

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)

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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.

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SOME ASPECTS OF MESOFAUNAL ECOLOGY OF TWO TEMPORARY PONDS

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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.

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PRODUCTIVITY OF THE BOLGODA LAGOON

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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

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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.

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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)

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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.

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

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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)

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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)**

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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.

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

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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

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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**

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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**

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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

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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

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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

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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

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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

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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

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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**

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and P. Ganashan
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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
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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

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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

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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*

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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

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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

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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 PHILIPPINENSIS* NEVILL IN METRO MANILA, AND ITS POSSIBLE ROLE IN THE CONTROL OF FASCIOLIASIS

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The gastropod snail *Lymnaea philippinensis* 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)

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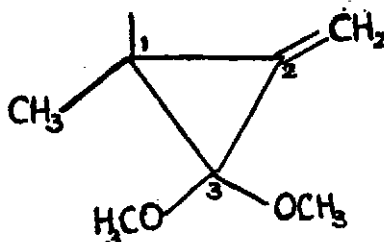
and S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

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 $CH_3-C=C(CH_3)CHO$) 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)

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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-dihydroxyfriedelan-3-one.

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

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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)

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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)

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S. Balasubramaniam
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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

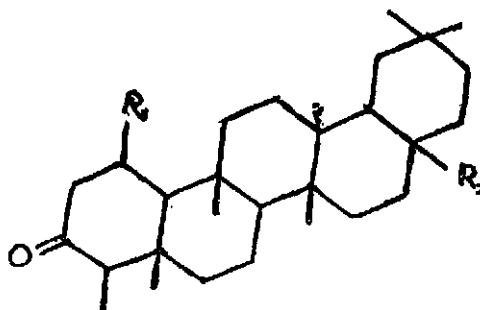
S. Balasubramaniam
(Dept. of Botany, University of Peradeniya)

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

1. Dharmaratne H. R. W. and Sotheeswaran S., *Proc. Sri Lanka Assoc. Adv. Sci.*, 37, 75 (1981).

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

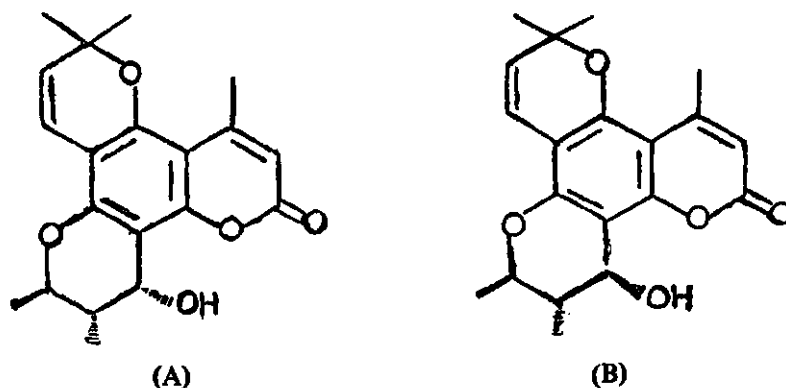
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As a part of continuing studies of the extractives of the plant family Guttiferae, the foliar constituents of *Calophyllum cordato-oblongum* Thw. were investigated. The light petroleum extract of the leaves had four coumarins, two of which have been 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($\text{M}^+ - \text{CH}_3$). 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

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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)

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and

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The isolation of a new trioxygenated 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 trioxygenated 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

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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.

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SCREENING OF SEAWEED EXTRACTS FOR BACTERICIDAL AND FUNGICIDAL ACTIVITY

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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*)**

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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***

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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

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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

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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

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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

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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

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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

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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

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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

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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*

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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*

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Recently we reported the isolation of zeylasterone, zeylasteral and desmethyl zeylasterone, 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**

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and **L. M. V. Tillekeratne**
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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)**

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and **R. H. Thomson**
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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)

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and

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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

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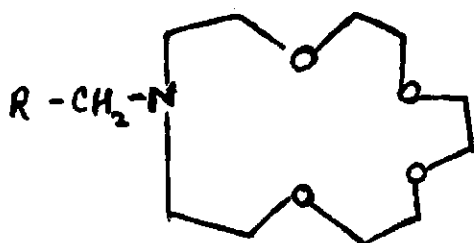
**ENHANCED RATES OF HYDROLYSIS OF ESTERS BY
AZACROWN ETHER DERIVATIVES**

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

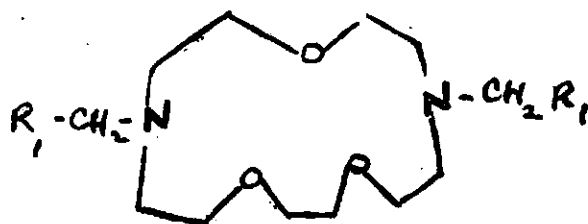
P. Camelleri and I. O. Sutherland
(University of Liverpool, England)

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).

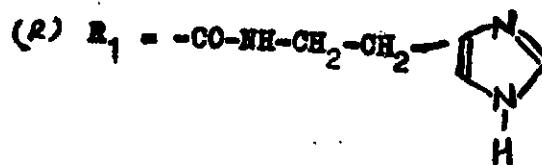
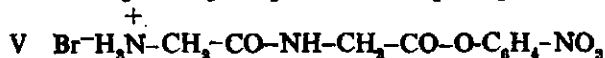
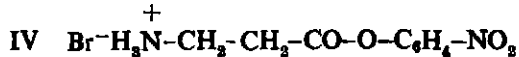
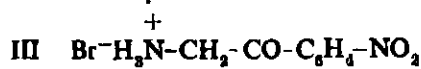
In this paper we report our results on the effect of azacrown ethers (I and II) having a hydroxy and amino groups on the ester hydrolysis reaction.



- 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	kx10 ⁵ mol ⁻¹ ls ⁻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

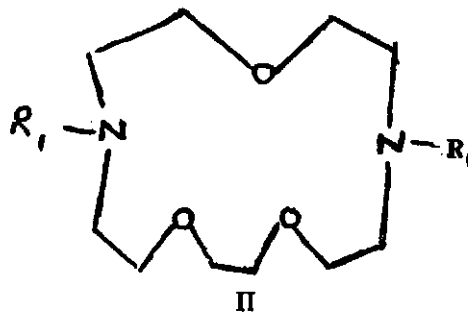
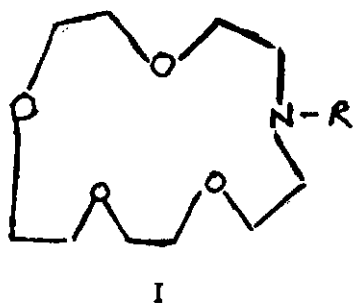
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SYNTHESIS OF SOME MONOAZA AND DIAZA-15-CROWN-5-COMPOUNDS

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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
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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

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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

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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

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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

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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

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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

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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*

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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

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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

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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-caprae*) 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

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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

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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

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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

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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

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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

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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

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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

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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

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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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SECTION F

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.

This work was supported by Friedrich Ebert Stiftung.

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COST OF ROAD ACCIDENTS IN SRI LANKA

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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.