

SECTION B : AGRICULTURAL SCIENCES AND FORESTRY

VARIABILITY OF QUANTITATIVE CHARACTERS IN BUNCH GROUNDNUTS

R. Pathirana

(Regional Agricultural Research Station,
Angunakolapelessa)

Thirteen quantitatively inherited agronomic characters were evaluated in twelve bunch groundnut (*Arachis hypogaea* L. Ssp. *fastigiata*) cultivars for five consecutive seasons since Maha 79/80. A single plant progeny from each cultivar was multiplied and used for the estimation of variability parameters and heritability.

Significant differences among cultivars were found for shelling percentage, number of seeds per pod, number of seeds and pods per plant, seed weight and pod weight per plant and the number of primary branches. Modificational variability of the identical character fluctuated within a narrow range in contrasting cultivars and seasons, recording low values (CV_m 8-12%) for the number of seeds per pod, 100 pod weight and 100 seed weight, medium values (CV_m 12-20%) for the yield index, plant height and the number of nodes on the main stem. All the other characters including pod and seed yield of plant recorded high modificational variability ($CV_m > 20\%$). Highly correlated characters such as seed weight, pod weight, number of seeds and number of pods per plant showed similar tendencies in modificational variability and heritability.

Some characters with identical heritability values recorded significant differences in the magnitude of modificational variability. In such cases the identification of genotypic differences under field conditions will be easier for characters with lower modificational variability.

Therefore, the degree of modificational variability should also be considered in predicting selection response of characters by their heritability values.

EVALUATION OF INDIGENOUS RICE VARIETIES FOR SUBMERGENCE TOLERANCE

S. D. G. Jayawardena and Edmond Rajapakse

(Central Agricultural Research Institute,
Gannoruwa)

Establishment of rice crops in the low-country wet zone is mainly by broadcasting pre-germinated seeds into puddled wet fields. During both seasons, times of crop establishment in the wet zone coincide with onset of the monsoon. As a result, farmers often broadcast germinated seeds into standing water or water accumulates after the seeds are sown. Under these circumstances poor seedling establishment in direct seeded rice is a common agronomic constraint that limits high yields in new improved rice varieties.

The popularity of indigenous rice varieties in the flood prone areas of the low-country wet zone is often attributed to their ability to stand shallow submergence at seedling stage. Therefore, diagnosis of genetic tolerance to seedling submergence and the evolution of suitable screening techniques to select seedlings possessing this agronomic trait is the primary step in breeding rice varieties for rice lands where flash floods and partial submergence occur during crop establishment. This paper explains the behaviour of indigenous rice varieties under submergence at seedling stage and discusses the success of a breeding program and a screening technique designed to diagnose the submergence tolerant character in a segregating population.

Submergence tolerance in indigenous rice varieties was based on seedling survival under submergence and recovery after water had receded. Rice varieties like *Karamana* and *Niwudu Samba* had the ability to survive submergence while varieties like *Molligoda* had faster recovering ability. The mechanism of seedling survival was based on better root development and reduced shoot development which facilitated better seedling anchorage and fast recovery.

STUDIES ON NITROGEN LOSSES DUE TO VOLATILIZATION IN RICE SOILS

C. S. Weeraratna

(Faculty of Agriculture, Ruhuna University College,
Matara)

Results of a number of greenhouse and field studies indicate that the efficiency with which rice utilizes applied nitrogen is considerably low(1). This is mainly attributed to high losses of applied nitrogen and these losses are due to volatilization, denitrification and leaching.

An experiment was conducted in Maahas clay, and Haplaquoll at the experimental farm of the International Rice Research Institute, Philippines, using ammonium sulphate and urea containing labelled nitrogen. PVC tubes, pushed into a uniformly puddled soil were filled with solutions of one of the two fertilizer materials. The content of the whole PVC tube was analysed for N¹⁵ labelled nitrogen fertilizer after a period of one week.

Results indicate that during the experimental period, approximately 60% and 40% of the N applied were lost from ammonium sulphate and urea respectively. The losses due to volatilization alone were 40% and 32% respectively.

Reference

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INCREASED YIELDS AND INCOMES FROM IMPROVED FERTILIZER MANAGEMENT PRACTICES AT THE KATUPOTHA CROPPING SYSTEMS PROJECT

J. Amarasena and N. Vignarajah

(Regional Agricultural Research Centre,
Makandura)

Fertilizer applications by farmers are invariably at lower levels, imbalanced, and at inappropriate times. This is a major constraint in rice production at Katupotha, as in most other rice tracts of Sri Lanka.

Studies were conducted in *Maha* 1980-81 and *Maha* 1981-82 in farmers' fields at Katupotha to demonstrate to farmers the benefits of correct fertilizer management practices.

The Agriculture Department fertilizer recommendation was adhered to in one half of the *liyadda*, while the farmers were allowed to carry on with their usual fertilizer application practices in the other half. The only variables between the two halves of the *liyadda* were the rates and types of fertilizers applied, and times of application.

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Yield increases ranged from 580 to 2,160 kg per hectare and from 500 to 2,000 kg per hectare, for *Maha* 1980-81 and *Maha* 1981-82 respectively. Based on the then existing market prices, the additional investment by adhering to Agriculture Department recommendations increased profit margins by Rs. 1,800 to 4,720 per hectare and Rs. 1,670 to 6,670 per hectare, for *Maha* 1980-81 and *Maha* 1981-82 respectively.

Because farmers use very little or no basal fertilizers (P and K), it would be worth increasing the subsidy on these fertilizers. The additional expenditure to government could be offset, if necessary, by reducing the subsidy on nitrogenous fertilizers.

NITROGEN LOSSES FROM FARM YARD MANURE AND NITROGENOUS FERTILIZERS ON A RED LATOSOL

D. M. Jinadasa and M. W. Thenabadu
(Post Graduate Institute of Agriculture, University of
Peradeniya)

The study was conducted at the Kilinochchi Regional Research Centre during *Maha* 1981/82 on a Red Latosol. Urea and ammonium sulphate were each applied at the equivalent of 40, 80 and 120 kg N/ha in six split doses at two week intervals, with and without basally incorporated farm yard manure (FYM 5t/ha, 0.8% N o.d.).

Lysimeters, each 56 cm in diameter and 86 cm tall were used. Two chilli plants were grown in each and treated with nitrogenous fertilizer. In addition, there were no fertilizer control treatments with and without plants. During dry periods soil moisture at 15 cm depth was maintained at less than 0.03 MPa (0.3 bar) as measured by tensiometers. The soil was drained on seven occasions and leachates collected and analysed for nitrate, ammonium and total nitrogen.

The total nitrogen content ranged from 2.7 to 5.5 ppm, over sampling dates, with higher rates following fertilizer application. The ratios of nitrate-N to ammonium-N averaged 9 : 1 both accounting for an average of 93% of the total nitrogen. In the no-fertilizer treatments leachates had only 0.4 ppm nitrogen. Addition of 40 kg N/ha equivalent as FYM in a single dose only doubled the concentration, while adding inorganic fertilizer at this rate in six doses raised the total nitrogen approximately ten-fold, to 3.9 ppm. The source of inorganic fertilizer made no difference to total nitrogen, but application of ammonium sulphate doubled ammonium-N concentration in the leachate. Addition of 120 kg N/ha, when compared to 40 kg N/ha, raised total nitrogen by a third to half, to an average of 6.2 ppm. The highest nitrate ion concentration was 28 ppm with 120 kg N/ha urea and FYM. Nitrogen uptake by the chilli plants, as percentage of that applied, averaged 28% whilst that lost to drainage averaged 23%.

SULPHUR CONTENT IN RAINWATER IN SRI LANKA

M. A. Lathiff and S. L. Amarasiri
(Central Agriculture Research Institute, Gannoruwa)

The sulphur content of rainfall was determined over a period of one year at Amparai, Angunukolapalessa, Karadian Aru, Maha Illuppallama, Murunkan and Paranthan in the dry zone, at Bandarawela and Batalagoda in the intermediate zone, and at Bombuwela, Gannoruwa and Sita Eliya in the wet zone.

The amount of sulphur brought annually by rain ranged from 23.9 kg/ha at Bombuwela to 4.9 kg/ha at Murunkan. In general the sulphur deposition was higher in the wet zone than in the dry zone. The sulphur contribution from rainfall to agricultural crops in the dry zone is small compared to their sulphur requirements. For the dry zone it is estimated that the sulphur supply to crops from rain is smaller than from irrigation water. This points out the importance of conducting field experiments to determine the need for sulphur fertilization for the rainfed crops in the dry zone.

**EFFECTS OF DIFFERENT WATER MANAGEMENT PRACTICES AND WATER USE
EFFICIENCY OF SOME CASH CROPS GROWN ON THE LATOSOLS OF
THE NORTH WESTERN DRY ZONE OF SRI LANKA**

D. S. P. Kuruppuarachchi
(*Agricultural Research Station, Vanathavillu*)

Experiments were carried out in *Yala* 1980 and *Maha* 1980-81 in the north western dry zone of Sri Lanka to study the effects of three water management practices on crop yield and water use efficiency (yield per unit of water applied) of onion, chillies and bananas; drip irrigation was compared with traditional hand watered basin irrigation and rainfed farming.

It was found that drip irrigation at 10% depletion of the available water increased yields significantly over hand watered basin irrigation at 40% depletion of the available water and rainfed conditions for all three crops studied. Also drip irrigation resulted in water use efficiencies 1.5 to 2 times higher than basin irrigation and rainfed farming in all three crops.

The drip irrigation system brings about considerable saving of water which is particularly important where water availability is limited and cost of provision of water is high, as it is under tube wells drawing from the aquifers of the north western dry zone.

This study was jointly sponsored by the Department of Agriculture, Sri Lanka and the Ministry of Overseas Development, U.K.

**CROPPING SYSTEMS FOR THE RAINFED RICE TRACTS OF THE
LOW COUNTRY INTERMEDIATE ZONE**

J. Amarasena and N. Vignarajah
(*Regional Agricultural Research Centre, Makandura*)

Studies on cropping systems commenced at Alankara and Moragane in the village of Katupotha in 1977. The large catchment area and the perennial vegetation in it endows the Moragane tract with a more abundant supply of water. In contrast, the Alankara catchment is small with hardly any perennial trees in it. Consequently, the farmers at Moragane grow rain-fed rice crops during both seasons. But at Alankara rice is grown only in the *Maha* season in the entire tract, and only in the valley bottom in the *Yala* season.

Rice yields in these tracts ranged from 1 to 2 tons per hectare in the *Maha* season before the commencement of studies. With timely cultivation and crop establishment, improved weed and fertilizer management practices and with the use of the right varieties appropriate for each land category, yields of rice have increased to 2.5 to 4.5 tons per hectare.

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In *Yala*, in the crest and mid-slope of Alankara where either no crops were grown or occasionally rice was cultivated with marginal or no returns, it has been possible to demonstrate that green gram, cowpea, groundnut, black gram and some vegetables could be grown with considerable success.

The net result is that farmers in these tracts and elsewhere, who have followed the new cropping systems approach at Katupotha, have been benefited with increased incomes. Production of rice and other crops mentioned have also increased.

AN ATTEMPT AT IDENTIFICATION OF THE EDIBLE AND SOME WILD SPECIES OF *DIOSCOREA* IN SRI LANKA

M. N. M. Ibrahim, H. A. J. Gunathilake
(Coconut Research Institute, Lunuwila)

and

S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

Dioscoreas are usually cultivated in home gardens for their yams. In spite of the *Dioscoreas* being popular under coconut in small holdings, it is only during the last few years that some trials have been attempted along scientific lines. For successful intercropping, suitable species and varieties of *Dioscoreas* have to be selected and recommended for the different agroclimatic zones. This study was undertaken to collect, identify and evaluate the different *Dioscorea* cultivars available in Sri Lanka.

Living collections maintained at the Coconut Research Institute, were used in this study. Identification of the collected samples was based mainly on vegetative characters. Twelve such characters adapted from Santapau (1951) were used to characterise the different species and some of the cultivars. A total of 28 accessions were collected from various localities and grown at Lunuwila. These were identified as belonging to 6 different species. The three edible species along with some of the forms recognised are as follows: *Dioscorea alata* (Gugurala; Ini-ala; Jaffna purple; Jamburala; Kahata-ala; Kahata-angala; Khondhol; Kiri-Khondhol; Kiri-wal-ala; Lay-Dhantha; Panu-Khondhol; Raja-ala; Raja-walli; Raja-ini-ala; Ratna-walli and Ratu-Khondhol), *Dioscorea bulbifera* (Udala) and *Dioscorea esculenta* (Angili-ala; Hingurala; Kukul-ala; Katukukul-ala).

Accessions of the following wild species namely *D. pentaphylla*, *D. spicata* and *D. tomentosa* were studied from the living collections at Lunuwila and also from herbarium specimens at Peradeniya.

USE OF CHEMICAL AND TRADITIONAL METHODS TO INDUCE SPROUTING IN *DIOSCOREA* SPECIES (*DIOSCOREA ALATA* L.)

M. N. M. Ibrahim and M. de S. Liyanage
(Coconut Research Institute, Lunuwila)

The presence of a definite dormant period (4-4½ months) in *Dioscorea* yams imposes a physiological limitation for staggered planting and producing off season crops. Hence, for year-round production of yams to become a reality, simple and effective methods to break tuber dormancy is essential. Chemicals such as calcium carbide and ethylene chlorohydrin have been successfully used to induce sprouting of *Dioscorea* yams,

but, the use of chemicals at village level seems to be remote both due to its cost and non availability. The use of Kappitiya leaves (*Croton aromaticus* L.) and biling leaves (*Averrhoa bilimbi* L.) to induce ripening of banana led to the contention that these leaves could be useful material to induce sprouting of yams. In the study reported here, a chemical method using calcium carbide is compared with traditional methods and their relative effects studied on two *Dioscorea* cultivars.

Results demonstrated the superiority of calcium carbide treatment over the traditional methods of treating with kappitiya or combination of kappitiya and biling leaves, in breaking the dormancy of *Dioscorea alata* cultivars. However, treatment of setts with kappitiya and biling leaves induced a relatively high degree of sprouting compared with those treated with kappitiya leaves only. All treatments were much better than the untreated control.

With different treatments, both heads and middles sprouted earlier than the tails. With tails, treatment with calcium carbide was more effective in breaking the dormancy than others.

The different pre-treatment methods will not only help to stagger the planting time but also allow the selection of most vigorous setts in the nursery for planting in the field.

EFFECT OF SEED INOCULATION ON NODULATION AND GROWTH OF WINGED BEAN (*PSOPHOCARPUS TETRAGONOLOBUS* (L). (DC).

R. Senaratne and D. A. B. N. Amarasekera
(Dept. of Agronomy, Ruhuna University College, Matara)

Investigations were carried out to ascertain the effect of seed inoculation with *Rhizobium* strains viz. SL 147 (Local) and TAL 309 (Foreign) on nodulation and growth of winged bean cv SLS 40 during the early stage of establishment. The experiment was conducted at Mapalana on Red Yellow Podzolic soil.

Results showed that nodulation started 3 weeks after germination in inoculated as well as in uninoculated plants. On the 45th day following inoculation with both the strains, increases in the effective number of nodules, and dry weight of nodules, leaves and total plants were observed. Moreover, inoculated plants showed a higher nitrogen content in nodules and leaves. The local strain gave higher values in the said parameters throughout the experimental period (75 days). On the 75th day mean plant dry weights recorded in respect of the control and the local strains were 20.9 g and 46.4 g respectively.

Correlation studies showed that both dry weight of nodules and effective number of nodules were highly significantly correlated with leaf and plant dry weight on the 60th and 75th day.

EFFECT OF SEED TREATMENT ON GERMINATION OF IPIL-IPIL (*LEUCAENA LEUCOCEPHALA* (L). BENTH) SEEDS

R. Senaratne and P. S. J. W. Serasinhe
(Dept. of Agronomy, Ruhuna University College, Matara)

Ipil-Ipil is propagated by seeds which have a seed coat impervious to water. This gives rise to irregular and delayed germination affecting the uniformity of germinated plants. This paper reports results of three pre-treatments (namely, soaking in 60° C water for 24 hours (T₁), soaking in conc. H₂SO₄ for 5 minutes (T₂) and mechanical scarification (T₃) effected with a view to hastening germination.

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The approximate number of days taken for 50% germination of the control, T₁, T₂, and T₃ were 12, 6.5 and 7.5 days respectively. On the 12th day, the control had only about 48% germination whilst T₁, T₂, T₃ had 94.0%, 96.0% and 87.0% respectively. All the 3 treatments had hastened germination over the control. However, T₂ was more effective than T₁ and T₁ was more effective than T₃.

Final percentages of germination observed on the 16th day, in respect of the control T₁, T₂ and T₃ were 93.8%, 95.0%, 96.2% and 89.4% respectively. Though T₂ has given a higher % germination, it was significantly superior only to T₃. The relatively poor final percentage germination observed in T₃ may be due to the damage caused to cotyledons in the process of scarification.

PHYSICAL AND CHEMICAL PROPERTIES OF SALINE SOILS UNDER PADDY IN THE SOUTHERN PROVINCE OF SRI LANKA

K. D. Nandasiri Weerasinghe and Devini de Silva
(Dept. of Agronomy, Div. of Agric. Engineering,
Ruhuna University College, Matara)

Studies were carried out to examine the levels and types of salinity in rice soils along the coastal strips of Matara (Kiralakele Project) and Angunakolapellessa (Batatha and Hungama).

Soils under investigation in Batatha and Hungama areas were highly compact. Bulk density of the root penetrating layers of these soils ranges from 1.6 - 2.0 g/cm³, but ill-drained soils of Kiralakele Project showed considerable low bulk density (1.0-1.2 g/cm³). Electrical conductivity of the water from various resources of the area varied from 3.55 to 8.56 mmhos/cm.

Clay content of the Batatha soil was 31.3% and the soil was alkaline (pH 8.1). The alkalinity increased with depth. However the electrical conductivity of the soil was low (0.74 mmhos/cm). Similar characteristics were observed in Hungama soils, except for the high concentration of water soluble salts (Cl⁻, SO₄⁻ ions) and the high electrical conductivity (8.68 mmhos/cm). The electrical conductivity of the Kiralakele soil was (8.68 mmhos/cm) and the soil was acidic (pH 3.5).

Results of the analysis showed that the soils in Batatha, Hungama and Kiralakele were non-saline alkaline, saline alkaline (solonetz) and saline of Mangrove type respectively. Further investigations and experiments should be conducted, in relation to reclamation practices of these soils.

COMPARATIVE STUDY OF MAPALANA SOILS IN RELATION TO THEIR PHYSICAL PROPERTIES

K. D. N. Weerasinghe and P. L. A. G. Alwis
(Dept. of Agronomy, Div. of Agric. Engineering, Ruhuna
University College, Matara)

Physical properties of Mapalana soil from 3 elevations (high, mid and low elevation levels) and soils under rubber, coconut and cinnamon cultivation were investigated. It was observed that red-yellow podzolic soils with soft laterite occur at high elevations and at lower mid slopes. Low humic clay soils occur at low elevations.

The soils showed decreasing infiltration capacity (8.6, 7.2, 5.4 cm/hr), decreasing field capacity in upper meter layers (23.83, 22.90, 18.17%), decreasing mean weight diameter of water stable aggregates (1.23, 1.32, 0.96 mm) and increasing bulk density of the subsurface horizons of 30-60 cm (1.49, 1.56, 1.59 g/cm³) with drop

in elevation. Surface layers of red-yellow podzolic soils were subjected to compaction under plantation crops (bulk density 1.7, 1.8 g/cm³). Here the water retention ability was decreased by 25% compared to the undisturbed soils. A comparatively high infiltration rate of soil was observed under coconut cultivation (8.40 cm/hr). There was an apparent reduction of water stable aggregates in red-yellow podzolic soils under cinnamon cultivation (M.W.D. 1.25, 0.75 and 0.68 mm under rubber, coconut and cinnamon cultivations respectively).

UREA AND AMMONIUM SULPHATE TRANSFORMATIONS IN ACID TEA SOILS

K. N. Wickremasinghe and P. Nalliah
(Tea Research Institute, Talawakelle)

Hydrolysis, leaching and nitrification of fertilizer urea and ammonium sulphate added to tea soils were studied under simulated field conditions in 0.6 x 1.2 x 1.2 m rectangular pots using seven year old tea plants. Soil was packed according to the field profile and the soil solution sampled using soil solution samplers placed at different depths ranging from 10 to 100 cm.

Plants were fertilized with urea and ammonium sulphate equivalent to 7g N per pot (100 kg N/ha/application). Soil solution was sampled and analysed for unhydrolysed urea (1) NH₄⁺ NO₃⁻, K⁺ Ca⁺⁺ and Mg⁺⁺ daily during the first week after fertilizer application and at weekly intervals thereafter.

Because of the rapid conversion of urea to ammonium ions by the activity of urease in tea soils (2) unhydrolysed urea was not detected even at the 10 cm depth after irrigation at 1 cm and 2 cm irrigation per day. Even under forced irrigation equivalent to 5 cm rain per day unhydrolysed urea was detected only at the 10 cm depth. This clearly rules out the possibility that urea, being neutral, could get leached rapidly beyond the root zone and become unavailable to the plants on these soils.

The degree of nitrification and subsequent leaching of the nitrate were found to be similar with both urea and ammonium sulphate fertilizers. The release of K⁺, Ca⁺⁺ and Mg⁺⁺ to the soil solution was again similar in both instances.

These findings and observations suggest that urea can be used as effectively as ammonium sulphate in fertilizing tea.

References

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A STUDY ON THE EXTENT TO WHICH FIBROUS AGRICULTURAL RESIDUES ARE BEING UTILIZED IN INTEGRATED CROP-LIVESTOCK MANAGEMENT SYSTEMS IN TWO MAJOR AGRICULTURAL DISTRICTS OF SRI LANKA

M. N. M. Ibrahim, M. A. Thilakasiri and D. T. Mathes
(Coconut Research Institute, Lunuwila)

The Third world countries suffer with the problem of inadequate food supply, and more important the problem of low animal protein intake. The main limitation to the supply of animal protein through livestock production in Sri Lanka is the insufficient supply of animal feed. This problem to a large extent can be corrected if the fibrous agricultural residues which are a potential source of animal feed could be incorporated into their rations.

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In the survey reported here an attempt is made to investigate the present situation of livestock production in two major Agricultural districts of Sri Lanka (Kurunegala and Matara) with emphasis on the availability and utilisation of crop residues and natural grasses as animal feed.

With the exception of the drier areas of the Kurunegala district, the majority of the farmers owned small herds of animals (1-2 animals). Farm holdings with highland allotments below three acres were a dominant category, and this coincided with the farmers in this category involved more in livestock production. In both districts the animals are generally reared for draft and milk purposes, with more emphasis on the former.

Land under improved pastures in both districts were negligible, and the main source of green feed the animals obtained was from wayside grasses or natural pastures. In the Matara and Kurunegala districts these contributed to 97.3% and 70%, respectively. Generally paddy lands provided seasonal grazing grounds. In both districts straw feeding is practised, and straw constitutes the sole or major proportion of the ruminant diet in drier areas of the districts and the same is true in the wetter areas between the monsoonal rains where even the natural pastures dry off. Various combinations of straw, natural pastures and leguminous tree tops are used as maintenance, growth and production diets. It is clearly evident that in areas where year-round green or dry pasture production is not possible, and in such instances where straw is used as an alternative feed, the calf mortality rate is low, and the milk yield and the number of days in milk are satisfactory. The survey establishes the importance of crop residues in integrated crop-livestock management systems.

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PRE-EMERGENT WEED CONTROL IN DRY SOWN RICE

U. H. Dhanawansa

(Regional Agricultural Research Centre,
Makandura)

Chemicals recommended for weed control in rice in Sri Lanka are of the post-emergent type. In rain-fed rice farming, post-emergent chemical weed control is not popular among farmers because they do not want to risk the danger of moisture stress by draining out the water in the rice fields. On the other hand, rice fields are sometimes too dry or there is too much of rain when the critical period of weedicide application is due.

Pre-emergent weedicides are applied after sowing but before germination. Essentially, the availability of moisture for satisfactory germination of rice coincides with the pre-emergent weedicide application. Therefore, none of the above constraints become operative unless there are too heavy rains that would wash off the chemicals. Besides, application of chemicals on a vegetation free ground is far more convenient and labour saving.

Preliminary investigations were carried out at the Makandura Research Centre, Katupotha Cropping System Project and in farmers' fields in *Maha* 1981-82 and in *Yala* 1982 with the objective of testing various pre-emergent chemicals at different concentrations. Satisfactory weed control was obtained with the following treatments : Machete (Butachlor 60%) 2.0 l/ha, Rilof-H (Piperophos + 2.4D IPE) 2.0 l/ha, Goal (Oxyflurofen 24%) 0.5 l/ha, Dual (Metolochlor 50%) 2.0 l/ha, Ronstar (Oxadiazon 25%) 5.0 l/ha and Galex (Metolochlor 50% + Metabromur on 50%) 3.0 l/ha.

Phytotoxic effects have not been observed with the treatments indicated above.

**ROLE OF BROAD-LEAF WEEDS AS ALTERNATIVE HOSTS
TO THE BENEFICIAL INSECT FAUNA IN
VEGETABLE PLOTS**

M. A. S. K. Ranasinghe and M. M. Mahsoon
(Dept. of Agricultural Biology, University of Peradeniya)

Weeds are considered to be undesirable plants with no value to the farmer. However, some flowering weeds have been found to harbour various insects which are natural enemies of other pest species. This study showed the presence of several beneficial insect species i.e. predators and parasites on broad-leaf weeds growing around the vegetable plots located in a farming area near Peradeniya. Altogether beneficial insects belonging to 18 different families were found on weeds belonging to 5 families including Amaranthaceae and Euphorbiaceae. Thus the small scale farmer may be benefited by the selective retention of some weeds growing around his vegetable plots that enhance the beneficial insect fauna.

**STUDIES ON THE RING-BARKING OF YOUNG TEA PLANTS BY
WHITE GRUBS AND THE FUNGI *PHOMOPSIS*
AND *ROSELLINIA***

P. V. Arulpragasam
(Tea Research Institute, Talawakelle)

Many plants are lost annually in young clearings, specially during the first two years, due to the ring-barking of these plants at the collar region. In the past, these deaths have been mainly attributed to the fungus *Phomopsis theae*, which is known to cause collar and branch canker in young tea. The role of *Rosellinia arcuata*, the fungus which causes black root disease of tea and the larvae of the Scarabaeid beetles, commonly known as 'White grubs', in the ring-barking of young tea plants have been overlooked.

Correct identification of the cause of these deaths, because of the similarity of the symptoms, is important from the point of view of the control measures to be adopted to prevent the spread of the diseases, because the control measures are different in each case.

It was found that deaths due to *Phomopsis* occur with the onset of the monsoon although infection takes place during the dry season. This has often been confused with the ring-barking caused by *Rosellinia*, which also occur during the early part of the monsoon. But in this case it was found that infection takes place during wet weather. By microscopic examination of the fruiting bodies and spores found on the dead region it was possible to identify the causative organism. Attack by white grubs was found to be seasonal, irrespective of weather, occurring during August to December. The callus, in the case of white grub attack was found at soil level with the bark below being completely eaten by the grub and no spores were found on the dead region. Heavy thatching during dry weather, was found to reduce the incidence of *Phomopsis*. Whereas, if this thatch is not thinned out or removed during wet weather, then the incidence of *Rosellinia* and white grubs was found to be enhanced. From these studies it appears that *Rosellinia* causes more deaths in young plants than hitherto believed.

SEED PADDY PRODUCTION : PATHOLOGY AND PROSPECTS

S. N. de S. Seneviratne, Premala Jeyanandarajah and V. H. Nicholas*
(Central Agricultural Research Institute, Gannoruwa)

The characteristics which make for good seed paddy include genetic purity, freedom from weed seeds and extraneous matter and seed health. Seed health depends on two important factors-infection with seed-borne pathogens, and the "physiological status" of the seed to produce vigorous seedlings. The latter aspect

* Research Assistant, National Science Council.

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is influenced by environmental conditions which have a bearing on seed filling and processing. Adverse conditions may result in poor seed characterised by low germination, un-uniform stands and weak seedlings.

In recent studies, about nineteen genera of fungi have been recorded seed-borne in rice. Although *Pyricularia oryzae*, the blast fungus, is regarded as the most dangerous pathogen, it has not been detected seed-transmitted in a viable form. Of the others, *Trichoconis padwickii* and *Drechslera oryzae* exert their pathogenic potential only when seed is "physiologically" weak-poorly filled, light seed matured under relatively unfavourable conditions. Other common seed-borne fungi like *Curvularia* spp. are for the most part saprophytes. These seed-borne fungi have been recorded from different agro-ecological regions of the country and they are not restricted to any geographical area.

There is therefore a case for organising seed paddy production in climatically favourable regions with assured irrigation adopting intensive farming practices to ensure the production of quality seed paddy of good "physiological status". Such well filled, heavy seed will give excellent stands of vigorous seedlings unaffected by weak pathogens and with the potential for high yields. Perhaps, the establishment of "seed production zones" in Sri Lanka ought to be considered with this activity organised in extensive tracts as an industry engaging "professional" farmers, backed by technical expertise and supported by skilled agriculturists.

✓ PRELIMINARY STUDIES ON THE MICROFLORA ON LEAVES OF RUBBER (*HEVEA BRASILIENSIS*)

A. de S. Liyanage and P. K. Samaradeewa
(Rubber Research Institute,
Agalawatta)

Different aspects of leaf colonisation by the phylloplane microbes is still poorly understood. This study was done to determine the influence of some factors controlling the leaf surface microbes and to examine their interactions with *Colletotrichum gloeosporioides*. Leaves of comparable ages were compared by the leaf washing technique.

The total population of micro-organisms was greater on old than on young leaves. The total number of micro-organisms and also the specific composition of the microflora was affected by the weather conditions, with less numbers being recorded during the dry period. However, with the onset of rains the microbial population increased, especially that of fungi. This increase was associated with the appearance of species not recorded earlier. So far, seventy-three isolates of fungi, two bacteria and a few yeasts and actinomycetes have been isolated.

These isolates were grouped into three categories depending on their reaction to *C. gloeosporioides*. Species of *Trichoderma*, *Aspergillus* and *Penicillium*, unidentified species of a fungus and a bacterium showed antagonism to *C. gloeosporioides*.

✓ PRE- AND POST-PENETRATION BEHAVIOUR OF *COLLETOTRICHUM GLOEOSPORIOIDES* IN RUBBER (*HEVEA BRASILIENSIS*) LEAVES

P. K. Samaradeewa and A. de S. Liyanage
(Rubber Research Institute, Agalawatta)

Colletotrichum leaf disease, caused by *Colletotrichum gloeosporioides*, is a disease affecting immature leaves of rubber. Although chemical control is feasible, cultivation of resistant varieties appears to be more economical. This study was conducted to study the behaviour of this fungus in susceptible and resistant cultivars.

C. gloeosporioides, grew well on susceptible cultivars. On penetration, the fungus ramified within the palisade and spongy tissues and aecia were formed at 72 hours after inoculation. In resistant cultivars fungal growth was slow and more appressoria were detected compared to a susceptible reaction. The host cells of resistant cultivars, reacted to fungal penetration, causing an intense discolouration of the cell contents. A movement of nuclei in epidermal and palisade cells towards the site of infection was also noted.

Leaf exudates of resistant clones suffered the growth of the fungus, but stimulated the formation of appressoria, which was not observed in exudates of susceptible cultivars. Inhibitory phenols were detected in the exudate of resistant clones.

VARIATION OF LEAF SURFACE MICROBIAL POPULATION WITH RAINFALL

U. K. Wickremasinghe
(Div. of Plant Pathology, Tea Research Institute,
Talawakelle)

Studies on leaf surface micro-organisms have progressed considerably since the existence of a phylloplane microflora was first described. Effect of climatic factors on composition of leaf microflora and temporal variations in populations have been well documented.

Composition of microbial population inhabiting tea leaves were studied using cultural techniques. Composition of the microflora on two leaves and the bud was determined with modified leaf washing techniques to suit the tea leaf. A number of aerial contaminant fungi, bacteria and yeasts were found to be common inhabitants of the tea leaf. Secondary to this determination, variations in population sizes of each of the microbial groups in relation to rainfall was monitored. Fungal population after heavy rainfall seems to be much less than during dry periods following moderate rains. The composition also seems to be affected by rainfall. Bacteria and yeasts exhibited remarkable consistency in population size and composition. This could be explained in terms of their tenacious hold on the leaf surface which helps in withstanding the washing effect of rain water.

THE RELATIONSHIP BETWEEN COLLETOTRICHUM LEAF DISEASE AND SOUTH AMERICAN LEAF BLIGHT OF RUBBER (HEVEA BRASILIENSIS)

L. C. Wijetilaka, D. M. Fernando, A. de S. Liyanage
and P. A. J. Yapa
(Rubber Research Institute, Agalawatta)

South American leaf blight (SALB) is the most serious disease in *Hevea*. Breeding for SALB resistance is important as an insurance against the accidental introductions of *Mycrocyclops ulei*. It has been demonstrated that some of the SALB resistant clones are also resistant to *Colletotrichum* leaf disease (CLD); the peroxidase activity (PA) and glycoside content exhibited a negative relationship with SALB resistance. The purpose of this study was (1) to examine whether these factors react similarly to CLD resistance and (2) possibility of using these factors to indirectly assess SALB resistance in countries where SALB is absent.

Chromatographical analysis revealed that there are no qualitative differences among the leaf phenols, amino-acids and sugars. However, quantitative differences were evident in leaf phenols when bio-assayed with a standard spore suspension. Total phenol contents were not correlated with SALB resistance.

SECTION B

PA increased 24 h after inoculation and was more in leaves of infected tolerant clones than in diseased susceptible leaves. Later, PA declined after 72 h in both diseased susceptible and tolerant leaves. Total phenols and flavanol content also showed a similar pattern during infection, whereas polyphenol oxidase activity did not show a marked variation during infection.

Glycoside content and PA exhibited an inverse relationship with SALB resistance. These factors could therefore be used to evaluate SALB resistance in countries where the disease does not exist.

EFFECT OF TEMPERATURE ON SYMPTOM PRODUCTION IN POTATO TUBERS BY ISOLATES OF *MACROPHOMINA PHASEOLINA*

V
Premala Jeyanandarajah

(Central Agricultural Research Institute, Gannoruwa)

The pathogenic effect of 31 isolates of seed-borne *Macrophomina phaseolina* from 13 host plants and 10 locations representing 7 agro-ecological regions were assayed on potato tubers.

External symptoms induced were a blackening and killing of eyes in 7-10 days. Internally, charcoal rot as well as dry and soft rots were observed.

The development of symptoms was influenced by temperature and differences were observed between isolates. Almost all isolates from the three regions of the low country dry zone caused maximum infection at 35-40°C. With the isolates from the low country intermediate zone, low country wet zone and mid country wet zone, the temperature for maximum infection ranged from 30-40°C. No symptoms were observed at 25°C but symptoms developed when tubers held at 25°C were subjected to a temperature of 35°C.

EFFECTS OF TEMPERATURE ON THE GROWTH CHARACTERISTICS IN CULTURE OF ISOLATES OF SEED-BORNE *MACROPHOMINA PHASEOLINA*

✓
Premala Jeyanandarajah

(Central Agricultural Research Institute, Gannoruwa)

Growth characteristics in culture of 31 isolates of *Macrophomina phaseolina* from a range of plant hosts and from different locations were studied on a potato dextrose agar medium at temperatures of 20°C, 25°C, 30°C, 35°C and 40°C.

Characteristic differences were observed between isolates in growth rate and colony morphology. Growth was negligible at 20°C but increased with temperature to an optimum near 35°C and then declined rapidly, only small irregular colonies being developed at 40°C.

At 30°C, six isolates showed fluffy growth, thirteen were appressed to the medium, and the rest were intermediate in appearance. The optimum temperature for growth also varied with the isolates, maximum growth occurring at 35°C for 14 isolates and at 30°C for the rest. A slight variation from the optimum growth temperature was accompanied by a marked reduction in the growth rate.

BIOASSAY OF CONIDIA AND BLASTOSPORES OF *VERTICILLIUM LECANII* ON WHITEFLY SCALES

P. Kanagaratnam

(Coconut Research Institute, Lunuwila)

For both glasshouse and laboratory studies, it was necessary to develop a bioassay technique to measure the effect of concentration of the two spore types of *Verticillium lecanii* on *Trialeurodes vaporariorum*, the glasshouse whitefly. This was investigated initially by single assays, using only conidia, and later by paired assays for comparing conidia and blastospores in the laboratory. Tobacco leaf discs bearing whitefly scales of known age were treated with fresh spore suspensions and incubated at 20°C under wet, humid and dry conditions. Scale mortality was assessed after one week. Control mortality was low in most assays. Distinct profuse growth of *V. lecanii* was seen covering the treated scales, individually. The data from each assay were individually subjected to probit analysis. The slopes within the ten paired assays did not differ significantly. Therefore it was concluded that both the spore types responded similarly to the different experimental conditions in each assay. Thus the data were reanalysed using parallel probit lines within each pair. The $\text{Log } L_{c_{50}}$ values varied between assays for both spore types, depending mainly on the humidity. Analysis of the differences between spore types indicated that blastospores were significantly more potent than conidia at the 0.01% level. The $\text{Log } L_{c_{50}}$ values for conidia ranged from 4.17 ± 0.33 to 7.00 ± 0.37 and for blastospores from 3.30 ± 0.47 to 6.84 ± 0.13 . The slopes of the parallel probit lines for both spore types in the ten assays ranged from 0.47 ± 0.09 to 2.09 ± 0.50 .

PATHOGENIC EFFECTS INDUCED IN CUT SHOOTS BY SEED-BORNE ISOLATES OF *MYROTHECIUM* SPP.

Premala Jeyanandarajah

(Central Agricultural Research Institute, Gannoruwa)

When cut shoots of brinjal, capsicum, chilli, cowpea, snake-gourd and soyabean were held dipping in culture filtrates of potato dextrose liquid medium in which several seed-borne isolates of *Myrothecium roridum* and *Myrothecium verrucaria* were grown, symptoms of wilt, watersoaked leaf lesions, leaf spots, vein clearing, vein banding, veinal necrosis, leaf withering and leaf drop were induced. Veinal necrosis was a particularly prominent symptom and isolates varied in the severity of this symptom induced.

Isolates of *M. verrucaria* were most virulent causing severe veinal necrosis in brinjal and chilli and leaf withering and wilting in snake-gourd and soyabean.

Two isolates of *M. roridum* caused discolourations of main veins and prominent watersoaked lesions along the veins in snake-gourd. These isolates also induced vein banding and brown to black circular leaf spots in soyabean. Another isolate of *M. roridum* produced very mild symptoms on all the hosts tested. With cowpea, leaves developed veinal necrosis and wilted. In capsicum, wilt and leaf drop were observed.

Filtrates ceased to cause pathogenic effects when diluted to 1 : 50 - 1 : 100 with water.

INCREASING PHOSPHORUS AVAILABILITY OF EPPAWALA APATITE

C. S. Weeraratna

(Faculty of Agriculture, Ruhuna University College, Matara)

Studies conducted on Eppawala apatite indicate that the availability of P in this material to plants is considerably low. The objective of this investigation was to examine some methods of increasing P availability in Eppawala apatite.

SECTION B

Two types of soils, viz. reddish brown latasolic and reddish brown earth, were incubated separately under flooded and unflooded conditions with ground apatite and one of the following: straw, cow dung and sulphur. These materials were incorporated at 2%. The available P content, indicated by NaHCO_3 extractable P (Olsen's P) was determined at fortnightly intervals.

Results indicate that incorporating straw or cow dung increases the P availability of Eppawela apatite. With straw, under aerobic conditions, the increase was observed after two weeks of incubation over a period of 8-12 weeks in both soils. With cow dung too the available P increased over controls from the second week to the sixth week. Under anaerobic conditions this effect was observed only in the case of cow dung. Sulphur did not have any significant effect on phosphorus availability.

These investigations were carried out with a grant provided by the National Science Council.

BIOASSAY OF *BACILLUS THURINGIENSIS* ISOLATES WITH THE GREATER WAX MOTH *GALLERIA MELLONELLA

P. Kanagaratnam

(Coconut Research Institute, Lunuwila)

Isolates of *Bacillus thuringiensis* were screened against the wax moth, *Galleria mellonella* to find a better bacterial strain than the best commercial product. For bioassays bacterial powders supplied by Dr. H. T. Dulmage from U.S.A. were used. An artificial food was used for the assays. Evenly sized larvae, 7 days old at 30°C, of average weight about 0.2 mg were used. After incubation at 30°C for 7 days the larval mortality was assessed.

The mean $L_{c_{50}}$ value for the standard was 0.00091% bacteria in the food. The $L_{c_{50}}$ of the test isolates ranged 0.0013%–11.0%. The active isolates were in the serotypes 5 and 7. No isolate was more active than H-serotype 5a 5b which was used once in commercial "Thuricide" and as standard in these bioassays.

24 assays with 12 relatively inactive isolates had probit lines with a mean slope of 3.06 ± 0.40 while the twelve assays with six active isolates had a mean slope of 3.3 ± 0.20 . Thus the slopes of probit lines of active and inactive isolates were not significantly different. The average slope of about 3 indicates that both infectivity due to spores and toxic effect due to crystals were responsible for the larval mortality. The $L_{c_{50}}$ values indicate that the toxins from different isolates of *B. thuringiensis* had different level of insecticidal activity against *G. mellonella*.

* This paper was presented at the 37th annual sessions held in December 1981.

SECTION C: ENGINEERING, ARCHITECTURE AND SURVEYING

✓ THE NEED FOR CONSTRUCTION MANAGEMENT IN THE CONSTRUCTION INDUSTRY OF SRI LANKA

Felix Weerakkody
(International Construction Consortium,
Iceland Buildings, Colombo 3)

During the last few years Sri Lanka witnessed a considerable growth in the domestic construction industry. A number of construction companies were suddenly formed to cope with the sudden expansion in the construction industry. However, within a short period some of the newly formed companies were forced into liquidation. This paper illustrates some of the factors such as an improper assessment of inflation, inadequate planning of cash flows, delayed certification and receipt of progress payments, inadequate preparation prior to pricing a tender, etc. as being responsible for the early liquidation and that by the application of modern construction management techniques, these construction companies could have been successfully administered.

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TRANSPORT POLICY IN THE URBAN DEVELOPMENT CONTEXT

✓ Naga Jayawardena
(Urban Development Authority, Colombo)

At the present time there is a great awareness and lively discussions are taking place on the state of the economy, energy usage and the environment. In this situation attempts to modify the urban system for future use with new investments, renovations and replacement of facilities becomes a complex problem.

One such service element in the urban situation is transportation. It is necessary to fashion this to satisfy the wishes and needs of the majority of the urban population within reasonable limits.

We are now at the cross road or at a crisis point in urban development. We are also in the process of changing the urban form by controlling the future location and intensity of land use which will have far reaching effects in the future. We have to visualise the role of the movement of people and goods within the total concept of the city and its environment by regulating accessibility and within the available resources manage the mobility of the people to improve the quality of life.

Coherent policy is needed for guidance, to identify and anticipate problems connected with movement locational planning, assessing and coordinating the relative roles of the different modes of transport, optimising the use of the existing infrastructure and ensuring safety of the urban population.

This Paper attempts to survey the present situation in urban transport, focus on the need for policy formulation, identify the outlook, the basic elements for a rational policy and the steps needed for implementation.

∫ PALMYRAH SUGAR PRODUCTION

K. Sivalingam
(Planning Unit, Jaffna Secretariat, Jaffna)

In 1972 the Ceylon Institute of Scientific and Industrial Research introduced new technology for the improvement of palmyrah sugar manufacturing process in Jaffna District.

SECTION C

The subsequent transformation of this cottage industry into a modernized small scale industry based on intermediate technology opened up several areas of industrial research. The development of standard process technology for sugar and other sap products is another need which has arisen as a result of this transformation.

MANUFACTURE OF SPHEROIDAL GRAPHITE IRON IN A JOBBING FOUNDRY IN SRI LANKA AND ITS APPLICATION

P. Ariyagama, R. N. Wijewardane, J. M. Ranasinghe Banda
and C. Arunasaleswaran
(Ceylon Steel Corporation, Oruwela, Athurugiriya)

The paper describes the methods adopted in the Steel Corporation foundry for the production of castings in spheroidal graphite iron.

Spheroidal Iron, is a modern material fast replacing traditional gray iron in industry. Although new to Sri Lanka, the material has gained wide acceptance in other countries.

Spheroidal graphite iron is distinguished by its high strength, toughness and ductility combined with excellent casting properties and good machinability. It has a high modulus of elasticity and good resistance to corrosion. It derives its name from the form of graphite. In Spheroidal Graphite iron, the graphite is present in the form of spheroids. This interrupts the continuity of matrix less than that of graphite flakes in gray iron, when it is subjected to tensile forces. The phenomenon will enable the Spheroidal Graphite iron to have high strength and toughness. Spheroidal Graphite iron will be a reasonable substitute for steel in casting thin and intricate shaped items. It is also known as Nodular Cast iron and Ductile iron

The charge materials used are high-purity pig iron, steel scrap and spheroidal graphite iron return scrap.

The nodularising treatment is done in a preheated treatment ladle. The treatment ladle will have a pocket at the bottom, to accommodate the nodularizer, which is covered with a thin mild steel plate.

/ ON THE WRINKLING OF SHEET METAL DURING DEEP DRAWING

J. S. Gunasekera
(Dept. of Mechanical Engineering, Monash University,
Australia)

Wrinkling is an undesirable phenomenon which occurs during deep drawing of thin sheet metal pressings, particularly those with sloping wells. Some recent studies on the wrinkling behaviour of sheet steels have shown that wrinkling will occur upon the attainment of a critical ratio of the major strain ϵ_r to the minor strain ϵ_θ and this has been represented on the forming limit diagram as a wrinkling limit curve.

The present investigation has shown that for a given material the critical factor in wrinkling is the ratio of the stresses, σ_r/σ_θ or the ratio of the increments of the plastic strains $d\epsilon_r/d\epsilon_\theta$ rather than the ratio of the total strains $\epsilon_r/\epsilon_\theta$ as has been postulated by previous researchers.

COMPUTER AIDED MODELLING OF THE HOT FORGING PROCESS**J. S. Gunasekera***(Dept. of Mechanical Engineering, Monash University,
Clayton 3168, Australia)***H. L. Gegel and J. C. Malas***(Air Force Materials Laboratory, Wright-Patterson Air
Force Base, Dayton, Ohio, USA)*

A rigid-visco-plastic finite element formulation is used to model the hot forging process and to predict the metal flow during the forging process. The central processor to the analysis of isothermal forging of Aluminium and Titanium is a powerful and efficient finite element package called 'ALPID' (Analysis of Large Plastic Incremental Deformation) developed by the U. S. Air Force Materials Laboratory in collaboration with Battelle Columbus Laboratories. Efficient and user friendly pre and post processors are developed to control the input and output of information.

Experiments on actual and model materials have shown that the finite element predictions agree with the experimental ones within a few percent. The display of results of finite element analysis and visualization and understanding of the geometries of preforms and finished products are enhanced by the use of shaded colour graphics.

**COMPUTER AIDED DESIGN OF EXTRUSION DIES
FOR A WING SPAR CAP****J. S. Gunasekera***(Dept. of Mechanical Engineering, Monash University,
Clayton 3168, Australia)*

A new material-Aluminium 2024 with 20 per cent SiC whiskers has been developed for aircraft structural parts. This material has a superior modulus of elasticity, compared to the conventional Aluminium alloy and can therefore reduce the weight of a typical wing structure by as much as 40 per cent.

However, a problem has been encountered in the extrusion of the complex geometries of the wing structure. Conventional extrusion technology with the use of shear dies has failed to produce these complex geometries without the loss of the critical mechanical property. A new concept is developed for the design of complex streamlined dies for the extrusion of a wing spar cap using the newly developed metal matrix comopite. The visualization and the understanding of the complex three dimensional geometry of dies are enhanced by the use of shaded colour graphics.

**QUANTITATIVE AND QUALITATIVE ANALYSIS OF QUALITY DATA
APPLICABLE TO POLYPROPYLENE WOVEN SACKS****R. A. Dayananda and B. G. W. N. Yatawara***(Mikechris Industries Ltd., Seeduwa)*

This Paper is a Statistical Study of the quality of polypropylene woven sacks, manufactured at Mikechris Industries Ltd., Seeduwa, conforming to internationally accepted standards.

The study has two main aims : (i) to construct quality control charts; (ii) to prepare optimum sampling plans.

In the construction of quality control charts, mean and range charts were employed.

The optimum sampling size is established by making use of the Military Standards, and Dode and Romig L T P D System. Further, past information on the behaviour of the process and economy are made use of to develop Bayesian sampling schemes. Tables giving the critical values and the optimum sample size as applicable to the above product covering appropriate ranges of values of various parameters have been prepared.

SECTION D: LIFE AND EARTH SCIENCES.

SOME ASPECTS OF BACTERIAL ECOLOGY IN NEGOMBO ESTUARY

T. K. Madurapperuma and G. S. Widanapathirana
(Dept. of Botany, University of Kelaniya)

Heterotropic bacterial population including bacteria involved in nitrogen transformation and faecal coliforms of Negombo estuary were studied. At the same time variation of dissolved oxygen, biological oxygen demand, chemical oxygen demand, concentration of nitrate, ammonia, pH temperature, salinity and rainfall data were also recorded.

Water samples were taken every two weeks from pre-selected sites of Negombo estuary for a period of 6 months. Heterotrophic bacterial populations were isolated by dilution plate technique, using tryptone soya agar and Zobell's medium. The bacterial flora involved in the four major steps of the nitrogen transformation and the coliforms were estimated by most probable number (MPN) technique using recommended media and methods.

The total viable counts were obtained by aerobic incubation, ranging from 3×10^2 to 4×10^6 in tryptone soya agar and from 18×10^1 to 15×10^6 in Zobell's medium. Twenty eight different species of bacteria were isolated. Most species were isolated in tryptone soya agar medium. Out of these bacterial species, 65% were found to be gram positive and 83% of this were found to be *Bacillus* sp. About 10 different species of *Bacillus* were recorded. *Staphylococcus* sp and *Bacillus* sp were the predominant gram positive species isolated. Among the gram negative isolates, *Pseudomonas*, *Klebsiella*, *Aeromonas* and *Vibrio* constituted the major groups.

Denitrifying and nitrogen fixing bacterial numbers were most numerous in low saline conditions and the number of nitrifying bacteria which were capable of converting nitrite to nitrate were found to occur in large numbers in extremes of high and low salinities. However, bacteria involved in the first phase of nitrification (i.e. conversion of ammonia to nitrite) could not be demonstrated. None of the *Bacillus* sp, isolated from the estuary, have the ability to utilize ammonia or urea as a nitrogen source.

MPN counts of faecal coliforms varied with the salinity of estuarine water.

AN INVESTIGATION OF PHYSICO-CHEMICAL FACTORS GOVERNING PHYTOPLANKTON GROWTH AT USWETAKEIYAWA AND IN THE COLOMBO PORT (JANUARY 1981 - JUNE 1981)

J. M. W. Jayasekera and P. J. Paulraj
(Dept. of Botany, University of Kelaniya)

Physico-chemical factors and their effects on phytoplankton growth were studied during a period of 7 months. Sites chosen were the Queen Elizabeth Quay and Guide Pier in the Port of Colombo (subjected to man's interference) and Uswetakeiyawa (a natural habitat).

Algal periodicity and physico-chemical factors were found to follow patterns similar to those recorded in Indian coastal waters. Salinity was high within the Port, since it was more sheltered when compared to Uswetakeiyawa and varied with the movement of ships and rainfall.

The water within the Port was highly alkaline when phytoplankton were a maximum, indicating high eutrophic conditions. Furthermore the period of incidence varied from that recorded at Uswetakeiyawa. Following monsoonal showers, the waters were productive during January-February 1981 at both sites, with a second incidence (which was more significant) being recorded during March-May 1981 within the Port.

A depletion of nutrient levels, (especially silicates) were found to cause a cessation of algal numbers. Values ranged from 9.4 - 10.5 μ g at Si/l limited growth, whilst the phosphate and nitrate levels fluctuated dependent on prevailing weather conditions and plankton incidence. The zooplankton incidence too had a bearing on algal numbers, since Copepods and Naupli were significant following algal blooms. This indicated grazing effects.

A succession of species was observed with *Ceratium* sp, *Peridinium* sp, *Skeletonema costatum* and *Nitzschia* sp being dominants. *Coscinodiscus* sp, *Asterionella japonica*, *Leptocylindrus danicus*, *Rhizosolenia* sp, and *Prorocentrum micans* were sub-dominants. The dinoflagellates and *Skeletonema costatum* dominated the warmer months, when temperatures and salinity ranged from 29.2° - 31.5°C and 28 - 35°C/005, respectively.

A SURVEY OF THE ALGAL FLORA AND ITS EFFECT IN AN OPEN RECIRCULATING COOLING WATER SYSTEM (JANUARY 1981 - JUNE 1981)

G. D. Chandrawathie and P. J. Paulraj
(Dept. of Botany, University of Kelaniya)

A major problem in the operation of an open recirculating cooling water system is the fouling of the water by microorganisms. A study was therefore undertaken to investigate the fouling of cooling water by algae, at the State Fertilizer Manufacturing Corporation, Sapugaskande.

Three sampling sites were chosen: site 1—after water clarification, site 2—top of the cooling tower and site 3—at the foot of the cooling tower.

Results indicated fouling by algae within the cooling water system and cooling tower. Growth was facilitated by high phosphate and nitrate levels. Phosphate replenishment was inevitable since sodium hexametaphosphate was added as an anticorrosive substance. Nitrate replenishment could have occurred as a by-product since the factory produces urea. Bacterial activity too could have been a contributory factor.

Silicate levels were low at sites 2 and 3, and high at site 1, since it was just after water clarification.

Algal counts ranging from 2.84×10^4 - 16.42×10^4 cells/l at site 1, were low, indicating efficiency of sand filters, but were high at sites 2 and 3 (i.e. 18.2×10^4 - 133×10^4 cells/l and 8.77×10^4 - 146.32×10^4 cells/l, respectively).

Navicula sp and *Anabaena* sp indicators of thermal pollution were recorded at site 2, when temperatures ranged from 38° - 41°C. However species diversity was marked at site 3, which recorded temperatures of 26° - 33°C, following cooling, within the cooling tower.

Fouling could be avoided by ensuring efficiency of sand filters, proper maintenance of underground pipelines (eliminating contamination), biologically—by covering the tower decks with tarpaulin, wood or black polythene, using an alternative anticorrosive substance to sodium hexametaphosphate and by using an effective microbicide.

SECTION D

SOME ASPECTS OF MESOFAUNAL ECOLOGY OF TWO TEMPORARY PONDS

N. Selvarajah and V. Rajaratnam
(Dept. of Zoology, University of Jaffna)

The northern region of Sri Lanka especially the Jaffna peninsula is provided with a large number of ponds. Most of them are temporary, collect water during precipitation and have considerable potential for freshwater fish culture.

In this study two temporary ponds namely the Aariakulam and Regal pond were selected. The study commenced at the initial filling of the ponds during the North-East monsoonal rains (September-December) and concluded when the ponds were dry or nearly so during the dry season.

Weekly samples were collected and quantitative and qualitative plankton sampling performed. Samples were analysed to determine salinity, oxygen content and total nitrogen content: temperature and pH were measured in the field and the depth and the area of the two ponds were surveyed.

Regarding the quality of the zooplanktons all the observed organisms were common in both ponds. But their populations varied due to various chemical and physical conditions. In most instances the populations were found to be dependent on the other zooplanktons. In both ponds, the organisms composing the community may be divided into three major groups: those that enter at the first of the succession such as *Chlamydomonas*, diatoms, and various ciliates: organisms that form algal mat such as blue greens; and organisms that become dominant later, Rotifera, *Cyclops*, *Daphnia* Ostracoda.

This work was supported by National Science Council Grant number RGB/81/10.

PRODUCTIVITY OF THE BOLGODA LAGOON

W. V. Jayantha Perera and J. Jinadasa
(Dept. of Biological Sciences,
University of Sri Jayewardenepura, Nugegoda)

The productivity of the Bolgoda lagoon was measured monthly for 18 months starting from January 1981 at two stations. Dissolved oxygen and certain plant nutrients were also monitored during the same period.

The dominant microflora for most of the year were microscopic green alga at the head and diatoms near the mouth. Quantities of dissolved nitrates and phosphates are highest from July to September and lowest from December to March, and in each case higher near the head than near the mouth of the lagoon throughout the year.

The amount of dissolved oxygen is high from June to August and from December to March.

The gross productivity of the lagoon is highest from November to January and lowest from July to August. It also increased from the mouth towards the head. The pattern of net productivity is parallel, except that near the mouth a reverse trend generally appears.

NITRIFICATION STUDIES IN A GARDEN SOIL OF JAFFNA

S. Kandiah and A. M. T. Saverimuthu
(Dept. of Botany, University of Jaffna)

Nitrification of urea, (a fertilizer extensively used by the Jaffna farmers) was investigated under laboratory conditions using soil samples obtained from a chilli garden in Thirunelvely.

Soil in polythene bags kept at 35% moisture content was treated with urea, equivalent to 5 cwt. per acre which is the currently used dosage for chilli. Samples removed at 2 to 4 -day intervals were analysed for ammonium-nitrogen ($\text{NH}_4\text{-N}$) and nitrate-nitrogen ($\text{NO}_3\text{-N}$).

$\text{NO}_3\text{-N}$ was found to increase from negligible amounts until day 22 after which a steady level was reached. $\text{NH}_4\text{-N}$ increased rapidly up to day 9 followed by a decrease, which was quite rapid initially but gradual thereafter. The net result of these changes after 36 days led to the recovery of only 56% of the applied nitrogen of which 45% was $\text{NH}_4\text{-N}$ and 11% $\text{NO}_3\text{-N}$. The balance nitrogen was mostly lost as ammonia. This was confirmed in a second experiment where the ammonia gas was trapped and estimated using filter papers soaked in dil. H_2SO_4 in a modified set up. Evolution of ammonia from urea-treated soil was very rapid during the first two weeks and ceased after three weeks.

STUDIES ON THE REPELLENCY OF PLANT DISTILLATES AGAINST ADULT *SITOPHILUS* SP.

V. K. Ganesalingam and V. Shivanandarajah
(Dept. of Zoology, University of Jaffna)

The volatile steam distillates of leaves of *Ocimum sanctum*, *Vitex negundo*, *Azadirachta indica* and *Citrus acida* were investigated for repellency against *Sitophilus* sp. in the laboratory using a Y-shaped olfactometer.

Of the plants tested *O. sanctum* was found to be the most effective repellent against *Sitophilus* sp. The other plants tested showed repellency of a significantly less degree than *O. sanctum*.

$O. sanctum > V. negundo \simeq A. indica \simeq C. medica$

The repellency of synergistic combination of volatile distillates of *O. sanctum* and *A. indica* was found to be as effective as that of *O. sanctum* alone.

$O. sanctum + A. indica \simeq O. sanctum$

With regard to the duration of the repelling effect of the steam distillates (crude water extracts) of the plants tested, it was found that the freshly prepared and 10 day old *O. sanctum* had the same effect. The preparation of *O. sanctum* 20 and 30 day old showed significantly less repellency than the freshly prepared or 10 day old *O. sanctum*. Similarly, the extracts of other plants too showed a significantly lower repellency than the freshly prepared or 10 day old *O. sanctum*.

$O. sanctum$ (fresh) $\simeq O. sanctum$ (10 day) $> O. sanctum$ (20-30 day)
 $\simeq V. negundo$ (0-30 day) $\simeq A. indica$ (0-30 day) $\simeq C. acida$ (0-30 day).

ISOLATION OF INTRACELLULAR SYMBIOTES IN SRI LANKA FROM THE EGGS AND FAT BODIES OF THE BROWN PLANTHOPPER, *NILAPARVATA LUGENS* (HOMOPTERA : DELPHACIDAE)

G. F. Rajendram and M. A. N. Selvadurai
(Dept. of Zoology, University of Jaffna)

Nasu *et al* demonstrated the existence of yeast-like organisms in the mycetocytes of eggs, fat bodies and ovaries of the brown planthopper, *Nilaparvata lugens* (Stal). In the females, these symbiotes are transferred from fat bodies to ovaries and penetrate into the egg through the ovariole pedicel. This paper describes the isolation and culture of intra-cellular yeast-like symbiotes from the mycetocytes of eggs and fat bodies of abdomen *N. lugens* occurring in Sri Lanka.

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N. lugens used in these studies was obtained from paddy fields in Amparai district and cultured in the laboratory in Jaffna. The mycetocytes were dissected out and cultured in lactose broth and lactose agar medium at 30-31°C.

Two kinds of yeast-like symbiotes were observed in both the eggs and fat bodies of *N. lugens*: (a) elongated sheath-like cells and (b) oval shaped cells. The elongated sheath-like cells were more predominant and significantly larger than the oval shaped cells.

The symbiotes appeared to decrease in size when cultured in lactose broth and lactose agar medium. The decrease in size of the symbiotes may be due to inadequate nutrients in the media.

Reference

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LABORATORY STUDIES ON THE EFFECTIVENESS OF *CYRTORHINUS LIVIDIPENNIS* (HEMIPTERA : MIRIDAE) AS A PREDATOR OF *NILAPARVATA LUGENS* (HOMOPTERA . DELPHACIDAE)

F. R. Devarajah and G. F. Rajendram
(Dept. of Zoology, University of Jaffna)

Culture techniques for rearing *Cyrtorhinus lividipennis* Reuter, a predator of *Nilaparvata lugens* (Stal) were described by Devarajah and Rajendram who also reported that *C. lividipennis* first instar nymphs fed only on eggs, while the second to fourth instar nymphs preyed on eggs and nymphs, and the adults attacked all stages of *N. lugens*. The present paper describes the results of experiments carried out to evaluate the effectiveness of *C. lividipennis* as a predator of *N. lugens* under laboratory conditions.

C. lividipennis males consumed an average of 2.8 eggs and the females 3.53 eggs of *N. lugens* per day. The adult male consumed an average of 0.23 first, 0.16 second, 0.13 third, 0.12 fourth or 0.09 fifth instar nymphs while the female consumed 0.28 first, 0.21 second, 0.16 third, 0.13 fourth or 0.10 fifth instar host nymph per day.

The first, second, third and fourth instar predator nymphs consumed an average of 1.21, 2.35, 2.93 and 3.04 host eggs per day, respectively.

The present studies indicate that *C. lividipennis* is an effective predator of *N. lugens*, particularly of the eggs and young nymphs.

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STUDIES ON THE SELECTION OF *PERPLANETA AMERICANA* OOTHECAE FOR OVIPOSITION BY THE PARASITE *EVANIA APPENDIGASTER* (HYMENOPTERA : EVANIDAE)

N. C. Kumarasinghe and J. P. Withanachchi
(Dept. of Biological Sciences, University of
Sri Jayewardenepura, Nugegoda)

Evania appendigaster is an oothecal parasite of the cockroach *Periplaneta americana*, in Sri Lanka. Cockroach eggs take 44 days to develop after which the nymphs emerge leaving an empty ootheca. Hence oothecae of 0-44 days old are available for oviposition by *E. appendigaster*. Experiments indicated that

E. appendigaster is able to distinguish between empty and viable oothecae and that it does not oviposit in empty oothecae.

Since the age of a viable ootheca varies from 0-44 days, preference for oothecae of a particular age was tested. Results indicated that *E. appendigaster* oviposits in fresh oothecae of any age. However, development of *E. appendigaster* up to adult stage occurs only in oothecae of 0 - 30 days old. Experiments were carried out to find out whether *E. appendigaster* can distinguish an ootheca already parasitized. Results indicated that parasitized ootheca will be selected by the same or different female(s) during the first four days after oviposition, and not thereafter.

P. americana oothecae are parasitized by another Hymenopteran; *Tetrastichus hagenowii*. Therefore experiments were carried out to determine whether *E. appendigaster* is able to distinguish oothecae parasitized by *T. hagenowii*. Results indicated that it cannot distinguish an ootheca parasitized by *T. hagenowii*.

When *E. appendigaster* oviposits in an ootheca already parasitized by *T. hagenowii* it is only *T. hagenowii* that emerges because *E. appendigaster* eggs are destroyed by the larval stages of *T. hagenowii*.

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**THE EFFECT OF HAL VATERIA COPALLIFERA ALSTON BARK
ON SOME BIOLOGICAL ASPECTS OF MICROORGANISMS IN FERMENTING
COCONUT SAP (TODDY)**

S. I. Abeygunawardena, H. Gunawardena,
G. S. Widanapathirana and I. Balasooriya
(Dept. of Botany, University of Kelaniya)

The effect of the addition of dried *V. copallifera* bark on the microbial population and associated changes in some major and minor chemical constituents of fermenting sap was studied under natural conditions.

Samples of coconut sap in the presence (treated) and absence (untreated) of the dried *V. copallifera* bark were collected in the traditional way. These samples were subjected to micro-biological and biochemical studies.

Microorganisms responsible for the fermentation of coconut sap included *Enterobacter aerogenes*, *Saccharomyces chevalieri*, *Bacillus polymyxa*, *Bacillus macerans*, *Candida tropicalis* and several others. These micro-organisms appeared in all samples, irrespective of the presence or absence of *V. copallifera* bark, but their abundance was higher in untreated samples. Bacteria such as *Staphylococcus* spp and *Micrococcus* spp were absent in the treated sample.

The addition of *V. copallifera* bark appears to affect the rapid growth of the micro-organisms and the associated physico-chemical changes. Comparative data on pH, non-reducing sugars and ethanol in the two samples indicated the inhibitory effect of *V. copallifera* bark on micro-organisms responsible for the conversion of sugars to ethanol. No significant difference was observed in the di-acetyl content of the two samples. However, concentration of lactic acid was higher in samples collected in the presence of the bark.

The untreated sap also contained certain amounts of polyphenolic compounds, but apparently had no significant effect on the fermentation process at the concentrations present. The growth of bacteria and yeast decreased with the increase of the polyphenol content in the treated samples.

Some of the microorganisms isolated from fermenting coconut sap were inhibited by aqueous extracts of *Vateria* bark. Anti-microbial activity of the separated polyphenolic compounds of *Vateria* bark were also tested.

We thank the National Science Council of Sri Lanka for financial support (Grant No. RG/76/11) and Mrs. Barbara Kirsop of the National Culture Collection, Surrey.

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THE USE OF SODIUM METABISULPHITE TO INCREASE ALCOHOL YIELDS IN THE COCONUT SAP FERMENTATION INDUSTRY

U. Samarajeewa, D. T. Mathes, M. C. P. Wijeratne
and T. Warnakula

(Coconut Research Institute, Lunuwila)

The coconut sap contains sufficient sugars to produce about 10% alcohol in controlled fermentation. However the average yields recorded in the industry is only 6.5%. This is due mainly to activity of "wild yeasts" and bacteria. Sodium metabisulphite is used successfully in the wine industry to suppress unwanted microorganisms. However its use in the coconut sap fermentation industry could cause additional problems due to high ambient temperatures and the methods of collecting and fermenting sap.

Yeasts isolated from coconut toddy and those used in other alcoholic fermentation industries were tested in the laboratory for their ability to ferment coconut sap containing variable amounts of sodium metabisulphite. Nine cultures of toddy yeasts produced no alcohol above 100 ppm of preservative. A natural inoculum from toddy produced alcohol even at 200 ppm. The Champagne and Hock yeasts produced alcohol at 100 ppm but not at 200 ppm. The alcohol production by Sautern yeasts was not affected up to 200 ppm of preservative.

Different concentrations of sodium metabisulphite were introduced into toddy collecting pots in the fields. The results showed a statistical average of 8.4% alcohol in 3½ days with metabisulphite levels less than 200 ppm. The resulting toddy did not possess the usual sulphurous odour.

MORPHOLOGY OF ZIRCONS FROM VIJAYAN COMPLEX ROCKS OF EASTERN SRI LANKA

H. A. H. Jayasena and Kapila Dahanayake
(Dept. of Geology, University of Peradeniya)

Vijayan Complex rocks of Eastern Sri Lanka consist dominantly of microcline granites/gneiss, hornblende biotite gneiss, augen gneiss, migmatite with isolated calc gneiss and quartzite bands. Representative samples of these rocks were collected from an area covered by 1 inch topographic sheets of Vakaneri and Rukam. Zircon grains were separated from crushed rock samples using the ro-tap and the isodynamic magnetic separator. The - 80 + 120 sieve fractions containing zircon grains were mounted on slides and studied under the polarizing microscope.

The study reveals that zircon grains in microcline granite/gneiss samples were elongated and euhedral whereas in hornblende biotite gneiss, augen gneiss and migmatites, such grains were present in association with rounded ones. However in calc gneiss and quartzite the zircon grains were noted to be more or less exclusively rounded in shape.

Our observations suggest metasedimentary origins for calc gneiss and quartzite which perhaps initially existed as impure limestones and sandstones respectively in a Precambrian sedimentary environment. Hornblende biotite gneiss, augen gneisses and migmatites could also represent earlier metasediments which had been probably affected by igneous activity concurrent or subsequent to the formation of microcline granites/gneisses.

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**PETROLOGY OF SOME DOLERITES FROM THE PRECAMBRIAN
VIJAYAN COMPLEX OF SRI LANKA**

Kapila Dahanayake and Tara Tampoe
(*Dept. of Geology, University of Peradeniya*)

Precambrian Vijayan Complex of Sri Lanka consists of widely occurring hornblende biotite gneiss, microcline granite/gneiss, augen gneiss, migmatite, calc gneiss, quartzite and dolerites. Geological studies in the Eastern Vijayan covered by 1 inch topographic sheet of Polonnaruwa, Vakaneri, Rukam and Elahera reveal the frequent occurrence of basic doleritic bodies, for the most part, discontinuous in character. These bodies, whose exposure sometimes is confined to distinct cobble-like rubble characterized by spheroidal weathering, occur in conformity or as cross cutting structures in association with hornblende biotite gneiss.

Petrological studies of some cross cutting dolerites reveal the existence of ophitic texture characteristic of dolerites *sensu stricto*. In such rocks, plagioclase laths are seen associated with augite and rare olivine. However in the conformable type, which is more common, the mineralogy is dominated by green hornblende, plagioclase and garnet with accessory augite, quartz, magnetite and zircon. The replacement of augite to hornblende is common and corona structures characterize these rocks. The coronas show a central clinopyroxene or garnet body surrounded by amphibole and magnetite in a plagioclase groundmass.

Mineralogical observations suggest that some of the dolerites have been subjected to retrograde metamorphism, in the process obliterating their mineralogy, texture and structure. As such, most of the initially cross-cutting bodies could get rotated during metamorphism into structural parallelism. The doleritic bodies unaffected by metamorphism probably exist as cross cutting bodies which retain the initial ophitic texture. However the conformable doleritic bodies with evidence of retrograde metamorphism would represent the metamorphosed equivalents and these could properly be referred to as meta-dolerites.

**CHARNOCKITE AS THE MAJOR SOURCE ROCK OF
SRI LANKAN GEMSTONES**

A. P. Ranasinghe and Kapila Dahanayake
(*Dept. of Geology, University of Peradeniya*)

In Ratnapura and Elahera, the two major gemming areas of Sri Lanka, the underlying lithology is dominated by the rock suite—charnockite, garnetiferous gneiss and granulite. Earlier mineralogical studies¹ have established garnetiferous gneisses and granulites as the source rocks of corundum, the principal gem mineral of Sri Lanka. The present exercise consisted of a comparative evaluation of mineralogy of major rock types occurring in the two important gemming areas. The study based on microscopic examination of mounted sections of - 80+120 sieve fraction of crushed rock samples indicates that in both gemming areas charnockites contain a higher percentage of corundum than the other two source rocks.

This work was supported by an NSC grant.

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SECTION D

PRELIMINARY HYDROGEOCHEMICAL STUDIES ON THE MUTURAJAWELA PEAT DEPOSIT

C. B. Dissanayake, A. Senaratne and S. V. R. Weerasooriya
(Dept. of Geology, University of Peradeniya)

and G. P. Wannigama
(Dept. of Chemistry, University of Peradeniya)

Water samples were collected on a square grid basis from the Maturajawela peat deposit and analysed for copper, total iron, manganese, cobalt and zinc using atomic absorption. Average total trace metal concentrations were generally well below W. H. O. accepted maxima and below the values determined in a perimeter outside the peat deposit. The low values are due to absorption by humic matter and clay sediments associated with peat. Among the trace metals, copper showed the expected high preference for peat. Ground water pH averaged 4.5 to 6.0. Conductivity and salinity were high due to underground seepage of saline water from the nearby canal through permeable clay sediments. In some locations such seepage accounted for relatively high trace metal concentrations and an odour of hydrogen sulphide.

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FLUORIDE ION LEVELS IN DRINKING WATER SYSTEMS

C. B. Dissanayake, S. V. R. Weerasooriya
(Dept. of Geology, University of Peradeniya)

and G. P. Wannigama
(Dept. of Chemistry, University of Peradeniya)

Soil suspensions in the pH range 4.2-12.6 from the wet, intermediate and dry zones of Sri Lanka were investigated for their fluoride ion adsorption ability. Dry zone samples showed lowest adsorption while wet zone samples showed highest adsorption. In all samples, adsorption was found to increase with pH, content of organic matter, clay and free oxides of aluminium (III) and iron (III). Present study shows how these soil variables can be applied to maintain fluoride ion levels in the desired range required for dental health. Clay filters can be used to adsorb excess fluoride ions.

All fluoride ion determinations were made with Orion fluoride ion selective electrode/pH meter.

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USE OF GEOCHEMICAL MAPS IN ENVIRONMENTAL MONITORING, A CASE STUDY WITH NITRATE, NITRITE AND AMMONIUM IONS

C. B. Dissanayake, A. Senaratne and S. V. R. Weerasooriya
(Dept. of Geology, University of Peradeniya)

and G. P. Wannigama
(Dept. of Chemistry, University of Peradeniya)

The large number of Sri Lankan villagers who use wells are exposed to serious pollution hazards and collection of data on such pollution is timely. Well waters in the Kandy/Matale region were analysed for nitrate,

nitrite and ammonium ions, and for dissolved oxygen. Geochemical maps were prepared for environmental monitoring on the basis of these analyses.

Geologically weak zones showed seasonal fluctuations in the observed contour patterns. Nitrate levels increase two- to three-fold and supersaturation with dissolved oxygen occurs during the rainy season. Topography, elevational differences, geologic structure, etc. influence the levels of the three ions studied. Higher values for nitrate and ammonium ions were associated mainly with the proximity of pit latrines, population density and the permeability of the well overburden.

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HYDROGEOCHEMICAL DATA IN GEOLOGICAL MAPPING PROGRAMMES

C. B. Dissanayake and S. V. R. Weerasooriya
(Dept. of Geology, University of Peradeniya)

and G. P. Wannigama
(Dept. of Chemistry, University of Peradeniya)

Samples of ground/stream/lake water were collected from several parts of the island differing in their underlying lithology. Ground water chemistry was closely related to the underlying rock, whereas such a correlation seems to be less significant for stream/lake waters, where the solid rock phase and the aqueous phase are not in equilibrium.

The total dissolved solids increased with the ferro-magnesium content of the host rock. Terrains known to be mafic, felsic, etc. appeared as clusters in plots of calcium vs. magnesium. In some cases, abnormally high potassium: sodium ratios up to 0.5 were observed. These can be ascribed to the entry of potassium into the aqueous phase from the crushed rock or from other contaminant sources.

Hydrogeochemical data can thus be used in geological investigations especially when rock outcrops are not being exposed.

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CHOANEPHORA CUCURBITARUM: THE CAUSATIVE AGENT OF FLOWER BLIGHT DISEASE OF WINGED BEAN PSOPHOCARPUS TETRAGONOLOBUS

S. A. Gunasekera, N. P. Liyanage
(Dept of Botany, University of Kelaniya)

and T. V. Price
(School of Agriculture, La Trobe University, Australia)

Flower blight of winged bean *Psophocarpus tetragonolobus* (L) DC) was noted in Papua New Guinea in 1977 by Price (1980), and subsequently at the Water Resources Board Nursery, Torrington Square, Colombo in February 1981. Petals of infected flowers either get off-coloured, covered by a sporulating fungal mass and eventually fall off or the flowers fall off suddenly without showing external signs of fungal attack.

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The causative fungus was isolated for the first time, identified as *Choanephora cucurbitarum* (Berk & Rae) Thaxt. (IMI 256433) and its pathogenicity was established. *C. cucurbitarum* grows well and produces conidia and sporangia on 2% Malt extract agar (MEA) at 28-32°C. Conidia collected from diseased flowers range from 35.3-82.4 (56.7) μm in length to 23.5-47.1 (33.2) μm in breadth; while conidia collected from MEA plates range from 35.3-70.6 (54.6) μm in length to 23.5-41.2 (31.5) μm in breadth. Liquid water and external nutrient source is necessary for conidial germination. During conidial germination on MEA films at 28-32°C, they develop a single germ tube in about 2-2½ hrs; this increases in length and branches in about a further 1-1½ hrs and about the same time a second germ tube makes its appearance.

Infection occurs mainly through petals and less frequently through sepals. Wounding facilitates infection by a conidial suspension, but is not a prerequisite for infection except with very young flowers. All stages of flower development are equally susceptible for infection by a conidial suspension after wounding.

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SOME FUNGI ASSOCIATED WITH LEAF SPOTS OF WATER HYACINTH IN SRI LANKA

S. Hettiarachchi, S. A. Gunasekera and I. Balasooriya
(Dept. of Botany, University of Kelaniya)

Forty different kinds of leaf spots on water hyacinth, *Eichhornia crassipes* (Mart.) Solms. from 8 different sites in the Western and North Western provinces of Sri Lanka yielded 70 fungal isolates which belonged to 15 genera. Only 5 species were found to be pathogenic to water hyacinth. These species produce leaf spots on artificial inoculation after damaging the leaf surface.

Fungal isolate	Herb IMI No.	Pathogenicity	Diameter of spot in mm.	% Frequency of occurrence
<i>Myrothecium roridum</i> Tode ex Fr	261802	high	15	7.5
<i>Cercospora piaropi</i> Jarp.	261803	medium	10	20.0
<i>Septofusidium elegantulum</i> (Pidlopl.) W. Gams	261800	low	8	7.5
<i>Curvularia tuberculata</i> Jain	261801	low	3	15.0
<i>Phaeotrichoconis crotalariae</i> (Salam & Rao) Subram.	261804	low	3	12.5

Of these species *M. roridum* and *C. piaropi* have been reported to cause leaf spots of water hyacinth in India and Florida. *S. elegantulum*, *P. crotalariae* and *C. tuberculata* have not been recorded to be pathogenic to water hyacinth. This was the first occasion that *C. piaropi* was received at CMI in artificial culture (*personal communication*, CMI).

Leaf spots often yielded more than one pathogenic fungus and also non-pathogens, such as *Curvularia lunata* (Wakker) Boedjin (IMI 264391), *Glomerella cingulata* (Stonem.) Spauld. and Schrenk (IMI 264392), *Idriella lunata* Nelson & Wilhelm (IMI 264393), *Penicillium oxalicum* Currie and Thom and *Fusarium* sp.

Isolation from naturally occurring leaf spots suggest that pathogenic fungi form disease complexes among themselves and/or with the above non-pathogens in various combinations. Occasionally leaf spots yielded only non-pathogenic fungi suggesting the occlusion of the primary pathogen.

(This work formed a part of the Sri Lanka contribution to the Regional Research Project on the Management of Water hyacinth sponsored by the Commonwealth Science Council and UNEP.)

**BREEDING STUDIES ON YARD—LONG BEAN
VIGNA SESQUIPEDALIS (L.) FRUW**

S. Aathiththan, K. Theivendirarajah,
(Dept. of Botany, University of Jaffna)

and P. Ganashan
(Agricultural Regional Research Station,
Karadian Aru, Batticaloa)

The native popular varieties of yard-long bean 'Hawari' and 'Polong' were characterised and hybridized. Of the reciprocal crosses, the hybrid progeny obtained from the cross Polong X Hawari was promising and showed hybrid vigour. The F_2 progeny raised gave rise to various combinations of segregants. The study made in the F_2 population revealed that the characters seed colour, flower colour and pigmentation on pod were of single gene inheritance. Black colour of seed, purple colour of flower, and streaked nature of pods were found to be dominant over white colour of seed with black patches, yellow colour of flower and non-streaked nature of pod respectively. The variation in the pod length, weight and fleshiness observed in F_2 indicated that these characters were controlled by additive gene action.

The pedigree method of selection was followed and the individual plants were selected on the basis of the following agronomic aspects: early flowering, length, weight and fleshiness of pod, number of seeds per pod, number of pods per plant, plant with short internode, number of pods per peduncle, yield efficiency and reaction to pests, viral, bacterial and fungal diseases.

Progeny testing and further selection and purification were done with 68 selected segregants of F_2 . In the third generation, a few of these lines were promising for agronomic characteristics. The results of this investigation reveal that there will be more chances of obtaining promising breeding lines of yard-long bean with good combinations of economic qualities.

Financial support from Natural Resources, Energy and Science Authority of Sri Lanka (RGB/81/13) is acknowledged.

**SOME OBSERVATIONS ON THE DEVELOPMENT OF DOWNY MILDEW
PLASMOPARA VITICOLA ON GRAPES**

N. Ramanathan and A. Sivapalan
(Dept. of Botany, University of Jaffna)

Downy mildew of grapes caused by *Plasmopara viticola* (de Bary) Berl. & de Toni is one of the serious fungal diseases of grapes (*Vitis vinifera* L.) in all grape growing areas of Sri Lanka. The disease is usually observed from December to March.

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Laboratory investigations revealed that the germinating sporangia occur when the leaves are covered by dew. The sporangium germinates producing a single germ tube 18 h after inoculation at 25°C and penetrates the leaves through stomata. After colonisation within the leaves clusters of sporangiophores emerge out through stomata 72 h after inoculation but the infections become visible only on the 5th day after inoculation.

Infections were found to develop better at 20°C and 25°C and at temperatures above 25°C the fungus failed to develop. Infectivity of the fungus was also favoured when the leaf surface was covered by water drops than when the leaf surface was dry.

Although the sporangia are capable of germinating on both surfaces of leaves the germ tubes abort on the upper surface. The 4th, 5th and 6th leaves are found to be more susceptible to this fungus than the other leaves.

The luxurious development of the fungus at low temperatures and when the leaves are covered by dew is in accordance with the field observation that the disease is associated with periods of dew.

This work is supported by a grant from N. R. E. S. A., Sri Lanka (RGB/82/7).

LABORATORY EVALUATION OF FUNGICIDES ON DEVELOPMENT OF *ALTERNARIA ALTERNATA*

N. Ramanathan and A. Sivapalan
(Dept. of Botany, University of Jaffna)

Field observations indicated that *Alternaria alternata* was associated constantly with senesced leaves of onion with a possible role of causing leaf senescence. This fungus was isolated and found to have a temperature optimum of 25°C for germination of conidia at 100% relative humidity. However the growth of mycelium was better at 30°C than at 25°C.

The effects of two systemic fungicides (benomyl and baycor) and nine non-systemic fungicides (cupravit, morestan, pomarsol, sulphur, brassicol, morut, antracol, difolatan and daconil) at concentrations from 0-1000 ppm on the germination of conidia and mycelial growth rate of this fungus, under laboratory conditions were investigated. All fungicides except cupravit inhibited germination of conidia at 10 ppm.

The fungus responded differently to the various fungicides in its mycelial growth rate. Difolatan, benomyl and pomarsol retarded mycelial growth at concentrations between 10-500 ppm and prevented growth entirely at 1000 ppm. Morestan, brassicol, morut, baycor and antracol retarded mycelial growth (considerably) at concentrations between 10-1000 ppm. Cupravit and sulphur permitted certain amount of growth at all concentrations tested. The fungus was usually killed after 3 days on media containing daconil, benomyl or pomarsol.

Sporulation by the fungus was inhibited by benomyl, pomarsol, brassicol, morut, baycor, antracol, difolatan and daconil at 1000 ppm. However some fungicides showed stimulatory effects on growth at certain concentrations.

This investigation provides evidence that benomyl, daconil and pomarsol could be used to control *Alternaria alternata* under laboratory conditions.

BACTERIAL DEGRADATION OF HALOGENATED HYDROCARBONS

Ananda Nanayakkara and G. S. Widanapathirana
(Dept. of Botany, University of Kelaniya)

Ten different bacterial species which are capable of utilizing kerosene oil, were isolated from the soil by the enrichment culture technique. The soil samples were taken from the ground surrounding the base of the petrol and kerosene pumps. These micro-organisms were used to study the degradation of 10 different halogenated hydrocarbons.

The methods used for this were : (a) Growth; (b) Halide release; (c) Oxygen uptake.

These hydrocarbons are mono- and di-substituted aliphatics, mono- and di-substituted aromatics which contain Br, Cl or I atoms at either end in aliphatics or ortho, para or meta position in the benzene ring.

All the substrates tested except 1, 6-dichloro hexane and 1, 2-dibromopropane served as growth substrates for most of the organisms. Substrates such as 1-fluoro-hexadecane, 1-bromononane and 1-bromo-2, 6-dimethyl benzene were universal substrates for the majority of the organisms. These organisms also show an appreciable oxygen uptake but there are exceptions.

The values of halides released and growth in the substrates probably indicate that di-substituted hydrocarbons are more resistant to microbial degradation than the mono-substituted hydrocarbons. The values of halides released also indicate that di-substituted aliphatic hydrocarbons are resistant to microbial attack while the di-substituted aromatic hydrocarbons are not.

Pseudomonas aeruginosa, *Bacillus coagulans* and *Thermomonospora* species appear to be the most efficient organisms in the process of degradation of some of these chemicals.

Resting cell suspensions incubated with substrates that did not serve as growth substrate showed an appreciable oxygen uptake indicating that they are rapidly degraded and hence may be amenable to co-metabolic degradation in the natural soil.

STUDIES ON THE CULTURE OF *SIGANUS* SPP. AND *PENAEUS* SPP. IN FLOATING CAGES

K. Chitravadivelu
(Dept. of Zoology, University of Jaffna)

and K. D. Arudpragasam
(Dept. of Zoology, University of Colombo)

Trials were conducted in the Thondaimannar Lagoon on the culture of *Penaeus monodon*, *Penaeus indicus*, *Siganus javus* and *Siganus oramin* in floating cages.

Prawns were fed with a compounded feed of rice bran, fish meal and chicken mash. *P. monodon* showed a weight gain of 8.4 g. /month. The performance of *P. indicus* was poor.

Siganids were fed with *Cladophora* spp. and *Chaetomorpha* spp. collected from the lagoon. *S. javus* grew at the rate of 2.5 cm. per month, which compares well with results reported for similar culture of siganids in Tanzania (1) *S. oramin* grew at a slower rate of 1.8 cm. per month.

Net damage by crabs was a major problem. Three different types of protective outer cages were tested using woven palmyrah fibre, vinylon netting, and wire mesh. Palmyrah fibre was effective and cheap but easily waterlogged. Wire mesh was effective but expensive.

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Fouling of the netting was also a major problem. Rapid weed growths consisting of Chlorophyceae, Cyanophyceae and Bacillariophyceae developed and sheltered nematodes, copepods, rotifers and turbellaria. Barnacle encrustations developed on the net frames and on the supporting poles.

Further studies in other locations are needed in order to evolve viable culture systems for these species.

This work was carried out on a grant from the International Foundation for Science Sweden.

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Stockholm, International Foundation for Science, 1981, 26 p.

OBSERVATIONS ON THE FOOD AND FEEDING OF *SIGANUS LINEATUS*

K. Chitravadivelu and A. Sivapalan
(Depts. of Zoology and Botany, University of Jaffna)

Siganus lineatus (Cuvier and Valenciennes) is a moderate sized fish which inhabits coastal areas and brackish water bodies in Sri Lanka. This is found in the tropical parts of the Indian and Pacific oceans.

Stomach contents of fish ranging from 2.4 cm to 25.5 cm in standard length, collected from various places along the Northern coasts, Thondaimannar and Jaffna lagoons were examined.

S. lineatus frequents coral reefs and rocky localities, feeding in shoals. It has a small terminal mouth with a single row of close-set incisor-like teeth, on each jaw and feeds by scraping algae from rocks and corals and browsing on sea weeds.

Analysis of stomach contents revealed that *S. lineatus* is purely a herbivore feeding on 12 genera of diatoms, 4 genera of blue-green algae, 6 genera of green algae, 9 genera of red algae, a brown algae, *Dictyota* and an angiosperm *Thalassia*, of which the diatoms predominated. The major components were *Licmophora*, *Gomphonema* and *Navicula* (diatoms), *Oscillatoria* (blue greens), *Cladophora* and *Chaetomorpha* (greens) and *Gracilaria* and *Laurencia* (reds). *Thalassia* predominated over all the other genera except the diatoms.

When the variation in the feeding habits with the size of the fish was analysed by placing the fish in 3 cm length classes, no significant difference in the food was found.

This work was supported by the National Science Council on Research Grant No. RGB/81/11.

TRIALS ON THE POND CULTURE OF *PENAEUS INDICUS* AND *CHANOS CHANOS* AT BRACKISH WATER FISHERIES STATION, PITIPANA

J. M. P. K. Jayasinghe
(National Aquatic Resources Agency, Colombo 15)

The development of culture practices in brackish water of Sri Lanka is important in order to increase the production of prawn and selected species of fish. Culture trials were conducted at the Brackish water Fisheries Station, Pitipana, on the pond culture of *Penaeus indicus* and *Chanos chanos*.

Chanos chanos was cultured in a 0.15 ha earthen pond. Five hundred juveniles of the size range 6.9-8.9 cm were stocked in late December 1981 and were harvested in early June. Fertilization of the pond was done using 50 kg of urea and 15 kg of T.S.P. initially. Subsequently 15 kg of urea and 3 kg of T.S.P. was added monthly. No supplementary feeding was done. Over the six month period fishes grew to an average weight of 176 g and to an average length of 29 cm with a survival rate of 74.8%.

Penaeus indicus was cultured in a 0.15 ha earthen pond. Five hundred juveniles of the size range 4.2-6.6 cm were stocked in late April and were harvested in early June. Fertilization was done using 50 kg of urea and 15 kg of T.S.P. No supplementary feeding was done. Over the period of 70 days prawns grew to an average weight of 18.9 g and to an average total length of 14.8 cm with a survival rate of 42%.

A STUDY OF SPOILAGE IN PRAWNS STORED IN ICE

A. Vairavamurthy

(Bureau of Ceylon Standards, Colombo 3)

Prawns of head-on and headless types were stored in ice and assessed for organoleptic quality and indole. Organoleptic quality was assessed using a 7-point hedonic scale, 7 being very good 1 very poor, by a panel of 6-9 judges. Indole content was analysed using the modified spectrophotometric method².

The organoleptic quality deteriorated significantly, after a period of about 16 days in ice, in both head-on and headless prawns. Although absorbance at 570nm was present, the visible absorption spectrum did not indicate the presence of pure indole in prawn extracts up to 15 days in ice. The absorbance, it was suggested, was due to some substance similar to "Apparent Indole" or "Indole reacting substance" reported in fresh oysters and clams¹. Spectrally confirmable indole was found to be associated with prawns of poor organoleptic quality. Indole content of more than 30µg/100g was shown to indicate organoleptically unacceptable quality, although presence of lower levels would not necessarily mean good quality. Organoleptic quality of head-on prawns appeared to deteriorate faster than headless samples during the storage period, possibly due to the increased enzymic activities present in the head-on prawns. The rosindole complex formed when Ehrlich's reagent was added to prawn extracts, showed changes in absorbance at 570nm after keeping overnight. This aspect needs further study as it might give some information on the nature of indole related substances formed in prawns.

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OCCURRENCE OF *CHAETOGASTER LIMNAEI LIMNAEI* (OLIGOCHAETA) IN THE GASTROPOD SNAIL *LYMNAEA PHILIPINENSIS* NEVILL IN METRO MANILA, AND ITS POSSIBLE ROLE IN THE CONTROL OF FASCIOLIASIS

C. Dimatulac and L. Pinto

(Dept. of Biology, De La Salle University, Manila
Philippines)

The gastropod snail *Lymnaea philipinensis* in addition to being the secondary host of trematode larvae also harbors an oligochaete, *Chaetogaster limnaei limnaei*. Shigina (1970) found that *C. limnaei* actively fed on

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trematode larvae. But Basch and Altomar (1969) reported the penetration of *C. limnaei* by cercariae bringing about its destruction.

In this study it was found that *C. limnaei* with mucus as its food had a longer survival period than those with cercariae.

From 720 snails collected from 4 stations in Metro Manila during the period September 1981 to February 1982, a regression line of the number of *C. limnaei* per snail on the incidence of trematode infections was computerized and given as $Y = -2.731X + 3.855$. The percentage infestation of *C. limnaei* in snails ranged from 90% in Malabon to none in Las Pinas. Conversely, trematode infection was highest (25.6%) in Las Pinas and lowest (5.6%) in Malabon. The absence of *C. limnaei* in Las Pinas was related to the PO_4^{3-} and NO_3^- concentrations.

Regression of the number of *C. limnaei* per snail on the length of the snail gave the equation $Y = 0.088X + 2.249$. There was also a significant seasonal variation in the number of *C. limnaei* per snail.

Although *C. limnaei* was not an obligate predator, there was evidence that its presence arrested the incidence of trematode infection.

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SECTION E: PHYSICAL SCIENCES

COUMARINS FROM *MURRAYA GLEINEI* (RUTACEAE)

D. B. M. Wickramaratne, Vijaya Kumar
(Dept. of Chemistry, University of Peradeniya)

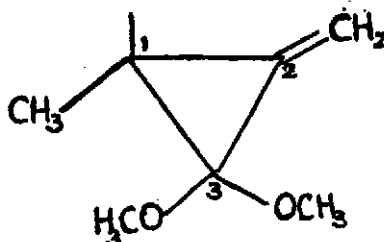
and S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

From the cold light petroleum extraction of leaves of the endemic *Murraya* species, *M. gleinei*, colourless crystals separated out. This crystalline material contained two compounds which were identified as coumarins.

One compound was shown to be sibiricin (5, 7-dimethoxy-8-(2, 3-epoxy-3-methyl butane) coumarin) by comparison of spectral and physical data. Conversion to sibiricin glycol (1) (mexoticin) (2) by treatment with oxalic acid confirmed the structure.

The second compound appears to be a new coumarin ($C_{16}H_{18}O_5$ m.p. 124–126°) and its 1H NMR spectrum showed the presence of 3-OMe groups, a long range coupled methyl group, 2(=CH₂) protons and 2 sets of AB double doublet due to coupling in the coumarin ring. The compound was therefore 7-methoxy coumarin into an 8 position substituent containing 2 methoxy groups. Formation of Murralongin (3) (8-substituent CH₃-C=C(CH₃)CHO) on acid treatment and other evidence suggested the side chain to be cyclopropanone dimethyl acetal with an exocyclic =CH₂ group.

The new coumarin is believed to have the side chain 1-methyl-2-methylene-3, 3-dimethoxycyclopropane.



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A NEW TRITERPENOID FROM *SALACIA RETICULATA* (CELASTRACEAE)

Dharmassree B. T. Wijeratne and Vijaya Kumar
(Dept. of Chemistry, University of Peradeniya)

We have previously reported(1) the isolation of ten friedelane derivatives from the methanolinsoluble fraction of the stem bark of *Salacia reticulata*.

The methanol soluble fraction was separated into two pigments and a colourless compound by chromatographic techniques. The least polar compound was the triterpene quinone-methide iquesterin. Pristimerin the most common quinone-methide in Celastraceae was found to be the major component of the extract.

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The most polar compound isolated appeared to be a friedelane keto-diol [mp 271-273°, (α)_D-29] from its ¹H-NMR spectrum. One of the hydroxy groups was found to be a primary alcohol group (CH₂OH, δ 4.0, dd J 12, 15 Hz) while the second was a secondary alcohol group (CHOH, δ 3.7, dd J 6, 12 Hz). Acetylation gave a keto-diacetate which on reduction with Li/ethylenediamine gave four products. The least polar product was identified as 3(α)-hydroxyfriedelane suggesting that the keto group of the parent compound should be at C-3. The next two polar compounds were diols and were oxidized separately by CrO₃/pyridine to give friedelane-3, 21-dione and a friedelane keto-aldehyde which we believe is 3-oxofriedelane-26-al. The mass spectrum of the diol with m/z 291 suggests the angular methyl oxygenation is at C₂₃ to C₂₇(ABC rings). The C₂₃ methyl doublet is clearly shown in the ¹H-NMR spectrum of the keto-diol, while the keto-aldehyde was not identical to 3-oxofriedelane-27-al and 3-oxofriedelane-25-al. From the position of the CH₂OH signal in the ¹H-NMR spectrum and keto-diol we believe the substitution as 26 rather than 24. The coupling constants of the CHOH signal suggests the 21-hydroxy group to have the 21(α) stereochemistry. The compound is therefore 21(α)26-dihydroxyfriedelane-3-one.

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A NEW TRITERPENE QUINONE-METHIDE FROM *ELAEODENDRON* SPECIES (CELASTRACEAE)

Gamini Weeratunga, Vijaya Kumar and Sinnathamby Balasubramaniam
(Faculty of Science, University of Peradeniya)

Triterpene quinone-methides which have recently become important as antitumour substances are found in several Celastraceae.

Light petroleum extract of root bark of *Elaeodendron balae* was found to contain four triterpene methides of which three have been identified as Pristimerin, tingenone (1) and 20-hydroxytingenone (2) on the basis of their physical properties and by comparison with authentic samples.

The other compound was spectroscopically slightly different from hydroxytingenone. Its NMR signals were shown to be similar to that of 22-hydroxytingenone (3) except in the angular methyl region. It showed signals for four methyls in the region δ 0.75-1.31 and for a vinyl methyl at δ 1.8. The fragment at m/z 265 in the mass spectrum supports the presence of a double bond in ring C. The UV λ_{max} at 446 nm (22-hydroxytingenone, 420 nm) suggested an extension of conjugation to 9,11. These and other data suggest the compound to be 3,22-dihydroxy-24, 29-nor-D:A-friedo-oleana-2, 5, 7, 9(11), 10(1)-pentaen-2, 21-dione for the new quinone methide.

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A NEW D:B-FRIEDO-OLEANANE DERIVATIVE FROM *ELAEODENDRON* *BALAE* (CELASTRACEAE)

Gamini Weeratunga and Vijaya Kumar
(Dept. of Chemistry, University of Peradeniya)

S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

The isolation and characterisation of a new triterpene from the light petroleum extract of the root bark of *Elaeodendron balae* is reported.

This oleanane derivative, $C_{30}H_{50}O_2$ was a diol with an olefinic linkage. Spectroscopic evidence suggested the presence of a ring -OH at C-3, an oxygenated angular methyl group in the form of a $-CH_2OH$ group and a double bond in ring B. The fragment at m/z 290 in the mass spectrum and the similar appearance of two protons signal of $-CH_2OH$ with that of 29-hydroxyfriedelan-3-one(1) suggested that the -OH group should be at C-29.

Acetylation with py/Ac_2O followed by selective deacetylation gave a product in which only the C-3 OH group was acetylated. It was oxidized with $CrO_3/pyridine$ to yield an aldehyde which on Huang-Minlon reduction yielded an alcohol identical with D : B-friedo-olean-5-en-3 β -ol (2) thus confirming the position of the double bond at C-5 and the secondary OH at C-3. Hence the structure is believed to be D : B-Friedo-olean-5-en-3 β , 29-diol and an attempt is being made to relate this compound to 29-hydroxy-D : A-friedo-oleanan-3-one.

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THWAITESIC ACID, A NEW LEAF ACID FROM TWO *CALOPHYLLUM* SPECIES (GUTTIFERAE)

H. R. W. Dharmaratne, S. Sotheeswaran
(Dept. of Chemistry, University of Peradeniya)

S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

Calophyllum lankaensis Kosterm. and *C. thwaitesii* Planch and Triana leaves were dried and were separately extracted with hot light petroleum (60-80°C). The acid fraction of the extracts were found to be a mixture of acids. In each case the following two acids were identified: Thwaitesic acid (ca. 30%) and Calozeylanic acid (ca. 30%) (1). The latter was the major acid of the bark extractives of these two *Calophyllum* species. Thwaitesic acid is a new acid and has been identified as 2,2-dimethyl-5,7-dihydroxy-8-(2-carboxy-1-phenylethyl)-3,4-dihydro-2-chromen.

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1,28-DIHYDROXY D : A-FRIEDO-OLEANAN-3-ONE. A NEW TRIOXYGENATED D : A-FRIEDO-OLEANAN FROM THE LEAVES OF *CALOPHYLLUM LANKAENSIS* KOSTERM., (GUTTIFERAE)

H. R. W. Dharmaratne, S. Sotheeswaran
(Dept. of Chemistry, University of Peradeniya)

and

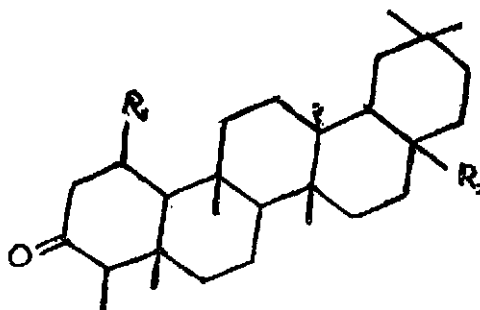
S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

During the investigation of the foliar constituents of the Sri Lankan (*Calophyllum*) species (1) a new trioxygenated D : A-friedo-oleanan was isolated from the leaf extractives of *Calophyllum lankaensis* Kosterm. (Guttiferae) It had a molecular formula $C_{30}H_{50}O_3$ (M^+ 458). The presence of the following functional

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groups were shown by ^1H n.m.r. spectra and/or i.r. spectroscopic data $-\text{CH}_2\text{OH}$, $\text{C}=\text{O}$, $-\text{CHOH}$. The ^1H n.m.r. spectra of the triterpene and its acetate showed that the $-\text{CH}-\text{OH}$ is at C-1 with $\text{C}=\text{O}$ at C-3. The mass spectral fragmentation of the triterpene diol and its derivatives showed that the $-\text{CH}_2\text{OH}$ is at C-28. The above data therefore indicate that the triterpene diol is 1,28-dihydroxy-D:A-friedo-oleanan-3-one (A). This is a new natural product.

In addition, the following compounds were isolated: D:A-friedo-oleanan-3-one (friedelin) (B), 28-hydroxy-D:A-friedo-oleanan-3-one (canophyllol) (C), 28-oxo-D:A-friedo-oleanan-3-one (Canophyllal) (D), 2(R), 3(R)-2, 3-dimethyl-5-hydroxy-6-(3-methyl butanyl)-6-(2, 7-dimethylocta-3, 6-dienyl)-7-oxo-8-(2-carboxy-1-phenylethyl)-2, 3, 6, 7-tetrahydro-benzo-4-pyrone (Calozeylanic acid) and 1-5, 1-7, 1-4', 11-5, 11-7, 11-4'-hexahydroxy 1-3', 11-8 biflavanone (Amantoflavone).



(A) $R_1 = \text{OH}, \text{H};$	$R_2 = \text{CH}_2\text{OH}$
(B) $R_1 = 2\text{H};$	$R_2 = \text{CH}_3$
(C) $R_1 = 2\text{H};$	$R_2 = \text{CH}_2\text{OH}$
(D) $R_2 = 2\text{H};$	$R_2 = \text{CHO}$

Reference

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TWO NEW STEREOISOMERIC COUMARINS FROM THE LEAF EXTRACTIVES OF *CALOPHYLLUM CORDATO-OBLONGUM* THW. (GUTTIFERAE)

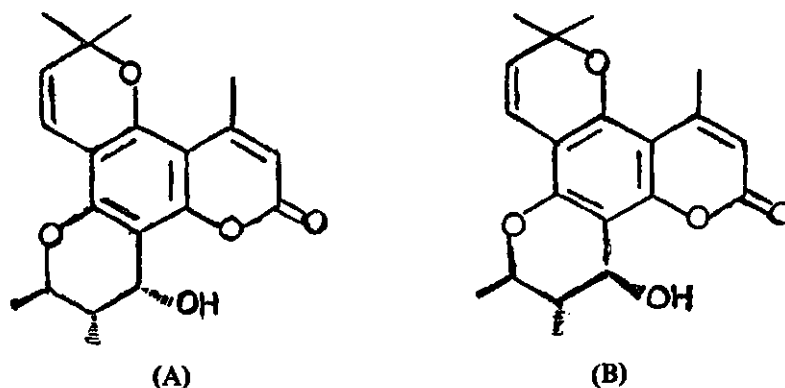
H. R. W. Dharmaratne, S. Sotheeswaran
(Dept. of Chemistry, University of Peradeniya)

and S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

As a part of continuing studies of the extractives of the plant family Guttiferae, the foliar constituents of *Calophyllum cordato-oblongum* Thw. were investigated. The light petroleum extract of the leaves had four coumarins, two of which have been characterised. Both had molecular formula $\text{C}_{20}\text{H}_{22}\text{O}_5$. Both had similar mass spectral fragmentations having the base peak at m/z 327(M^+-CH_3). This fragmentation is typical of the compounds having 2, 2-dimethyl-2H pyran system(1) (2) The presence of the following protons were confirmed from

the ^1H n.m.r. data: $-\text{CH}=\text{CH}(J=10\text{Hz}); \text{CH}_3-\text{C}=\text{CH}; -\text{CH}-\text{OH}; 2\times\text{CH}_3-\text{CH}; -\overset{\text{O}}{\parallel}{\text{C}}=\text{CH}=\text{C}$. The i.r. absorption at 1735 cm^{-1} ($\text{C}=\text{O}$) for both compounds suggested that they are coumarins. This proposal is quite reasonable since the u.v. spectra of both compounds were identical and were very similar to those reported for a number

of 5, 7-dioxygenated coumarins. Besides, both of these compounds gave the same oxidised product. The spectroscopic and chemical evidence show that these coumarins are 11, 12-dihydro-12 α -hydroxy-4, 6, 6, 10 β , 11 α -pentamethyl-2H, 6H, 10H-benzo [1, 2, 6; 3, 4, 6'; 5, 6, 6'']-tripyran-2-one (A) and 11,12-dihydro-12 β -hydroxy-4, 6, 6, 10 β , 11 α -pentamethyl-2H, 6H, 10H-benzo [1, 2, 6; 3, 4, 6'; 5, 6, 6']-tripyran-2-one (B).



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COMPOSITION AND SEQUENCE OF URONATE RESIDUES IN ALGINATES FROM BROWN SEAWEEDS USING ¹H-NMR SPECTROSCOPY

S. Shyamali de Silva, N. Savitri Kumar
(Dept. of Chemistry, University of Peradeniya)

and Per Aman

(Dept. of Chemistry, Swedish University of Agricultural Science,
Uppsala, Sweden)

Sodium alginate is a linear polymer of *D*-mannuronate and *L*-guluronate residues arranged in a block-wise pattern. The proportions of the two units vary widely in the alginates from different species. The physical properties of alginates depend not only upon the composition, i.e. the M/G ratio, but also upon the sequence of uronate distribution in the polymer. It has been shown(2) that high resolution ¹H-NMR spectroscopy may be used to determine not only the M/G ratio, but also the fractions of the four possible doublets MM, MG, GM and GG along the practically intact polymer chain.

Alginates were isolated from the sodium carbonate extract(1) of four species of brown seaweeds: *Cystoseira trinoids*, *Turbinaria conoides* and two unidentified species of *Sargassum*. Partial depolymerisation (to reduce the viscosity of the solution) was carried out with dilute acid (30 min., 100°C, pH 3.0). The hydrolysed samples (10 mg) were dissolved in D₂O (0.5 ml) and EDTA (3 mg) was added to each sample to prevent the interaction of traces of divalent cation with glycourans. ¹H-NMR spectra were run at 99.6 MHz on a JOEL-FX100 NMR spectrometer operating in the Fourier-transform mode. The spectra were recorded at 90°C.

Results (see Table) show that all four alginate samples analysed contain more guluronate than mannuronate residues. The doublet frequencies indicate that the polymer is composed of fairly long G blocks and shorter M blocks, and that the alternate MG and GM character is very small.

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TABLE

			F_G	F_M	F_{GG}	F_{GM}	F_{MG}	F_{MM}	M/G
<i>Cystoseira trinodis</i>	0.81	0.19	0.67	0.14	0.14	0.05	0.23
<i>Turbinaria conoides</i>	...	...	0.65	0.35	0.58	0.07	0.07	0.28	0.54
<i>Sargassum</i> sp. (linear)	...	...	0.65	0.35	0.59	0.06	0.06	0.29	0.54
<i>Sargassum</i> sp. (oval)	...	...	0.74	0.26	0.68	0.06	0.06	0.20	0.35

F_G and F_M — mole fractions of guluronate and mannuronate residues.

F_{GG} , F_{GM} , F_{MG} , F_{MM} — frequency of these doublets along polymer chain.

We are grateful to Prof. S. Balasubramaniam (University of Peradeniya) for the collection and identification of plant material; Dr. Hans Grasdalen for helpful suggestions and the University of Uppsala for facilities and assistance provided. We thank the International Foundation for Science for financial assistance and the National Science Council of Sri Lanka for a research grant.

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TRITERPENES FROM
THE STEM BARK EXTRACT OF *EUONYMUS REVOLUTUS*
(CELASTRACEAE)

P. Mangala Muthukuda, N. Savitri Kumar
(Dept. of Chemistry, University of Peradeniya)

and

Sinnathamby Balasubramaniam
(Dept. of Botany, University of Peradeniya)

The isolation of a new trioxxygenated friedelane derivative from the benzene extract of the stem bark of *Euonymus revolutus* (Celastraceae) was previously reported.(1) This paper reports the triterpenes isolated from the dichloromethane extract of *E. revolutus*.

Ten triterpenes have been isolated from the stem bark extract of *E. revolutus*. Seven of the triterpenes are friedelane derivatives. Four of these have been identified as D:A-Friedooleanan-3-one (Friedelin); D:A-friedooleanan-3,28-dione (canophyllal); D:A-friedooleanan-30-ol-3,28-dione; D:A-friedooleanan-29-ol-3-one and D:A-friedooleanan-28,29-diol-3-one. Spectroscopic evidence indicates that the remaining three triterpenes are lupane derivatives. One of these has been identified as betulin acetate.(1) The other two are trioxxygenated derivatives with the lup-20(29)-ene skeleton, [ν_{\max} 880 cm^{-1} ; δ_H 4.7, 4.6 (2H) and 1.66 (3H)]. Chemical studies are in progress to establish the structures of the unidentified friedelanes and lupane derivatives.

Previous reports and our own studies on the *Celastraceae* indicated that friedelane and lupane derivatives apparently do not co-exist in the stem bark. The only exception reported thus far has been in *Elaeodendron glaucum*(2), but subsequent work was at variance with this observation(3). Hence this is our first report of the coexistence of friedelane and lupane derivatives in a stem bark extract from the *Celastraceae*.

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ALKALOIDS OF ALSTONIA MACROPHYLLA

C. K. Hettiarachchi, L. S. R. Arambewela
(Natural Products Section, Ceylon Institute of Scientific and
Industrial Research, Colombo 7.)

and

K. T. D. de Silva
(Dept. of Chemistry, University of Sri Jayawardenepura,
Nugegoda.)

The genus *Alstonia* belongs to family Apocyanaceae. Two species of this genus, namely *A. macrophylla* and *A. scholaris* are found in Sri Lanka. The former (*S. 'Havari Nuga'*) is very common in Sri Lanka.

The chemical studies of *A. macrophylla* growing in other countries have been reported(1)(3). This plant is used by Phillipines to prepare important drugs.(2)

In the present study the powdered dried bark (2 kg) of *A. macrophylla* was extracted with 70% ethanol, concentrated, acidified with dilute hydrochloric acid and defatted using light petroleum (80°-100°). The aqueous solution was basified (with ammonium hydroxide) and extracted repeatedly with chloroform to obtain the tertiary bases (63.5 g).

The quaternary alkaloids present in the aqueous phase were precipitated as a picrate. This precipitate was dissolved and the alkaloid was converted into its chloride form by passing it through a Amberlite IRA 400 (cl) (wt-40 g).

The fractionation of the chloroform fraction yielded three indole alkaloids. The major alkaloid was a dimeric indole alkaloid. The ir data of the least polar compound indicates the presence of an oxo-enol ether function and the nmr data suggests a polycyclic structure resembling an indolehomotropene alkaloid.

The structures of these three compounds have been assigned using uv, ir, ¹H NMR and ms data.

We thank the National Science Council and International Foundation for Science for financial support.

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SCREENING OF SEAWEED EXTRACTS FOR BACTERICIDAL
AND FUNGICIDAL ACTIVITY

Sarath K. T. Gamage, N. Savitri Kumar
(Dept. of Chemistry, University of Peradeniya)

and

Sinnathamby Balasubramaniam
(Dept. of Botany, University of Peradeniya)

The recent chemical literature provides numerous examples to indicate that the marine algae are prolific producers of chemically and biologically interesting secondary metabolites. The existence of an abundance of marine algae in the coastal waters of Sri Lanka, prompted us to initiate a programme of screening of seaweed

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extracts for the presence of bactericidal (against *Staphylococcus aureus* and *Escherichia coli*) and fungicidal (against yeast) activity. Nineteen species of seaweeds have thus far been screened (see Table) amongst which nine species exhibited bactericidal and/or fungicidal activity. Extracts with pronounced activity were isolated from *Turbinaria conoides*, *Vanvoorstia spectabilis*, *Valoniopsis pachynema* and *Ulva lactuca*. The activity of each of these four extracts i.e. the zone of inhibition of growth of a particular organism was comparable and in two cases (*T. conoides* and *U. lactuca*) were greater than that of the standard drugs used under identical conditions.

Seaweeds were extracted by the slow percolation of aq. methanol, dichloromethane and light petroleum (40-60°) respectively. Bacteriological testing was carried out using the standard disc method (6 mm and 9 mm discs).

We are grateful to Prof. S. N. Arsecularatne, Faculty of Medicine, University of Peradeniya for permitting the use of facilities for bacteriological testing at the Dept. of Bacteriology. We thank the National Science Council of Sri Lanka for a research grant and the International Foundation for Science for financial assistance.

TABLE : SCREENING OF SEAWEED EXTRACTS*

Seaweed	Yeast	<i>S.aureus</i>	<i>E.coli</i>
<i>Dictyosphaeria favulosa</i>	-	-	-
<i>Caulerpa taxifolia</i>	-	-	-
<i>Cladophora</i> sp	+(petrol)	+(MeOH)	+(MeOH)
<i>Valoniopsis pachynema</i>	+(petrol)	+(MeOH) +(CH ₂ Cl ₂)	+(MeOH)
<i>Ulva lactuca</i>	-	+(MeOH)	+(MeOH)
<i>Cystoseira trinodis</i>	-	-	-
<i>Sargassum</i> sp.	+(MeOH)	+(MeOH)	+(MeOH)
<i>Stoechospermum marginatum</i>	-	+(MeOH)	-
<i>Turbinaria ornata</i>	+(petrol) +(CH ₂ Cl ₂)	+(petrol) +(CH ₂ Cl ₂) +(MeOH)	-
<i>T. Conoides</i>	+(petrol) +(CH ₂ Cl ₂)	+(petrol) +(CH ₂ Cl ₂)	+(petrol) +(CH ₂ Cl ₂)
<i>Vanvoorstia spectabilis</i>	+(CH ₂ Cl ₂)	+(CH ₂ Cl ₂)	-
<i>Sarcodia ceylanica</i>	-	-	+(MeOH)
<i>Gracilaria edulis</i>	-	-	-
<i>Hypnea musciformis</i>	-	-	-
<i>G. fergusonii</i>	-	-	-
<i>Acanthophora delile</i>	-	-	-
<i>Gymnogongrus pygmaeus</i>	-	+(MeOH)	+(MeOH) +(CH ₂ Cl ₂)
<i>Chrysiomenia uvaria</i>	-	-	-
<i>Bryocladia thwaitesii</i>	-	-	-

* active +
inactive -

**SOME OBSERVATIONS ON YIELD OF TODDY AND ITS ALCOHOL CONTENT
IN COCONUT PALMS (*COCOS NUCIFERA*)**

T. D. Ekmon

(State Distilleries Corporation, Seeduwa)

Coconut palms are tapped on a large scale for production of toddy in Kalutara District. The major portion of toddy produced is distilled in six private distilleries located in different places to produce coconut arrack. The palms licensed for distilleries are tapped from end of March to December which is generally referred to as "the season" and the period from January to March is referred as the off season or recess period. These distilleries manufacture arrack during the period April to December only.

Production of high strength coconut spirits is done in these distilleries under the direct supervision of the State Distilleries Corporation or Excise Department. The State Distilleries Corporation keeps a record of the number of trees licensed for tapping and the number of trees tapped and the total of toddy supplied to the distilleries. A record of the alcohol content of toddy, arrack produced etc. for these distilleries is also kept. In this paper an attempt is made to study the average yield of toddy per tree per day for different months of the year from 1977 to 1980 based on data maintained by the State Distilleries Corporation. Furthermore the monthly changes in alcohol content of toddy during different months of the year April to December were also studied. Monthly rainfall values in these areas were obtained from the Metereology Department and their influence on yield as well as alcohol content of toddy was also examined.

These studies revealed that there is a wide variation in yield of toddy obtained from the coconut palms in the Kalutara District during different months of the year, and it is highest in June or July and lowest in December and November. Further it was observed that generally rainfall does not make any significant impact on yield of toddy but it effects the strength of toddy to a great extent.

**CHEMICAL INVESTIGATIONS OF THE VOLATILE OILS FROM KEKUNA RESIN
(*CANARIUM ZEYLANICUM* THW.) AND *BIM-DUMMALA***

K. P. A. Senaratne, Indira L. Jayasinghe

*(Agro Industries Section, Ceylon Institute of Scientific and
Industrial Research, Colombo 7)*

and

A. L. Jayawardana

*(Natural Products Section, Ceylon Institute of Scientific and Industrial
Research, Colombo 7)*

The application of oil distilled from *Bim-dummala* (fossil resin) in the preservation of ancient paintings and wooden structures has been known for a long time. More recently the technique has been extended to the preservation of Ola-leaf manuscripts in the Museum.

Comparative analysis of the volatile oils from these two resins by gas chromatography showed interesting similarities. This evidence supports the view that *Bim-dummala* originates from *Kekuna* resin by fossilization.

The oil from fresh *kekuna* resin contains a large proportion of mono-terpene hydrocarbons such as Pinenes, Camphene, Terpinenes limonene p-Cymene and α -Phellandrene. The sesquiterpene and oxygenated mono-terpene compounds are present only in small amounts. The presence of 30% α -Phellandrene in this volatile oil has been reported(1). However no other compounds had been identified.

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The fossilized resin oil showed only traces of the mono-terpene hydrocarbon components and proportionately larger amounts of sesquiterpene and oxyterpene compounds.

The glc pattern of these compounds could be easily superimposed upon the sesquiterpene pattern seen in the oil from the fresh resin and among the sesquiterpenes identified were β -caryophyllene, α -humulene, farnesene and δ -elemene. Camphor and α -Terpineol were among the oxy-terpene compounds identified.

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THE RAPID ESTIMATION OF UNOXIDISED AND OXIDISED POLYPHENOLS IN TEA SOLUTION USING HPLC

Nalin Herath and Godwin Roberts
(Tea Research Institute, Talawakelle).

The relative concentration of unoxidised and oxidised polyphenols present in tea liquor is now known to determine the taste of the beverage. (1) Too high a quantity of unoxidised polyphenols gives rise to a harsh greenish taste in the beverage. The methods which had been used in the past to estimate the relative proportions of unoxidised and oxidised polyphenol in solution are generally time consuming. This paper reports the details of a method whereby both unoxidised and oxidised polyphenols could be estimated sequentially after fractionation on the HPLC. An isocratic elution mode (5% acetic acid) was used for the elution of unoxidised polyphenols while a gradient elution mode (59.5% water + 0.5% acetic acid + 40% acetone) was used for the elution of oxidised polyphenols from the same sample. The usefulness of this method is illustrated by the results obtained from a controlled fermentation experiment.

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THE EFFECT OF SEASON AND MANUFACTURING CONDITIONS ON THE DEVELOPMENT OF FLAVOUR IN BLACK TEA

V. Fernando and G. R. Roberts
(Tea Research Institute, Talawakelle)

Flavour development in black tea is most outstanding during the dry weather which prevails from January–March on the Western High elevation Tea Estates (Dimbulla District) where some of the best tea is grown. These teas are well known for their typical flavour and high price valuation. Many investigations have been carried out in attempts to explain the development seasonal flavour. (1) (2) In this study, black tea from a well known High Elevation Tea Estate was regularly analysed during flavour season for ether extractable steam volatile constituents by Gas Liquid Chromatography.

The variation in concentration of eight major flavour constituents was monitored and it was observed that there are appreciable changes in trans-2-Hexenal and linalool content of black tea during seasonal flavour development. The quality of leaf material and manufacturing practices particularly, withering and fermentation, affected the production of these compounds. The data obtained indicate that the relative concentration of these compounds are partly responsible for the flavour quality of Sri Lanka Black Teas.

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STUDIES ON IMPROVING THE FLAME RESISTANCE OF RUBBERIZED COIR

A. Coomarasamy and D. Nirmala
(*Rubber Research Institute, Telawala Road, Ratmalana*)

Rubberized coir is made by bonding a random web of curled coir fibre with natural rubber latex. It is used as cushioning pads in mattresses, car seats and upholstery, as a packaging material and in insulation. These products can be manufactured either by using semi-automatic production line or manually using simple equipment at a cottage industry level. The ready availability of both natural rubber latex and coir in twisted form in Sri Lanka, has resulted, in recent years, in large increase in the production of rubberized coir in Sri Lanka and these products are available at a medium price range for cushioning applications. The rubberized coir products available at present, are potential fire hazard, as both the coir and rubber are flammable materials. Hence it is necessary to develop suitable treatments for improving the fire resistance of these products.

In the present work treatment of coir and rubber compound have been tried out. Effectiveness of compounds such as boric acid, borax, boric acid-polyvinyl alcohol compound, chlorinated hydrocarbons such as Cereclor 45 and Cereclor 70, antimony trioxide, aluminium hydroxide, calcium pyrophosphate and ortho phosphate and locally available fluoro apatite, either alone or in combination with others have been studied. The effectiveness of natural rubber latex modified with bromotrichloromethane has also been studied in various formulations. Flame resistance was measured using a similar procedure as that adopted for American Motor Vehicle Safety Standard MVSS 302.

It has been found that the coir pads prepared with formulations containing PVA-boric acid compound, boric acid and calcium pyrophosphate, boric acid and antimony trioxide, antimony trioxide alone and rubber latex modified with bromotrichloromethane along with boric acid, had satisfactory flame resistant characteristics.

EFFECT OF HUMIDITY ON THE MOISTURE INTAKE OF LACE CREPE RUBBER

L. M. K. Tillekeratne, P. A. D. T. Vimalasiri and H. P. Sarath Kumara
(*Rubber Research Institute*)

Pale crepe is the purest form of light colour raw natural rubber available in the market today. The price paid for this visually graded form of rubber depends on the pure water white appearance of the rubber. It is known that both the non rubber constituents present in natural rubber latex and the excess moisture in the

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incompletely dried laces of rubber cause mould growth on rubber, thus lowering the quality. It was also suspected that the storage of the finished crepe rubber in humid atmospheres, tremendously increased the tendency to mould growth on the surface of rubber even after the non rubber constituents in the rubber are minimised by fractionation. Hence an attempt was made in this project to study how the humidity of the outer atmosphere affects the mould growth on crepe rubber.

The results of this experiment indicate that although the rubber hydrocarbon does not absorb moisture from the atmosphere, proteins and lipids in the non rubber fraction of the latex are hygroscopic and hence have a tendency to absorb moisture from the humid atmosphere.

Further, the results clearly show that the removal of a higher percentage of the yellow fraction reduces the moisture intake of the perfectly dried laces. The higher percentage of fraction remaining in the partially fractionated rubber and the yellow fraction itself accelerates the moisture intake in more humid atmospheres; reaching the volatile matter percentages above 0.7%, in a period of about a week. Effect of the removal of different percentages of yellow fraction from the latex and the effect when each grade of rubber is suspended at different humidity levels will be discussed.

MANUFACTURE OF GENERAL PURPOSE Cv NATURAL RUBBER IN SRI LANKA

L. M. K. Tillekeratne and P. A. D. T. Vimalasiri
(*Rubber Research Institute*)

In Sri Lanka a very high percentage of the rubber growing areas have been planted with the clone PB 86, which produces high Mooney viscosity rubber. Hence it has been found that Cv rubber grades with Mooney viscosity 50 ± 5 units cannot be produced in Sri Lanka from small-holders latex, which consist mainly of latex from the clone PB 86. However there is a big consumer demand for Cv rubber grades. Previous workers have employed the chemical RPA 3 to reduce the viscosity to acceptable limits. But RPA 3 is no longer available in the market, and hence an attempt was made in this project to employ two peptising agents tolyl mercaptan and a mixture of tolyl and phenyl mercaptans, which are commonly used in the crepe rubber industry as bleaching agents to achieve the required viscosity, without affecting the oxidisibility (PRI) of rubber.

It has been found that certain concentrations of the above named bleaching agents when used in block rubber, produced Cv rubber of viscosity between $50 \pm$ Mooney units. Special precautions to be taken in the process to preserve other requirements in the TSR scheme will be discussed.

THE CALIFORNIUM FISSION FRAGMENT MASS SPECTROMETRIC (FHIID.—MS) ANALYSIS OF PHENYLTHIOHYDANTOIN AMINO ACIDS

E. M. Jayasinghe
(*Dept. of Physics, University of Colombo, Colombo 3*)

I. Kammensky, P. Hakansson, and B. Sundqvist
(*Tandem Accelerator Laboratory, Uppsala, Sweden*)

All twenty naturally occurring PTH- amino acids can be easily identified with a new mass spectrometric technique called FHIID-MS (1, 2, 3).

All PTH amino acids yield a molecular ion as a proton adduct $(M + H)^+$ in positive spectra. Negative spectra do not give good yields but for most PTH amino acids $(M - H)^-$ is observed.

However FHIID-MS is a cheaper technique(4) compared with the cost of HPLC equipment. The HPLC is the standard method for identification of PTH-amino acids at present. Complete automation is discussed and is favourable since actually no conversion of 2 anilino 5- thiazolinone to the corresponding PTH amino acids is necessary (5, 6), thus saving time. With proper equipment, analysis time can be as short as one minute.

Abbreviations

FHIID-MS : Fast Heavy Ion Induced Desorption Mass Spectrometry.
 PTH-Amino acids—Phenylthiohydantoin Amino acid derivative.
 HPLC : High Pressure liquid Chromatography.

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THIN FILM DEPOSITION BY MEANS OF THE ELECTROSPRAY METHOD FOR CALIFORNIUM—252 FISSION FRAGMENT MASS SPECTROMETRIC STUDIES OF INVOLATILE MOLECULES

D. Happuarachchige, and E. M. Jayasinghe
 (Dept. of Physics, University of Colombo, Colombo 3)

An electrospray system and procedure has been developed for the routine preparation of thin films of involatile molecules for analytical measurements.

An anode-cathode design has been developed and conditions for reproducible performance established. Solvent systems for polar and non-polar molecules have been investigated. The method does not appear to degrade thermally-labile molecules.

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SOME CONSTITUENTS OF CALOPHYLLUM CALABA LEAVES

A. A. Leslie Gunatilaka, A. M. Y. Jasmin de Silva and M. I. M. Wazeer
 (Dept. of Chemistry, University of Peradeniya)

Continuing our studies on medicinal and related plants of Sri Lanka, the chemical constituents of the leaves of *Calophyllum calaba*, Guttiferae were investigated.

The acidic fraction (Na_2CO_3 soluble) of the hot methanol soluble portion of the light petroleum extract on methylation and purification by preparative TLC yielded the methyl ester of the already known chapelieric acid(1) and a new isomer of it, *iso-chapelieric acid methyl ester*. These were differentiated and identified with the aid of spectroscopic (IR, UV, MS, H-1 and C-13 NMR) data.

The sodium carbonate insoluble fraction yielded friedelin, D : A-friedo-olean-3 β -ol. 3 α , 28-dihydroxy-D : A-friedo-oleanane, canophyllol (28-hydroxy-D : A-friedo-olean-3-one) canophyllal and canophyllic acid.

We thank the Natural Resources, Energy and Science Authority of Sri Lanka for financial support.

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2, 3-DI-4/(8-HYDROXYQUINOLINYL)-BUTYROLACTONE—A NOVEL MINOR ALKALOID FROM *BROUSSONETIA ZEYLANICA*

A. A. Leslie Gunatilaka, S. Surendrakumar
(Dept. of Chemistry, University of Peradeniya)

and R. H. Thomson
(Dept. of Chemistry, University of Aberdeen, Scotland)

Our previous investigations on the alkaloids of the endemic Moraceae, *Broussonetia zeylanica*, resulted in the isolation of an antimicrobial alkaloid, 8-hydroxyquinoline-4-carbaldehyde(1) and a minor alkaloid 4', 6-dihydroxy-2, 3'-dipyridine.(2)

In this paper the isolation and structure elucidation of another minor alkaloid with a novel carbon skeleton is reported. Interpretation of its spectral data and comparison with those of model compounds suggested the new alkaloid to be 2, 3-di-4/(8-hydroxyquinolinyl)-butyrolactone.

We thank the University of Peradeniya and the International Foundation for Science for financial assistance.

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A NEW NATURAL PHENOLIC (9-8)-24-NOR-D:A-FRIEDO-OLEANAN TRITERPENE FROM *KOKOONA ZEYLANICA*

G. M. K. B. Gunaherath and A. A. Leslie Gunatilaka
(Dept. of Chemistry, University of Peradeniya)

Recently we reported the isolation of zylasterone, zylasteral and desmethyl zylasterone, a new series of phenolic D:A-friedo-oleanan triterpenes from *Kokoona zeylanica* (1)(2). In continuing our studies on this plant, we have isolated a minor constituent present in the phenolic fraction of the petroleum ether extract of the outer bark.

The structure of this minor constituent, $C_{30}H_{38}O_5$, m.p. 157-160°C, was established as 23-oxoisopristerin III (2. 3-dihydroxy-23-oxo-(9-8)-24-nor-D:A-friedo-oleana-1, 3, 5 (10), 6, 9 (11)-pentaen-29-oic acid methyl ester (20 α)) with the aid of spectroscopic evidence.

Occurrence of 23-oxoisopristerin III in nature is significant as its analogue, isopristerin III could be the possible biosynthetic precursor of recently isolated novel quinone-methides in nature, pristerinene and hydroxypristerinene (3).

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✓ **MOLECULAR REARRANGEMENTS IN D:A-FRIEDO-OLEANANES: ACID CATALYSED
REARRANGEMENT OF D:A-FRIEDO OLEAN-3-ENE-21-ONE**

A. A. Leslie Gunatilaka, S. D. G. S. Samaranyake
(Dept. of Chemistry, University of Peradeniya)

and L. M. V. Tillekeratne
(Dept. of Chemistry, University of Colombo, Colombo 3)

Molecular rearrangement in D:A-friedo-oleananes have been extensively studied due to its potential in aiding structure elucidation(1) and in synthesis of complex triterpenes(3). Availability of a variety of D:A-friedo-oleananes(2), prompted us to apply molecular rearrangements for the synthesis of some rare/biologically active triterpenes and herein we report the acid catalyzed rearrangement of D:A-friedo-olean-3-ene-21-one.

Treatment of D:A-friedo-olean-3-ene-21-one with glacial acetic acid and hydrochloric acid mixture in dichloromethane afforded olean-12-ene-21-one as the major product. Formation of this product is interesting as D:A-friedo-olean-3-ene under identical condition gave only olean-13(18)-ene.

We thank Natural Resources, Energy and Science Authority of Sri Lanka and International Foundation for Science for financial assistance.

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✓ **STRUCTURE OF A NOVEL QUINONE FROM (PLUMBAGO ZEYLANICA)
(PLUMBAGINACEAE)**

G. M. K. B. Gunaberath, A. A. L. Gunatilaka
(Dept. of Chemistry, University of Peradeniya)

and R. H. Thomson
(Dept. of Chemistry, University of Aberdeen,
Scotland)

In continuing our chemical studies on the phenolic fraction derived from the hot light petroleum extract of the roots of the medicinal plant, *Plumbago zeylanica*(1), we have isolated a minor (0.004%) quinone, C₃₄H₃₄O₆, m.p. 246-48°C, (α_D) 0°. This paper deals with the elucidation of its structure as 5, 6, 11, 13 (5a, 5b H)-tetrone-11a, 5b, 12, 12a-tetrahydro-1, 7-dihydroxy-5a, 11a-dimethyl-5b (3-(2-methyl-4-hydroxy-1, 4-naphthoquinone))-5H-dibenzo (b, h) fluorene, with the aid of spectral data (UV, IR, MS, ¹H and ¹³C NMR). An x-ray study has been undertaken to determine the absolute configuration at C-5a, C-5b, C-11a and C-12a.

Financial support from the Special Programme of Research, Development and Research Training in Human Reproduction, W.H.O., Geneva, is acknowledged.

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CONSTITUENTS OF *PLUMBAGO ZEYLANICA* (PLUMBAGINACEAE)

G. M. K. B. Gunaherath, A. A. L. Gunatilaka, M. U. S. Sultanbawa
(Dept. of Chemistry, University of Peradeniya)

and

S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

Plumbago zeylanica L. (Sinhala: Ela-nitul), a plant with a variety of medicinal applications(1) has been the subject of several investigations and the presence of plumbagin (5-hydroxy-2-methyl-1, 4-naphthaquinone), 3, 3'-biplumbagin, 3-chloroplumbagin, droserone, elliptinone, chitranone, zeylanone and isozeylanone has been reported.(2) (3).

From the phenolic fraction of the hot light petroleum extract of *P. zeylanica* roots we have isolated plumbagin (0.036%), droserone (0.0013%), isoshinanolone (0.036%) (3) and a new naphthalenone, 1, 2 (3)-tetrahydro-3, 3'-biplumbagin. The structures of these compounds have been established by spectroscopic evidence and chemical interconversions.

Financial Support from the Special Programme of Research, Development and Research Training in Human Reproduction, W.H.O. Geneva is acknowledged.

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CONVENIENT PREPARATION OF SOME CYCLOHEXA-1, 3- AND -1, 4-DIENECARBOXYLATES FROM BENZOIC ACIDS

B. M. Ratnayake Bandara
(Dept. of Chemistry, University of Peradeniya)

and Arthur J. Birch
Australian National University, Canberra

Cyclohexadienecarboxylic esters are useful synthetic precursors. A convenient method for the formation of methyl cyclohexa-1, 5-dienecarboxylates and methyl cyclohexa-2, 5-dienecarboxylates has been developed. The procedure for the 1, 3-diene esters involves the treatment of a benzoic acid with lithium and liquid ammonia, followed by subsequent boiling of the lithium salt of the dihydro-acid with potassium hydroxide and dimethyl sulfate in methanol. The treatment of the lithium salt of the dihydro-acid with dimethyl sulfate in methanol at room temperature yields the corresponding 1, 4-diene esters. This method is particularly useful for acid sensitive dienes.

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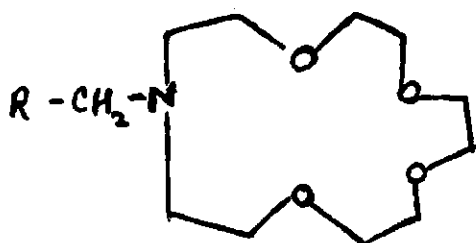
**ENHANCED RATES OF HYDROLYSIS OF ESTERS BY
AZACROWN ETHER DERIVATIVES**

R. Mageswaran, S. Mageswaran
(University of Jaffna)

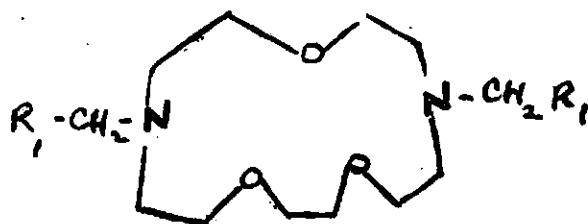
P. Camelleri and I. O. Sutherland
(University of Liverpool, England)

Several groups of workers are engaged in the synthesis of efficient and selective molecular catalyst to mimic enzymes(1). Rate enhancement in chemical reactions by substrate binding has been observed with cyclodextrins(2) hydrophobic systems(3) and crown ethers and their derivatives(4).

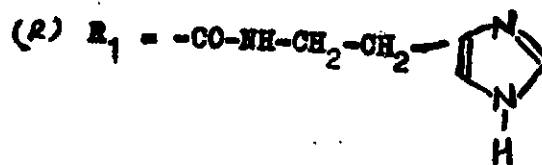
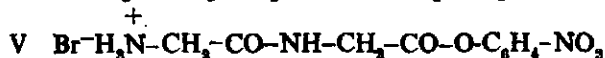
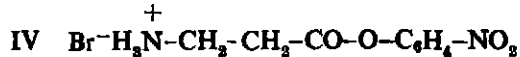
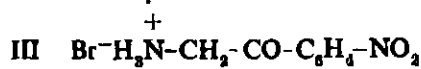
In this paper we report our results on the effect of azacrown ethers (I and II) having a hydroxy and amino groups on the ester hydrolysis reaction.



- I (a) R = 2-Phenylethyl
(b) R = 2-(*m*-Hydroxyphenyl) ethyl



- II (a) R₁ = 2-Phenylethyl
(b) R₁ = 2-(*O*-Hydroxyphenylethyl)
(c) R₁ = 2-(*m*-Hydroxyphenylethyl)
(d) R₁ = -CO-OMe



The observed rate constants and relative rates for the hydrolysis of the esters III, IV and V catalysed by crownethers I and II are given in the Table below.

	Substrate	Catalyst	$k \times 10^5$ $\text{mol}^{-1}\text{s}^{-1}$	Krel (approx.)
1.	III	I(a)	3.19	1
2.	III	I(a) + <i>m</i> -cresol	3.31	1.05
3.	III	I(b)	141.4	44
4.	III	I(b) + MeNH ₂ Br ⁻	31.5	10
5.	III	II(a)	2.88	1
6.	III	II(a) + <i>m</i> -cresol	5.95	2
7.	III	II(b)	17.3	6
8.	III	II(c)	198	69
9.	III	II(c) + MeNH ₂ Br ⁻	25.7	9
10.	III	II(d)	5.89	2

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	Substrate	Catalyst	$k \times 10^6$ $\text{mol}^{-1} \text{ s}^{-1}$	Krcl (approx)
11.	III	II(e)	31.9	11
12.	IV	I(a)	17.5	1
13.	IV	I(b)	66	3.9
14.	IV	II(q)	30.8	1
15.	IV	II(b)	38	1.2
16.	IV	II(c)	93.9	3.1
17.	V	I(a)	39	1
18.	V	I(a) + <i>m</i> -cresol	40.2	1
19.	V	I(b)	312	8
20.	V	I(b) + MeNH_3Br^-	82.5	2.1
21.	V	II(a)	30.1	1
22.	V	II(a) + <i>m</i> -cresol	29.5	1
23.	V	II(b)	61.6	2
24.	V	II(c)	270	9
25.	V	II(c) + MeNH_3Br^-	81.0	2.7
26.	V	II(d)	4.4	11
27.	V	II(e)	96.3	22

Reference

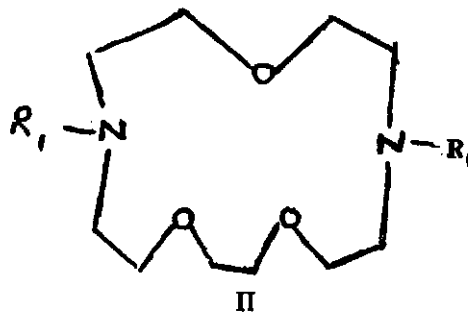
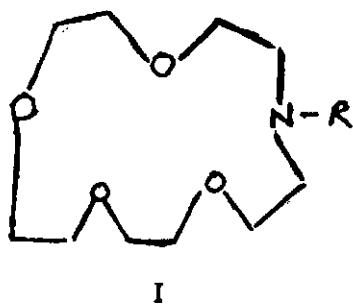
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SYNTHESIS OF SOME MONOAZA AND DIAZA-15-CROWN-5-COMPOUNDS

R. Mageswaran, S. Mageswaran
(University of Jaffna)

and I. O. Sutherland
(University of Liverpool)

As a part of our investigations(2) in the chemistry of crown ethers(3) we studied the catalytic activity of suitably substituted aza crown ethers in the hydrolysis of *p*-nitrophenylesters of amino acids and peptides. For this study several monoaza and diaza-15-crown-5 compounds were synthesised and this paper discusses the synthesis of the compounds I(c) to I(q) and II(b) to II(o).



- | | |
|--|---|
| (a) R = Tosyl | (a) R ₁ = Hydrogen |
| (b) R = Hydrogen | (b) R ₁ = 3-(<i>O</i> -acetyloxyphenyl) propionyl |
| (c) R = Benzyl | (c) R ₁ = 3-(<i>O</i> -Hydroxyphenyl) propyl |
| (d) R = 3-(<i>O</i> -Acetyloxyphenyl) propionyl | (d) R ₁ = 3-(<i>m</i> -Acetyloxyphenyl) propionyl |
| (e) R = 3-(<i>O</i> -Hydroxyphenyl) propionyl | (e) R ₁ = 3-(<i>m</i> -Hydroxyphenyl) propionyl |
| (f) R = 3-(<i>O</i> -Hydroxyphenyl) propyl | (f) R ₁ = 3-(<i>m</i> -Hydroxyphenyl) propyl |
| (g) R = 3-Phenylpropionyl | (g) R ₁ = 3-Phenylpropionyl |
| (h) R = 3-Phenylpropyl | (h) R ₁ = 3-Phenylpropyl |
| (i) R = <i>O</i> -Nitrocinnamoyl | (i) R ₁ = <i>m</i> -Nitrocinnamoyl |
| (j) R = 3-(<i>O</i> -Aminophenyl) propionyl | (j) R ₁ = 3-(<i>m</i> -Aminophenyl) propionyl |
| (k) R = 3-(<i>O</i> -Aminophenyl) propyl | (k) R ₁ = 3-(<i>m</i> -Aminophenyl)propyl |
| (l) R = <i>M</i> -Nitrobenzyl | (l) R ₁ = Benzoyloxycarbonylmethyl |
| (m) R = <i>m</i> -Aminobenzyl | (m) R ₁ = Methoxycarbonylmethyl |
| (n) R = <i>m</i> -Nitrocinnamoyl | (n) R ₁ = Carboxymethyl |
| (o) R = 3-(<i>m</i> -Aminophenyl) propionyl | (o) R ₁ = Histaminocarboxymethyl |
| (p) R = 3-(<i>m</i> -Aminophenyl) propyl | |
| (q) R = 3-(<i>m</i> -Ethylaminophenyl) propyl | |

Compounds I(a), I(b) and II(a) were synthesised by known¹ methods. Compounds I(c) to I(q) are synthesised from I(b) by either alkylation or acylation followed where necessary by reduction. Compounds II(b)-II(o) were synthesised by analogous methods from II(a). All new compounds are characterised by UV, IR, NMR spectroscopy and by high resolution mass spectral measurements.

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COMPLEXES OF NATURALLY OCCURRING LIGANDS WITH BIOLOGICALLY IMPORTANT METAL IONS IV

ISOLATION AND CHARACTERISATION OF METAL COMPLEXES OF 1-HYDROXYXANTHONE WITH MANGANESE, ZINC AND MAGNESIUM

A. C. M. Dangalla and O. A. Illeperuma
(Dept. of Chemistry, University of Peradeniya)

We have earlier reported⁽¹⁾ the synthesis of complexes of 1-hydroxyxanthone with copper, nickel and cobalt. These were orange or dark yellow solids and their compositions have been identified from analytical and spectral data. On account of the biological significance of these complexes, these investigations were extended to the complexes of this compound with other biologically active metals. The preparation and properties of the complexes of this ligand with manganese, zinc and magnesium are reported.

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These complexes were characterised using IR, UV and NMR spectroscopic data and elemental analysis. From these data the complexes were identified $MnL_2 \cdot H_2O$, $Zn(L)(OMe)(H_2O) \cdot H_2O$ and $MgL(OMe)(H_2O)$. The UV visible spectra indicate that the major absorptions are of the charge transfer type and usually occur in the range of 410 nm to 430 nm.

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COMPLEXES OF NATURALLY OCCURRING LIGANDS WITH BIOLOGICALLY IMPORTANT METAL IONS V ✓ DETERMINATION OF STABILITY CONSTANTS OF THE COMPLEXES OF 1-HYDROXYXANTHONE WITH SEVERAL METAL IONS IN SOLUTION

A. C. M. Dangalla and O. A. Ileperuma
(Dept. of Chemistry, University of Peradeniya)

The preparation of several stable complexes of 1-hydroxyxanthenes with biologically important metal ions have been reported earlier (2). Since xanthenes are commonly found in plants their solution studies involving the identification and stability constants of the corresponding metal complexes are important.

The stability constants for the different species involving several metal ions (Cu^{2+} , Ni^{2+} , $Co^{2+}Mg^{2+}$, Mn^{2+} and Zn^{2+}) have been determined (1) by a pH potentiometric titration technique in dimethyl sulfoxide. Here mixtures of the metal and the ligand in the appropriate molar ratios and in the presence of supporting electrolyte 0.1M KCl in DM30 were titrated with 0.01M KOH and the resultant pH values were obtained using a pH meter. The stability constants follow the Irving-Williams order for divalent ions towards donor ligands and is as follows: Cu^{2+} , Ni^{2+} , Co^{2+} , Mn^{2+} and Zn^{2+} , Mg^{2+} .

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✓ AMINO ALKYL AROMATIC COMPOUNDS AS FLUORESCENT pH INDICATORS

A. P. de Silva, R. A. D. D. Rupasingge and S. L. A. Peiris
(Dept. of Chemistry, University of Colombo, Colombo 3)

In spite of all their advantages over adsorption indicators, fluorescent pH indicators (1) suffer from the disadvantage that the pH range cannot be predicted from simple ground state measurements (3). We identify this problem as originating from the fact that almost all common fluorescent indicators have their protonation site directly attached to the chromophore. With a view to avoiding this problem, we have examined the pH dependent fluorescence behaviour of molecules which contain extrachromophoric protonation sites and which are capable of exciplex interaction. Amino, alkyl aromatic compounds (2) are examples of this class which fluoresce intensely in acid media but not in base. Known photochemical processes can therefore be exploited to develop this new type of fluorescent pH indicators. Practically useful examples from the anthracene and quinoline series will be described.

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UMBRELLA SUBSTITUENTS FOR THE PROTECTION OF FLUORESCENT AGENTS

A. P. de Silva and W. D. J. A. Norbert
(Dept. of Chemistry, University of Colombo,
Colombo 3)

Optical brighteners(2) and fluorescent dyes are examples of fluorescent agents which are currently used on a large scale. When these agents are used under tropical light intensities photodecomposition is a problem which leads to a shortening of their useful life. This is at least partly due to the bimolecular processes which the excited fluor molecule can undergo with various species present in the environment. As a model for this interaction, we have studied the fluorescence of some 1,3 diphenyl pyrazoline derivatives which are representative of optical brighteners, in the presence of certain organic halides. These halides act as quenchers by a collisional electron transfer which leads to photodecomposition(1). We find that extrachromophoric substituents considerably inhibit such fluorescence quenching by blocking some approach trajectories of the quencher. This is therefore a steric shielding or umbrella effect of substituents. Quantitation of such effects by Stern-Volmer methods and the failure of additivity of these steric effects will be exemplified.

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STUDY OF SIGMA INDUCTIVE EFFECTS USING THE PEOE METHOD

R. A. Thuraisingham and A. N. Abeywickrema
(Dept. of Chemistry, University of Colombo,
Colombo 3)

The iterative partial equalisation of orbital electronegativity (PEOE) (1) procedure which could be employed to obtain atomic charges in non conjugated sigma frameworks, is used to study sigma inductive effects. The atomic charges so obtained have been successfully correlated with ESCA core binding energies and acidity constants in non conjugated sigma bonded systems(1). Our calculations of atomic charges on substituted alkanes show that the sigma inductive effect falls off systematically along a saturated framework. The calculated transmission coefficient indicates that this effect is important only over a range of two or three bonds. In a series of halogen substituted acetic acids, it was found that neither the polarity of the O-H bond nor the charge on the acidic hydrogen atom were significantly effected by the substituent, indicating that sigma inductive effects on their acidity are minimal, contrary to popular beliefs. Calculations on the substituted alkanes also confirmed that sigma inductive effects are essentially additive and depends on the number of paths between the substituent and the probe atom. Further, the alkyl substituents were found to have a small, electron withdrawing inductive effect. Our results are in general agreement with findings where alternative methods have been employed(2,3).

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A NEW HIGH TEMPERATURE GAS CELL FOR ELECTRON SPECTROSCOPY

J. S. H. Quintus Perera
(Dept. of Chemistry, University of Peradeniya)

and C. A. McDowell
(Dept. of Chemistry, University of British
Columbia, Canada)

For many years there has been a tacit assumption that core electron binding energies were affected by chemical changes but not by phase changes. This led to an uncertainty of approximately 3-5 eV in most core level energies estimated by combining x-ray emission data for solids and optical data for atoms or ions (1) With the realization that, mostly due to many electron relaxation effects the binding energies of the solids were systematically lower than those of the free atoms (2) it became clear that the core level binding energies in free atoms would be very valuable.

However, as metals and most other elements require very high temperatures to generate atomic species, the lack of suitable high temperature gas cells has drastically limited the availability of these binding energies.

A new versatile high temperature gas cell has been designed and a photoelectron spectrum of silver atoms was obtained at 1400 K(3). The design of this high temperature gas cell will be discussed.

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STUDIES WITH THE ANALYTICAL SPECIES FORMED BETWEEN MOLYBDENUM (VI) AND PHENYL HYDRAZINE

R. S. Rnmakrishna and A. M. M. Abhayawickrema
(Dept. of Chemistry, University of Colombo,
Colombo 3)

The chromogenic species formed by reaction of Molybdenum (VI) with phenyl hydrazine was found to be extractable into butanol. Optimum pH of extraction was found to be 3-4 with an enhanced molar absorptivity at 520 nm of $2.59 \times 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ as compared to an aqueous ethanolic solution of $1.65 \times 10^4 \text{ l mol}^{-1} \text{ cm}^{-1}$ Beer's law is obeyed in the range 1.0 - 10.0 $\mu\text{g Mo cm}^{-1}$. A procedure for estimation of Molybdenum in algae is described.

Absence of reaction with reduced Mo(VI) using a Jones reductor confirmed the role of Mo(VI) as an oxidant. The nature of this analytical species is discussed.

Spot test for Mo useful in field estimations, is described using filter paper discs. The method was shown to work satisfactorily in the range 10-100 ppm of Mo.

STUDIES ON TRACE METAL AND CHEMICAL CONSTITUENTS OF ASCIDIAN *ASCIDIA POLYTREMA*

R. S. Ramakrishna, M. Mahendran
and A. J. Ismail
(Dept. of Chemistry, University of Colombo,
Colombo 3)

Trace metal contents (Fe, V, Cu) of the Ascidian (*Ascidia polytrema*) have been estimated. It was found that the tunic of this species contained higher levels of iron, less of vanadium and traces of copper. In contrast the other components were characterised by a total absence of vanadium and lower levels of iron.

Solvent extraction studies of the macerated tunicate material showed that most of the vanadium was either bound to lipids or pigments. Iron was found to be organically bound in tunichrome and was characterised λ_{\max} at 660 nm. This data is compared with other reported iron-binding system, *Ferroverdin*, and shown to be closely similar. The significance of these studies in bioinorganic chemistry will be discussed.

PRELIMINARY STUDIES IN BIOGEOCHEMISTRY FOR MINERAL PROSPECTING AND ENVIRONMENTAL IMPACT

S. A. Fernando, R. S. Ramakrishna
(Dept. of Chemistry, University of Colombo,
Colombo 3)

and S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

A systematic programme has been initiated in the use of biogeochemistry for mineral prospecting and in the evaluation of environmental impact. Two mineralised areas were selected for study of elemental concentrations in vegetation and supporting soils. Plant-soil correlations are reported for copper mineralisation. The results are presented for selected families of plants. Family *Myrtaceae* and the genus *Grewia* (*Tiliaceae*) showed significantly high values for Cu and Zn. Plant-soil mapping has been carried out and the variation of Cu/Zn ratios for soil samples and vegetation reported. The values for Cu showed a significantly low background level with distance from the mineralised area.

Samples of *Eugenia bracteata* (*Myrtaceae*) and *Tarnera asiatica* (*Rubiaceae*) together with their supporting soils were collected from different areas in Sri Lanka. Elemental amounts of Cu determined showed significantly different values as compared to the mineralised area. The results obtained could lead to identification of hyper-accumulators of significance to phytochemistry and in mineral prospecting.

The paper also reports study of use of different digestion techniques for evaluating optimum working procedures for chemical analysis.

STUDIES ON ILMENITE SANDS

A. A. Paul, J. P. R. Fonseka
(Ceylon Mineral Sands Corporation, Pulmoddai)

and R. S. Ramakrishna
(Dept. of Chemistry, University of Colombo,
Colombo 3)

Studies on a modified direct reduction technology on ilmenite have been carried out. These involve oxidation of the FeO content, reduction and use of catalysts for removal of metallic iron. This is followed by

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a mild acid leach for solubilisation of more iron and production of synthetic rutile. The results of a detailed laboratory study of the effect of roasting on ilmenite grains indicate that an optimum roasting time of 1½ hours is required. Sieve analysis indicated that expansion of mineral grains occurred on oxidation.

Another aspect of this work concerns heavy metal uptake by vegetation on tailings. The common sea shore plant (*Ipomea pes-capre* found abundantly on the ilmenite and zircon tailings of Pulmoddai showed high levels of Fe and Ti. Plant analysis showed that these metal contents were considerably higher than in a population collected from uncontaminated sites far away from the tailings. The heavy metal content was found to increase with the increase in Fe and Ti contents in the supporting sands. These results are shown to be of significance to plant physiology and biogeochemistry.

STUDIES ON THE EXTRACTION OF PHOSPHATE FROM EPPAWELA APATITE USING AQUEOUS ALKALINE SOLUTIONS

R. P. Gunawardane

(Dept. of Chemistry, University of Peradeniya)

The reaction of Eppawela apatite with Paranthan hydrochloric acid has been studied^{1,2} to produce a phosphate fertilizer. In the present study, extraction of phosphates from Eppawela apatite using aqueous alkaline solutions has been investigated.

The extraction was carried out using aqueous NaOH, KOH and Na₂CO₃ solutions in the concentrations ranging from 1M to 5M at temperatures from ambient to 85°C. Aqueous Na₂CO₃ solutions were found to be most effective while KOH solutions were least effective as an extracting agent. In all three cases, extraction efficiency was found to increase with increase in concentration. In the case of NaOH and Na₂CO₃ solutions, the optimum temperature for extraction was found to be around 60°C. 4-5M Na₂CO₃ solution at 60°C gave the best yield (17.3 %wt. P₂O₅) of extractable P₂O₅, which is equivalent to about 55% of total P₂O₅ in apatite.

The crystallization of the alkaline phosphate extracts yielded crystals of a mixed salt, alkali phosphate carbonate, which could be used as a phosphate fertilizer.

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STUDIES ON THE REACTION OF EPPAWELA APATITE WITH ALKALI HYDROXIDE AND QUARTZ

R. B. Dassanayake and R. P. Gunawardane

(Dept. of Chemistry, University of Peradeniya)

The molar ratio of apatite, soda ash and quartz, 1 : 2 : 1, respectively, was found to be suitable^(1,2) for the production of a fertilizer from Eppawela apatite. In the present study, the solid-state reaction of apatite with alkali hydroxides (NaOH and KOH) and quartz has been investigated in an attempt to replace soda ash by alkali hydroxide in the fertilizer composition.

Compositions having the molar ratios of apatite, alkali hydroxide and quartz ranging from 1 : 1 : 0 to 1 : 4 : 2 were heated at 950°C in a muffle furnace for 3 hours, and the available P₂O₅ contents of the products were estimated. The products were identified by power X-ray diffraction.

The molar ratios of 1 : 4 : 0 and 1 : 4 : 2 with NaOH gave the best yield of available P_2O_5 . The 1 : 4 : 0 composition contained rhenanite ($CaNaPO_4$) and free lime while 1 : 4 : 2 composition contained only rhenanite as the major phase. pH of the water extracts of the products varies from 8.0 - 11.3 and high pH values are associated with the presence of free lime in the product.

The results of this study indicate that a molar ratio of apatite and soda, 1 (apatite) : 4 (Na_2O), is required for the complete break down of Eppawela apatite and the molar ratio of apatite, alkali hydroxide and quartz, 1 : 4 : 2, is most suited for the production of a fertilizer.

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POLAROGRAPHIC STUDIES ON SOME PARA SUBSTITUTED ACETOPHENONES

✓ Ramyani S. Abeywickrema and D. G. A. Harshani de Silva
(Dept. of Chemistry, University of Colombo, Colombo 3)

Polarographic studies on several para substituted acetophenones in 50% aqueous isopropanol containing tetramethylammonium bromide supporting electrolyte, revealed that, in each case, the reduction was associated with a single two-electron irreversible wave. The half-wave potential ($E_{1/2}$) for the reduction of the carbonyl group was found to become progressively more negative for the methyl and methoxy substituents, whereas the reduction was found to become more feasible with chloro-, bromo- and N-acetyl substituents. Relative rates of reductions, calculated using the Tafel regions of the polarographic waves, were in agreement with the observed trend in the variation of $E_{1/2}$, and could be explained in terms of the electronic effects of the various substituents. A plot of $E_{1/2}$ against the substituent parameter (σ_p) was used to obtain information on the nature of the transition state in the reduction of acetophenones.

AN X-Y TABLE OF MICRON ACCURACY CONTROLLED BY A MICROCOMPUTER

G. M. S. de Silva
(Bureau of Ceylon Standards, Colombo 6)

The design and construction of an X-Y table having a positional accuracy of $\pm 5\mu m$ are described.

The X-Y table consists of two precision translators joined together at right angles to each other. The translators are driven by two 400 steps/rev. stepper motors controlled by an eight bit microcomputer (KIM 1 using 650Z).

A description of the interfacing of the computer to the motors and the development of driving software to obtain the required pattern of traverse are given.

An application of the table for thick film resistor trimming using a Neodymium YAG (Yttrium Aluminium Garnet) laser is outlined.

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PRELIMINARY STUDIES ON TAP WATER CHEMISTRY IN KANDY REGION

C. B. Dissanayake, A. Senaratne, S. V. R. Weerasooriya
(Dept. of Chemistry, University of Peradeniya)

and G. P. Wannigama
(Dept. of Chemistry, University of Peradeniya)

More than 80% of cancer cases are of environmental origin, long term exposure to low concentrations of certain metals being one of the contributing factors. Tap water is a potential carrier for such trace metals.

The composite sampling method was used throughout this tap water survey in the Kandy region. Zinc, copper, lead and iron were determined using atomic absorption. It was observed that metal concentrations depended on pH, temperature, period of contact with pipelines and the presence of soluble bicarbonates. The highest values observed for copper and lead were associated with heavily welded, aged pipelines. Nitrate content was higher in PVC pipelines than in metal pipelines, due to the ability of metals to denitrify the slightly acidic water.

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TRACE METAL ANALYSIS OF RIVER SEDIMENTS

D. Dharmadasa, A. I. Kulatilake
(Dept. of Chemistry, University of Peradeniya)

and R. S. Ramakrishna
(Dept. of Chemistry, University of Colombo,
(Colombo 3))

A programme for a systematic analysis of river sediments as an index of mineralisation and heavy metal deficiencies of significance to environmental studies has been initiated.

This paper reports results of a study of the stream sediments of the Rakwana sheet. Atomic absorption spectrophotometric analysis for Fe, Mn, Zn, Cu, Ca, Mg and Co have been carried out. The analyses have been supplemented by use of Instrumental neutron activation techniques. The results indicate high Mn and Zn of the order of 1000 - 2000 ppm. Sediments from Timbolketiya sheet also indicate high U and Th as analysed using neutron activation analysis. Samples were separated from quartz and subjected to acid digestion.

The significance of these results and the need for extended study will be discussed.

This work was supported by a grant from the Natural Resources, Energy and Science Authority of Sri Lanka.

SECTION F : SOCIAL SCIENCES

IMPLICATIONS OF ERRORS IN GOVERNMENT-DECISION-INFLUENCING DOCUMENTS AND SUGGESTED REMEDIES

J. Diandas

(*Macan Markar and Co., Colombo*)

Errors of fact, mainly in the presentation of statistical information, creep into documents used as basis for government decisions. Sometimes they do and sometimes do not influence decisions. The paper describes examples of such errors in some published and unpublished documents.

One such example is the data regarding the country's vehicle population where the number of vehicles on the register exceeds by 50% the number of vehicles licensed. Despite this Census Department Publications analyse and discuss the "on the register" figure authoritatively without apparently being aware of the discrepancy. Other examples deal with misunderstanding the weight ratios of urea and Naphtha, overstatement of electricity consumption for 1981 in a World Bank advisory report which uses the overstatement as base for a ten year forecast, and a ministerial speech wrongly depicting hydro-electricity as providing only 10% of the country's commercial energy.

The paper postulates that these errors arise either from the lack of independent evaluation of the document, or because its compiler has no feel for the subject matter, or from both these causes. The paper recommends a system of audit of such documents where important decisions are involved.

MONITORING AND EVALUATION AT THE CENTRAL GOVERNMENT LEVEL - SRI LANKA'S EXPERIENCE

V. Ambalavanar

(*Ministry of Plan Implementation*
Colombo 1)

Sri Lanka has about three decades of experience in planning work. During the early years after independence, planning was given a great deal of attention. The mid-fifties saw the birth of a National Planning Council, a Planning Secretariat and a Ten Year Plan. Yet monitoring and evaluation of the progress on implementation of plans did not get sufficient prominence until about ten years later.

The creation of the Plan Implementation Division in the Ministry of Planning and Economic Affairs in 1965 started a new chapter in the Planning process in this country. Within about two years of its creation the Plan Implementation Division started a quarterly monitoring and evaluation process which helped to keep track of the progress on the implementation of Government's Development Programmes.

The monitoring and evaluation work was aided by the Division's quarterly reports and the National Operations Room, which have gone through a considerable amount of changes over time. These changes were largely influenced by the general administrative arrangements that were available elsewhere (i.e. outside the Central Plan Implementation Organisation) to properly monitor development works and initiate follow-up action. Other factors such as the political philosophy, the experiences and monitoring in the recent and distant past also influenced the strategies of the Central Plan Implementation Organisation.

In view of these other factors that determined the framework under which Central Plan Implementation Organisation has been functioning in the country, it is desirable to judge its performance on the basis of its effectiveness within that framework.

The paper reveals that the Plan Implementation Division of the Ministry of Planning and Economic Affairs was very effective in monitoring and follow-up work during the period 1967 to 1970.

During the period 1971 to 1973, the importance and the effectiveness of the Plan Implementation Division was somewhat overshadowed by the large volume of work done and the influence exerted in other spheres by the Ministry of Planning.

The period 1973 to 1977 could be classified as a period when the newly created Ministry of Plan Implementation was trying to evolve an appropriate method for monitoring evaluation and follow-up.

Since 1977 the availability of other Government machinery at the centre to perform the role of co-ordination and follow-up work has reduced the Ministry's burden in such areas. The Ministry of Plan Implementation therefore, adopted as one of its major objectives, the creation of an awareness to development matters in the country and elsewhere. As an organisation which helped to spread development consciousness which kept the Government apprised of major bottlenecks and constraints to development, and which had the responsibility of performing the co-ordinator's role in selected areas, the Ministry continues to play a very useful role.

A SIMPLE LOW-COST SURVEY OF GOODS TRANSPORT

J. Diandas
(*Macan Markar and Co.,
Colombo*)

Where data is required in order-of-magnitude terms rather than in detailed terms, and especially where it is needed to confirm already established trends, traffic surveys can prove expensive. The paper describes a survey of goods traffic around Puttalam, which employed school children.

School Children were stationed in pairs to cover 14 traffic movements at three locations. Each pair worked one 8-hour shift. The full 24 hours therefore required 84 students. At three way or "T" junctions (such as the Kalpitiya turn-off at Palavi), six traffic flows were identified; that is, from each route of origin, traffic moved in one of two possible directions. Each student pair had to observe only one such flow thus simplifying the task. Each pair had an observation sheet ruled in columns and had to fill in the time of each lorry in the designated flow as well as observable particulars about size of lorry, degree of load and nature of cargo. Supervision was exercised by one school teacher and one project engineer who circulated between the locations especially at shift change.

The results were on the whole satisfactory. It is concluded that local school children can be used for surveys of this type, provided the data sheets are carefully and attractively designed, the children adequately instructed, and one or more teachers involved.

This work was undertaken as part of the Puttalam District Flood Protection and Drainage Project.

AN INTEGRATED DEVELOPMENT PLANNING APPROACH: A MICRO LEVEL PROJECT IN THE COLOMBO URBAN AREA

A. L. S. Perera and K. D. Fernando
(*University of Moratuwa*)

Integration is currently a widely used term and may mean different things to different people. It could be basically classified as Internal and External. Internal integration would mean the integration of elements of sub-systems to achieve managerial efficiency and external integration would mean that the sub-system is a part of a general Socio-Economic and Physical System. Integration could also be classified as explicit or implicit. The former would mean that integration is designed to achieve efficiency of the organisation of the planning system while the latter would mean the integration of the ideological, methodological and information base.

The latter may perhaps be more important than the former in achieving planning objectives. The concept developed in this paper depicts the type of integration that could be achieved in a micro level urban development project.

Since western colonial rule was established in Sri Lanka, Colombo became the primate city and the focal point of the export-import trade based on port activities. As a result of this the city was a major attraction for capital investment. Thus the spontaneous and unplanned development and its growth had created multifarious urban problems related to congestion, concentration, inadequacy of infrastructure facilities in terms of increasing demand from urban activities, under utilization of space in terms of high potential value of land, etc. which had not been solved by the plans which were introduced in successive periods prior to the Colombo Master Plan of 1974.

A pilot project was introduced in Peliyagoda Urban Council area in 1978 incorporating the concept of integrated development approach.

Peliyagoda Integrated Urban Development Project is located in the northern fringe of the City of Colombo, which is approximately 1.8 km from the Colombo City Centre and the Port. Also, it is located at a strategic nodal point in terms of transportation.

At the initial stage an extent of 245 ha of low lying land have been identified for this development, in order to achieve three main objectives *viz.* the relocation of some of the industries and warehouses in the City of Colombo to ease the congestion in the City, development of the under-developed land in the Colombo Urban Area and finally the integration of the development with the local community.

The methodology which has been adopted for the purpose of formulating a planning strategy to achieve the above objectives consists of three activity areas based on (a) a survey related to industrial and warehousing location in the city, (b) identification of strategic locations for the relocation and new development of industries and warehouses, and (c) the development of urban facilities as supporting factors for such development. This is a planning process which consists of 12 stages in achieving the objectives of integrated urban development.

The salient feature of this development process is that it will bring many benefits to an under-developed area of Peliyagoda. It will also integrate the local community with development. Such an integrated development is replicable in other areas.

SOME ASPECTS OF INDUSTRIAL LOCATION POLICY IN THE CITY OF COLOMBO

A. L. S. Perera
(University of Moratuwa)

During the past several decades industries have developed in a haphazard manner in the Colombo Urban Area and particularly within the City of Colombo and its immediate environs. The impact of this uncontrolled growth became increasingly evident in the early 1970s. Demiecki, a U.N. Expert attached to the Colombo Municipal Council observed that the rapid growth of industries has caused many serious environmental problems, while the Colombo Municipal Council having discussed the problem at length, passed a motion in 1974 according to which no new industries were to be allowed in the city and serious thought to be given to the gradual shifting of existing industries out of the city. The Colombo Master Plan Project sponsored by the United Nations Development Programme observed that although the magnitude of the problems in the City of Colombo are not as serious as in many third world cities, the time is opportune to take remedial action before such problems reach unmanageable proportions.

The Urban Development Authority which came into existence in 1978 has taken several steps with a view to regulate the development of industries in a conducive manner and for the general environmental improvements within the City of Colombo.

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These include, (a) identification of industries that could be allowed in the City of Colombo, thus preventing major and inappropriate industries being located in the city, (b) identification and planning of areas outside the city which are suitable for the location of new industries and re-location of some industries and warehouses currently located in the city, (c) guiding industries and warehouses to suitable location outside the city and (d) formulation of Development Regulations and maintenance of standards by ascertaining the infrastructure and other needs of industries and warehouses.

These measures undoubtedly set in motion the emergence of a new and desirable pattern of development in the city although there are some problems to be overcome. A more effective mechanism to create public awareness and better integration among the relevant public agencies is a necessary pre-requisite to surmount some of these difficulties.

AN ANALYSIS OF THE OLIGOPOLISTIC NATURE OF THE MARKET FOR AGROCHEMICALS IN SRI LANKA

Renton de Alwis

*(Coast Conservation Division, Ministry of Fisheries,
Colombo 7)*

The marketing strategies by agro-chemical companies in Sri Lanka indicate that it is a non-price competitive market. While there is an apparent rigidity in the price structure, firms are involved in assessing each others marketing strategies, such as radio, TV and poster advertising campaigns, product presentation methods, conduct of demonstrations, and pay offs to officials and village leaders.

The paper attempts to identify the nature of the strategies adopted by five of the leading companies involved in the marketing of weedicides and insecticides in Sri Lanka. The information and data gathered by the author while conducting a survey of weedicide and insecticide marketing in the Polonnaruwa, Anuradhapura, and Kurunegala Districts, form the basis of the analysis, to illustrate the impact of the strategies of non-price competition at the farmers level. The analysis includes the response of farmers to advertising campaigns, the levels of influence achieved through marketing strategies by the different companies, the nature of informal relationships that exist between the dealers and officials, etc.

The paper will be presented in four parts. (1) The theoretical framework of an oligopolistic market and relation of these features to the market for agrochemicals in Sri Lanka. (2) Analysis of the nature of the price structure for weedicides and insecticides and the methods of product differentiation adopted by the different firms. (3) An analysis of the nature of non-price competition adopted by the firms at three different levels i.e. (a) Recruitment of marketing personnel and relationships with the Agriculture Department officials and Research organizations (b) Nature of advertising campaigns and adoption of other methods of persuasion at the regional levels. (c) Selling of products at the farmer level and the nature of the factors of influence. (4) An overall summary of findings and conclusions highlighting the nature of the actual benefits/disbenefits to the farmer from the existing marketing structure.

KNOWLEDGE AND ATTITUDES OF SMALL RUBBER GROWERS TOWARDS INTERCROPPING PRACTICE

A. S. Widanapathirana
(Rubber Research Institute)

Rubber has been grown mainly as a single crop in the past. However, the practice of monoculture cannot be continued because of the pressure for land for cultivation of food crops. Intercropping of rubber lands during the immature period of rubber, should therefore be given high priority. The practice of intercropping has other

advantages; the improvement of maintenance quality of rubber lands which results in the shortening of immature growth period and the supplementation of growers income during the non-productive phase of rubber are two important considerations.

The objectives of this study are to: (a) enumerate farmer's knowledge and attitudes on different aspects of intercropping and (b) identify the farmer's source of knowledge with regard to intercropping.

The area selected was one where intercropping was not adopted.

The investigation indicates that most farmers are not conversant with all technical aspects of intercropping practice. Nevertheless, all growers are aware of the existence of the practice of intercropping.

The study reveals two types of farmer attitudes towards intercropping; firstly, the attitudes towards specific technical components which make up the entire process of intercropping and secondly those which are related to the concept of intercropping, in general.

Analysis of sources of information on intercropping reveals that the majority of rubber farmers obtain such knowledge from mass media such as printed form and radio, while less significant sources include extension agents and other farmers. However, a noteworthy feature of intercrop-adoption behaviour is that all sources identified have been instrumental mainly in making farmers aware of the existence of practice. The study suggests that a well planned motivational campaign with much emphasis on extension inputs is vital for wide scale adoption of intercropping practice on rubber holdings.

IMPACT OF FARM-STRUCTURE AND RELATED PROBLEMS ON AGRICULTURAL OPERATIONS IN THE PADDY GROWING AREAS OF THE GALLE DISTRICT

Upali Vidanapathirana
(Research Department, People's Bank)

The intensity of exploitation of paddy lands is largely determined by the nature of man-land relationships. This is particularly applicable to the comparatively densely populated coastal districts falling within the wet zone of Sri Lanka where the paucity of capital restrains the application of improved techniques. The high population density and man-land relationships have given rise to a variety of farm structures, tenurial complications and numerous related problems. Amongst them had been the high incidence of farm fragmentation and the consequent presence of farms of minute size with a number of parcels scattered everywhere. As an immediate consequence of this situation, the efficiency of farm operations is hindered and farm supervision is made difficult and time consuming.

The objective of this study is to examine the nature of farm structure problems and the impact on farm operations.

A questionnaire was administered in 9 cultivation officer areas in the Galle District and the information so gathered was analysed and tested using chi-square statistics.

The findings reveal a few notable dimensions of the farm structure problems in the Galle District such as the incidence of excessive fragmentation accompanied by the complicated tenurial arrangements in the paddy growing areas. The impact of this state of affairs on farm operations has been found to be statistically significant at the tested level.

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TRANSPORT TRENDS SHOWN BY AVAILABLE STATISTICS

J. Diandas

(*Macan Markar and Co., Colombo*)

Previous attempts at presenting an overview of transport trends in Sri Lanka were published in *Economic Review*, Nov. 75, and *Energy in Sri Lanka SLAAS*, Jan. 80. The first of these was oriented towards an overview of transport activities and the second towards the energy intensity of different transport modes. The present study is aimed at a wider data base, up-dating to 1981 and including the relative importance of transport in GNP and of transport manpower in total employment.

Data was extracted from available published and unpublished sources from 1964 to 1981. Attempts to resolve conflicting statistics, especially as to the country's actual vehicle population have not yet been successful. Despite these, tentative findings are presented showing that travel by bus has increased considerably and continuously while travel by car has remained almost static and travel by rail has declined. Within the bus mode, travel by private bus has increased dramatically at the expense of travel by state-owned buses. However fare increases within the time frame were reflected by fall in travel showing an elasticity of about -3.

Other findings are that the movement of goods has increased with road transport increasing and rail transport declining significantly. Road accidents have increased alarmingly.

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COST OF ROAD ACCIDENTS IN SRI LANKA

W. B. Selvanayagam

(*Ministry of Plan Implementation, Colombo 1*)

In the paper an attempt is made to evaluate the cost of road accidents in Sri Lanka. The calculations are based on estimates currently prevailing in Sri Lanka. The total measurable costs have been estimated on the basis of, (1) Costs of medical treatment; (2) Damage to property; (3) Loss of future output; (4) Administrative costs.

The costs of medical treatment are estimated on the basis of cost per day of an in-door patient and an out-door patient. Damage to property has been estimated on payments made by the Insurance Corporation. Loss of future output has been based on a number of averages, (average wage, average consumption, average duration of working life) and the values of consumption and production in the future have been discounted to give present day values. Other costs that arise as a result of road accidents include those associated with the administration of insurance, costs imposed by accidents on the police and the coroners.

In addition to the above, an input value is given for personal bereavement and suffering to arrive at the total costs of an accident.

Then the existing method of estimating the cost of road accidents in Sri Lanka is analysed and the shortcomings pointed out in the light of the true costs estimated earlier.

Finally an attempt is made to evaluate the cost of road accidents as against the cost of preventive measures which the State may adopt to save lives.