decrease ($P<0.05$) until the day 21st. Similarly there was a significant loss ($P<0.05$) of epididymal sperm motility. Histological observations in treated groups showed a significant ($P<0.05$) reduction in the thickness of cauda epididymal. It is clear that at least some of the observed effects were a result of structural hence functional changes of epididymal epithelium due to Chlorpyrifos exposure. We conclude that effects of Chlorpyrifos may be inversely dose dependent on the reproductive system in rats. In low concentrations epididymal epithelium structure is affected and thereby epididymal functions on sperm maturation were in jeopardy.

D 208

Epididymal epithelium may depend on rete - testis fluid for the maintenance of its structural integrity while epididymal sperm transfer time of the hamster may be longer than 40 days

In many mammals, sperm are neither motile nor fertile immediately after their release from the germinal epithelium and require a period of maturation in the epididymis. Sperm transit through the epididymis, an obligatory passage, at different time intervals in different species. We studied sperm transfer times and sperm retention times of the different regions of the hamster epididymis. Hamster epididymis was ligated from the initial segment. Their epididymal sperm characteristics were studied on days (treatments) 3, 6, 12, 15, 18, 24, 18, 32, and 40. Total number of sperm in each treatment was significantly different. Sperm transfer times of each region were different in caput 18 days, corpus 14 days and cauda 8 days. Sperm motility was retained in the caput region until 12 days post ligation while in corpus and cauda this was 18 and 32 days. Results showed higher motility reaction and storage increase towards distal regions of the epididymis, while sperm transfer time increased towards the proximal regions of the epididymis. Epithelium structure showed marked alterations compared to control data. Epithelium become stratified after 12 days post ligations in proximal regions of the epididymis and in the cauda, epithelium became more flattened. After 24 days post ligations epithelium showed projections into the lumen of the duct. Contents of the duct showed mucous appearance with sperm debris at first and later included epithelium parts including cell debris and parts of the nuclei. By the day 24 post ligation majority of sperm were immotile thus showed partly loss of partly loss of epithelium function along with structural changes. The study showed characteristic clustering patterns of epithelium under experimental conditions. The study stressed characteristic of rete testis fluid and continuous sperm flow to the epididymal duct for proper function of the epididymis. Our findings are supported by previous many molecular level findings on epididymal sperm maturation. Nevertheless, this study has shown that in hamster epididymal sperm transit time could be as long as 40 days.

D 209

Bioassay of *Sylepta derogata* larvae using the isolated protozoan pathogen of *Spodoptera litura* larvae

Sylepta derogate and *Spodoptera litura* larvae are the dominant foliage feeding insect pests of Okra plants grown in the southern part of Sri Lanka. However, their different feeding habits may reduce their competition for food and the leaf roll made by *S. derogata* larvae protect it further from the natural enemies and contact insecticides. Generally microbial control agents are very effective in controlling insect pests live in cryptic habitats (Dale, 1997). Therefore, present work was carried out to study the effect of microsporidian pathogen isolated from *S. litura* larvae on the mortality of *S. derogate* larvae.

Insects were collected from the okra plants grown in the Matara district. They were individually reared in the laboratory. *S. litura* larval population had heavy larval mortality due to the infection of microsporidian pathogen *Vairimorpha* sp. Estimation of Microsporidian population in the deal larvae ranged from 10.4×10^7 to 46.3×10^7 per mL.

Bioassay was carried out using the 3rd instar *S. derogata* larvae. Larvae were fed on the okra leaves treated with the serial dilutions of the microsporidians. 50% of larval mortality occurred in the 1.24×10^3 /mL concentration. 100% larval mortality occurred in the microsporidian concentration above the 10⁴/mL. Observations of the present

study indicate that the suitability of the microsporidian pathogen as an effective bio control agent of *S. derogata* larvae.