VIDU 14-2-1

WATER HYACINTH - THE SILENT PURIFIER OF NATURE'S WATER BODIES

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Water hyacinth *(Eichhornia crassipes)* is a 'God given' plant for purification of natural water bodies says professor Haider of Decca University, a pioneer in studies on water hyacinth. Prof. Haider is one of the increasing number of scientists world over who are begining to convinced of the remarkable ability of water hyacinth to purify polluted waters. The fantastic ability of water hyacinth to survive, absorbe, accumulate and metabolize many a toxic elements from various types of polluted waters which no other plant can survive in, sometimes for even a few minutes or hours, has well been documented.

True, that water hyacinths are generally considered a pest due to their tremendous growth rate and extreme hardiness. One acre of water hyacinths has been reported to have a potential of producing over 70 tons of (63,640 Kg) dry plant material annually when grown under favourable nutrient conditions. This works out to about 175 Kg of dry matter per day per acre which by any standard is quite tremendous. Area-wise water hyacinths can double in 6-7 days during a growing season under favourable conditions. Such phenominal growth also implies removal of nutients from its sorroundings, whether they be toxic or non toxic, thereby purifying the aquatic medium. Nitrogen, phosphorous and potassium are three elements utilized by hyacinths for such prolific growth. Nitrogen and phosphorous are the two major elements responsible for eutrophication of natural water bodies due to natural and cultural reasons. Water hyaciths perform a process of natural purification of eutrophic waters and the plants can be harvested off once the job is completed.

The undesirable characteristic of water hyacinth namely the prolific growth is also the secret behind its ability to purify polluted waters. It is these same undesirable characteristics that can be desirable attributes thereby utilizing in controlled biological systems for pollutant removal.

The ability of water hyacinths to remove pollutants from contaminated waters has been investigated extensively both on developing and developed countries. Studies by researchers at NASA in the USA lead this field.

Water hyacinths have the potential for removing over 3500 pounds (1591 Kg) of nitrogen and over 800 pounds (364 Kg) of phosphorous annually from sewage effluent. It can absorb and metabolize over 150 pounds (68 Kg) of phenols every 72 hours, from waters polluted with this chemical. It can also remove over 120 g of trace heavy metal contaminants, every 24 hours, reports Dr Wolverton of NASA.

The capability of water hyacinths to absorb heavy metal ions including such toxic metals as lead and mercury from contaminated waters is quite astonoshing (see Table 1.)

Capability of water hyacinths to remove various pollutants from contaminated waters

chemical/metal pollutant	Quantity removed/absorbed Kg/ per acre/ per day
Cadmium	0.161 Kg
Lead	0.042 Kg
Mercury	0.036 Kg
Nickel	0.120 Kg
Silver	0.156 Kg
Cobolt	0.137 Kg
Strontium	0.237 Kg
Phenols	8.640 Kg

(Wolverton *et al.* 1976)

Scientists in a number of countries such as USA, China, Malaysia and Bangaladesh have attempted to make use of what water hyacinths are doing silently in nature-to utilize them in controlled biological systems for pollutant removal. The results have been

extremely promising. For instance, in a trial in Florida, USA, when sewage was passed through a pond at a rate of 2.2 million litres per ha per day (2000,000 gallons per acre per day), water hyacinths in the pond have removed 80 per cent of the nitrogenous matter and 40 per cent of the phosphorous compounds in 2 days. There are numerous reports with similar results from scientsts other countries.

Water hyacinth culture removes algae and faecal bacteria, greatly reduces suspended matter and removes odour causing compounds. As a result, the resultant effluent is clear, odourless and contain little nitrogen and phosphorous.

In some Asian countries such as China and Malaysia water hyacinths have been used in treatment systems for pig farm waste. Malaysians and Sri Lankans have reported successful of water hyacinths in treating rubber factory effluents in experimental trials. In Sri Lanka water hyacinths are being used in a ponding system for treatment of textile factory effluents. These represents only a few instances of utilization of water hyacinths in biological treatment systems for various industrial effluents.

A couple of NARESA funded research projects, a few years ago looked into the possibility of using Eichhornia in treatment systems for several types of rubber factory effluents. With appropriate preconditioning and dilutions, it was shown that water hyacinth can be successfully used in ponding systems for treating effluents from crepe and latex concentrate factories.

Significant reductions in effluent parameters such as Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) have been achieved by using water hyacinths in treatment ponds. Studies carried out at the Rubber Research Institute, Sri Lanka show that a 90 per cent reduction of BOD and a 80 per cent reduction of COD in rubber factory effluents can be obtained by ponding systems with water hyacinths in period of about 10 days. This 10 - day treatment period or retention time as compared to 22 days required for conventional ponding systems (without plants) is a remarkable improvement.

This in turn brings down the land requirement for construction of ponding systems by 50 per cent thus making it more attractive to most rubber plantations where land for setting up of ponding systems, is scarce. In Sri Lanka a rather peculiar situation exists with regard to water hyacinth. Although water hyacinth can do the trick as far as pollutant removal is concerned, Sri Lankan rubber planters can not make use of this research finding since growing dissemination and transport of water hyacinth has been declared a punishable offence by a gazette notification in 1905.

Eichhornia crassipes is not the only aquatic plant adapted for growing in waste waters. As far as the removal of pollutanta is concerned it certainly ranks top. Among the other aquatic plants that seem to grow well in waste waters are several common weeds, for example the common weed *(Phragmites communis)*, bulrush *(Scripus lacastris)*, duck weeds *(Lemma* spp. and *Spirodela* spp.*)*, forms of elodea *(Elodea canadensis), Ergaria densa*, (hydrilla) and *Ceratophyllum demersum* etc.. Water lettuce *(Pistia stratiotes)*, another aquatic plant of floating type like water hyacinth, has been investigated extensively as waste water purifier.But can not match hardy water hyacinths since it can not withstand high concentrations of toxic elements in waste waters. *Pistia* is therefore more suitable for polishing of pre-treated effluent prior to final discharge.

The Max plank Institute of West Germany has developed and patented a water treatment process that uses reeds and bulrushes to purify water. Bilogical treatment systems with water hyacinths provide an attractive alternative to costly waste water treatment methods such as oxidation ditch, activated sludge system etc. These bilogical systems are also energy saving and their operational and maintenace costs are very low.

However, the anaerobic- facultative ponding systems are not without problems. The main drawback of water hyacinth lagoons being that the root system of the plant provides an ideal breeding ground for mosquitoes which could pose a health problem particularly in the tropics where malaria and other mosquito-borne diseases are common. Researchers

have found an answer to this too - the use of larvae feeding fish species. The improved qualilty of water in lagoons with water hyacinth allows *Gambusia affinis,* commonly refered to as mosquito fish, to flourish in it and naturally control mosquitoes by feeding on the larvae.

Despite so much of information gathered over the years on the economic potential of water hyacinth and other aquatic plants through a wide range of uses including pollutant removal the general attitude towards aquatic plants seem to remain the same.

Dr. N.W. Pirie who is world famous for his pioneering work on leaf proteins, in 1960, in a short note entitled "Water hyacinth - curse or crop" made an eloquent plea for a change in single minded approach to eradication, in favour of re-orientation towards utilization.

Shouldn't we appreciate what aquatic plants particularly water hyacinths are doing silently to our natural water bodies - namely purification. Shouldn't we recognise and appreciate this silent act of water hyacinths and extend it to our own advantage in the way we wanted. Professor Bates and Professor Hentges of University of Florida said in 1974 that "Eradication has presumably not worked since we are worse off in 1974 than in 1960. Simply stated the aquatic infestation is ever present. Like it or not, such vegetation appears to be a relatively stable component of tropical environment. It seems logical to make most of these plants and use them to serve man and his environment."

VIDU 14-2-4

AQUATIC ORNAMENTAL PLANTS OF SRI LANKA

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There are many different species of aquatic plants that are used to decorate aquaria, in-door and out-door ponds over the world. Most of these originate in the tropics and for that matter Sri Lanka is not an exception. The topography and numerous habitats of the country provide necessary environmental requirements for these plants.

Present paper is and attempt to review some of the commonly used ornamental water plants found in Sri Lanka and their distribution. Notes are also given on propagation and cultivation of the plants.

1. Genus : *Aponogeton* (Figure 1) (Common name : English- Ruffled Sword plant, Sinhalese- Keketiya)
(Family : Aponogetonaceae)

Habitat: Pools, ponds, lakes, seasonal tanks and slow-flowing waterways both in shade and in the sun.

Five species, namelly, *A.crispus* (Distribution: Central Western and Southern provinces), *A. rigidifolius* (Distribution: Southern and Central provinces), *A. undulatus* (Distribution: in all areas except the Eastern, Northern and Central provinces), *A.echinatus* (Distribution: Southern province), *A. natans* (Synonym: *A. monostachyus* (Distribution: Western province and North Central province) are ideal for deep, large aquarium tnks or garden ponds. All but *A. Crispus* are very easy to grow. They are very tolerant of the variable composition of soil and water and does not need a lot of light. Propagation is from the young plants produced on runners. *A. crispus* has a few special requirements and may stop growing from time to time, but will recommence of its own accord.

2. Genus: *Bacopa* (Figure 2) (Common name : English- Baby's tears, Sinhalese- Heen lunuwila)
(Family: Scrophulariaceae)

Habitat: In marshy areas

Species *B. monnierii* (Synonyms: *Herpestes monnieria, Lysimachia monnieria*) (Distribution: all provinces except the Northern province) can be used in aquaria and garden ponds of any type. Plant does not need special requirements to grow but too strong light induce growth of algae which may cover the plant. Propagation is by cuttings.

3. Genus: *Cabomba* (Figure 3) (Common name : Englilsh Fanwort, Sinnhalese- Budu Ras pasi)
(Family: Nymphaeaceae)

Habitat: In ponds, lakes, ditches, ponds and water-holes

This genus has two species suitable for aquaria. *C. aquatica* (Synonym: *Nectris aquatica, Villarsia aquatica*) (Distribution: North Western, Western, and Southern Provinces) and *C. carotiniana* (Synonym: *C.peltata, C. pinnata, Nectris peltata*) (Distribution: Central and Western provinces) are good for any type of aquaria or garden ponds. *C. aquatica* is difficult to cultivate as it requires soft water. It also needs high temperatures and sunlight. Latter one is easy to grow and it only needs good light. Propagation is by cuttings.

4. Genus: *Cardamine* (Figure 4) (Common name: English-Chinese Ivy, Sinhalese-Diya Bo)
(Family: Brassicaceae or Cruciferae?)

Habitat: In lakes, ponds and somtimes in slow-flowing streams and in ditches

Species *C. hirsuta* (Distribution : Central and Western provinces) is suitable for all types of garden ponds and aquarium tanks. Plant requires a lot of light and develop well in rich soils. Propagation is easy by top cuttings.

5. Genus: *Ceratophyllum* (Figure 5)(Common name: English - Hornwort, Sinhalese - Diya hawari)
(Family: Ceratophyllaceae)

Habitat: In ditches, rivers, canals and pools

Species *C. demersum* (Synonyms: *C. aspersum, C. cornutum, C. cristatum*) (Distribution: Western central and southern provinces) that is also found in brackishwater is more suitable for large garden ponds or aquarium tanks. However, the plant grows in good light and needs nutritious water, It has water purifying properties. Plant can be propagated from pieces of plants and each piece will develop into a new plant.

6. Genus: *Ceratopteris* (Figure 6) (Common name: English - Water Sprite, Indianfern, Sinhalese - Kukul Andu)
(Family: Parkeriaceae)

Habitat: In rice fields, ditches and water logged meadows

Species *C. thalictroides* (Distribution: Central, Western and Southern provinces) is not difficult to grow but does require good light and warm temperatures. It is good for both aquaria and garden ponds. Propagation by young plants growing at lobes.

7. Genus: *Cryptocoryne* (Figure 7) (Common name: Sinhalese- Attudiyan)
(Family: Araceae)

Habitat: In rivers, streams and springs

There are about thirteen species belonging to this genus which are ideal for deep aquarium tanks or garden ponds, namely, *C. parva, C. becketti, C.legroi, C. willisii, C. Ciliata, C. walkerii, C. thwaitesii,* (Distribution: all in the Central province while *C. walkerii* also grows in the Eastern province and *C. thwaitesii* in the western province), *C. nevillii* (Distribution: mainly found in Mahaweli river and some of its tributaries), *C. petchii, C.lucens* (Distribution: Both in Central and Eastern provinces), *C. lutea, C. wendtii,* and *C.spiralis* (Distribution: all three species are mostly found in the Western Central province. The later one is also found in the Eastern and Western provinces together with *C. undulata* while *C.wendtii* also grow in the Central province).

C. beckettii has few special requirements and grows well in clay mixed soils. Propagation of all species is possible from runners. *C. petchii* and *C. nevillii* need strong light. *C. parva* is almost impossible to grow underwater.

8. Genus: *Egeria* (Figure 8) (Common name : english-;Canadian Water weed, Sinhalese-Gona parandala)
(Family: Hydrocharitaceae)

Habitat: In rivers, lakes and ponds

Species *E. densa* (Synonym: *Elodea densa, Anacharis densa*) (Distribution: all area except the Nothern province of Sri Lanka) requires a great deal of light to grow. Good for both aquarium tanks and garden ponds. Propagation is by pieces of plant and can be cultivated either in rooted or free floating form.

9. Genus: *Eichhornia* (Figure 9) (Common name: English- Water Hyacinth, Sinhalese- Japan Jabara)
(Family: Pontederiaceae)

Habitat: In tanks,slow folwing rivers and marshy areas

Species *E. crassipes* (Distribution: throughout the Island except in the Northern province) has become a notorious weed, but some aquarists regard its hanging roots as a useful cover for fry. Therefore more suitable for breeding aquarium tanks but also can be used in medium and large sized garden ponds and aquarium tanks. Plants need good light.

10. Genus: *Hydrilla* (Figure 10) (Common name: English-Water Serpent, Sinhalese- Diya Sarupa, Diya sarpa)
(Family: Hydrocharitaceae)

Habitat: In tanks and slow flowing rivers

species *H. verticillata* (Distribution: throughout Sri Lanka) is suitable for large aquarium tanks or garden ponds. Easy to grow either in its rooted or free floating form, provided it is given a good deal of light. Planting calls for care, because the very fragile stalks must not be damaged.

11. Genus: *Hydrocotyle* (Figure 11) (Common name: English-Water pennywort, Sinhalese- Diya Gotukola)
(Family:Umbelliferae)

Habitat: In rice fields, damp places and slow flowing ditches

Species *H. sibthorpiodes* (Distribution: Central province) is suitable for deep aquarium tanks. Plant needs a great deal of light. Regular topping is needed to keep the plant submerged. Propagation by runners.

12. Genus: *Hygrophila* (Figure 12) (Common name: English-Water Wistaria, Indian water star, Sinhalese-Heen mukunuwenna)
(Family: Acanthaceae)

Habitat: In ditches, rice fields and slow- moving waterways (eg: Irrigation canals)

Two species, *H. differmis* (Synonym: *Synnema triflorum*) (Distribution: throughout Sri Lanka except in the Northern province) and *H.polysperma* (Synonym: *Hemiadelphis polysperma, Justica polysperma)* (Distribution: Central, Western and Southern provinces) are specially suitable for larger aquaria. Easy to grow but requires a lot of light. Plant can be propagated using cuttings. Even severed leaves will produce young plants where they have been cut. Runners are also produced at the root of the plant.

13. Genus: *Lagenandra* (Figure 13)(Common name: none)
(Family:Araceae)

Habitat: In marshy ground in low-lying tropical forests

Species *L. thwaitesii* is suitable for medium as well as big aquarium tanks and garden ponds. Though it can survive for long times underwater, it does not grow well nor propagate well underwater. It grows vigorously if grown emersed in a humid atmosphere, therefore ideal for a paludarium.

14. Genus: *Limnophila* (Figure 14)(Common name: English- ; Ambulia, Sinhalese - Kahata pasi, Rainda pasi)
(Family: Scrophulariaceae)

Habitat: Shallow still waters such as rice fields, shallow ponds and ditches, marshes, paddy fields

Species *L. indica* (Distribution: Eastern and Central provinces), *L. heterophylla* (Synonym: *L. reflexa)* (Distribultion: Eastern, Central, Southern and Western province) and *L. sessiliflora* (Distribution:Eastern and Central provinces) need light and rich soil for cultivation. Plant is more suitable for open garden ponds. Propagation is by cuttings.

15. Genus: *Lobelia* (Figure 15) (Common name : English - Cardinalflower, Sinhalese - Mihindupada)
(Family: Lobeliaceae)

Habitat: In ditches and slow-flowing water courses

There are five species which can be used as ornamental plants.Species*L. zeylanica* (Distribution: Throught the country), *L. trigona, L. affinis, L.excelsa* (Distribution: All three species in Central province and *L. affinis* also in the Western province) and *L. nicotianaefolia* (Distribution: Western province) are suitable for any type of aquarium or pond but lot of light and clean water is required. Propagation is by riped seeds.

16. Genus: *Ludwigia* (Figure 16) (Common name: English- False loose strife)
(Family: Onagraceae)

Habitat: Moist places, rice fields, dithches and marshy terrains

Species *L.Palustris* (Synonym: *L. mullerti, L. natans, L. repens)* (Distribution: Central and Western provinces) is easy to grow but needs good light, therefore more suitable for open aquarium tanks and garden ponds. Propagation is by cuttings which can be planted in groups.

17. Genus: *Marsilea* (Figure 17) (Common name: English - Four - leaved water colve, clover-fern, Sinhalese-Diya ambiliya)
(Family: Marsileaceae)

Habitat: In ditches, ponds and water holes

Species *M. quadrifolia* (Distribution: in all areas except the Northern province) is not a good aquarium plant because the leafstalks tend to become disproportionately long and untidy. If given good deal of light it will tend to remain short, but, then, it will grow so abundantly that other plants may be choked.

18. Genus: *Myriophyllum* (Figure 18) (Common name: English - Water Milfoil, Sinhalese - Girapihatu)
(Family:Haloragidaceaeor Halorrhagaceae or Haloragaceae)

Habitat: In Canals and sometimes in clear water lakes

Species *M. indicum* (Distribution: throughout Central, West Central and Southern provinces) is suitable for any type or aquarium tank or garden pond but generally needs a good deal of light and clear water. Easy to propagate by pieces of plant. Plant must be protected against attacks of algae, particularly, the thread algae.

19. Genus: *Naias* (Figure 19) (Common name : English: Flexible Naias, water nymph, Sinhalese: Heen parandal)
(Family: Naiadaceae)

Habitat: Both in fresh and brackishwater shalloe ponds and lakes

Species *N. minor* (Distribution: Central, Eastern and western provinces) needs good light and clear water. More suitable for open garden ponds and aquarium tanks. Propagation is by means of cuttings.

20. Genus: *Nechamandra* (Figure 20) (Common name: Sinhalese- Diya Pokuruwenna)
(Family: Hydrocharitaceae)

Habitat: In tanks, ponds and lakes

Species *N. alternifolia* (distribution: throughout the Central and Western province) is more suitable for

open garden ponds and tanks. propagation is by cuttings.

21. Genus: *Nelumbium* (Figure 21)(Common name: English - Lotus, Sacred lotus, Sinhalese - Nelum, Piyum)
(Family: Nelumbonaceae)

Habitat: In ponds and lakes

Species *N. nucifera* (Distribution: in all provinces except the Northern province)is more suitable for large garden ponds and needs mud substrate. Propagation from seeds or from young plants formed on the root stock.

22. Genus : *Nymphaea* (Figure 22) (Common name: English- Water Lily, Sinhalese- Manel)
(Family: Nymphaeaceae)

Habitat: In lakes and ponds

Species *N. pubescens* (Distribution: all areas except northern province) is ideal for large garden ponds and needs good light and space to grow. Propagation is by young plants formed on the toot stock or on short runners.

23. Genus: *Nymphoides* (Figure 23) (Common name: English- Small-leaved water snow-flake, Sinhalese-Kuru sudu olu)
(Family: Gentianaceae)

Habitat: In pools, ponds and solw-flowing rivers

There are two species, namely *N. parvifolium* (Distribution: Eastern and Western provinces) and *N. indicum* (synonym: *Limnanthemum indicum)* (Distribution: Eastern and Western provinces) are ideal for open, large garden ponds. Propagation is by young plants emerging at nodes.

24. Genus: *Nymphoides* (Figure 24)(Common name : English - Golden floating heart, Sinhalese - Kuru kaha olu)
(Family: Menyanthaceae)

Habitat: In lakes, ponds and slow-flowing waters

Species *N. aurantiacum* (Distribution: Eastern and Western provinces) is ideal for open, large garden ponds. Propagation by young plants emerging at nodes.

25. Genus: *Ottelia* (Figure 25) (Common name : None)
(Family:Hydrocharitaceae)

Habitat: In rice fields, tanks, shallow clear water ponds and areas subject to regular flooding

Species *O. Alismoides* (Synonyms: *O. indica, Stratiotes alismoides, Damasonium indicum)* (Distribution: Central and eastern provinces) needs a lot of space, good light and warmth. Plant is more suitable for large garden ponds. Propogation is by seed.

26. Genus: *Pistia* (Figure 26) (Common name : English - Water Lettuce Sinhalese - Diya gowa)
(Family: Araceae)

Habitat: In lakes, ponds and still water pools

Species *P. stratiotes* (Distribution: Western and Southern province) is more suitable for open aquarium tanks. The plant needs a lot of light. Propagation is by underground stems.

27. Genus: *Potamogetonm* (Figure 27)(Common name: English-Fine leaved pond weed, Sihalese- Krail Diya pasi, Heen diya thana)
(Family: Potamogetonaceae)

Habitat: In ponds and slow flowing rivers, water pools and lakes

Three species, *P. crispus* (Distribution: Central and Western provinces), *P.pectinatus* (Distribution: throughout the island) and *P. roxburghianus* (Distribution: Western, Central and Southern

provinces) are good for large aquarium tanks and garden ponds.

Plant requires good light. Propagation is by cuttings but new branches sprout from runners at regular intervals. *P. pectinatus* favours brackishwater with plenty of calcium concentration.

28. Genus: *Rotala* (Figure 28)(Common name: English-tooth cup)
(Family: Lythraceae)

Habitat: In rice fields, irrigation channels and ditches

Species *R. indica* (Synonym: *Peplis indica)* (Distribution: Southern and Eastern provinces) needs ample space and sun light, therefore, more suitable for garden ponds. Water should be little alkaline. Plant is sensitive to sudden temperature changes. Propagation is by cuttings.

29. Genus: *Salvinia* (Figure 29) (Common name: English- Salvinia Sinhalese-Japan pasi, Barawa pasi)
(Family: Salviniaceae)

Habitat: In ponds, lakes, rivers and ditches

Species *S. cucculata* (Distribution: throughout the Island) is considered to be a pest and extremely difficult to irradicate it. However, it is considered to be ideal as cover for fry and easy to grow, therefore good for breeding aquarium tanks. Adequate light and nutritious water is needed. Propagation is by laterral branches that grow from the main plant.

30. Genus: *Trapa* (Figure 30) (Common name : English-Water chestnut, Water caltrop)
(Family: Trapaceae)

Habitat: In ponds, pools and slow flowing waterways

Species *T. bispinosa* (Distribution: Central province) is ideal for garden pools. Propagation is by runners.

31. Genus: *Vallisnaria* (Figure 31)(Common name: English-Common eel grass)
(Family: Hydrocharitaceae)

Habitat: In rivers and lakes with clear water

Species *V. spiralis* (Distribution: throughout the country) is easy to grow but light is needed and the plant grows well in soils with lot of iron, therefore more suitable for garden ponds. Propagation is by runners.

32. Genus: *Vesicularia* (Figure 32)(Common name: English-Java moss)
(Family: Hypnacea)

Habitat: In shallow, fast-flowing streams and water courses

Species: V. dubyana (Distribution: Central and Western provinces) is a very undemanding plant. Grows well either anchored to the bed or when floating free. Plant is suitable for aquaria and garden ponds. Propagation is by cuttings.

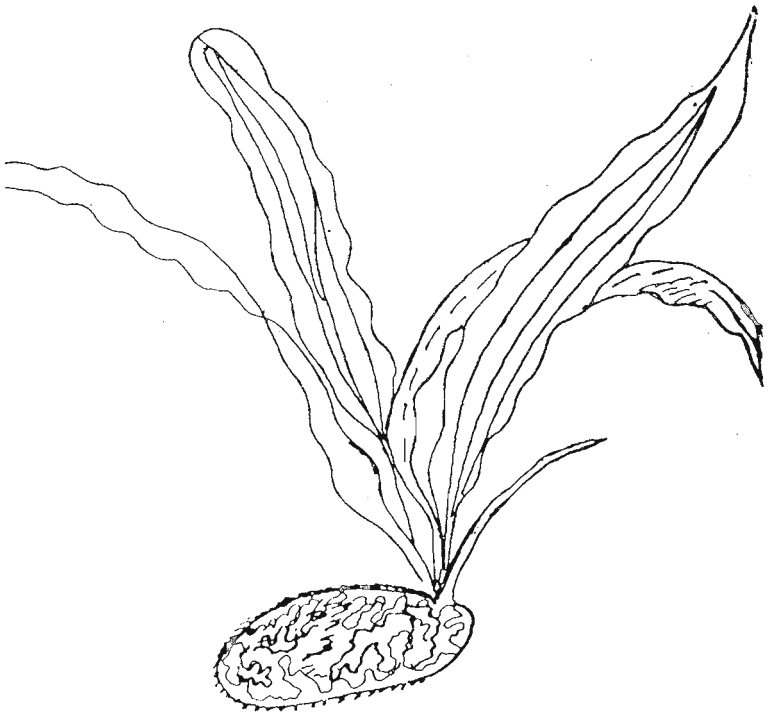

Figure 1 : Genus - APONOGETON

Figure 2 : Bacopa

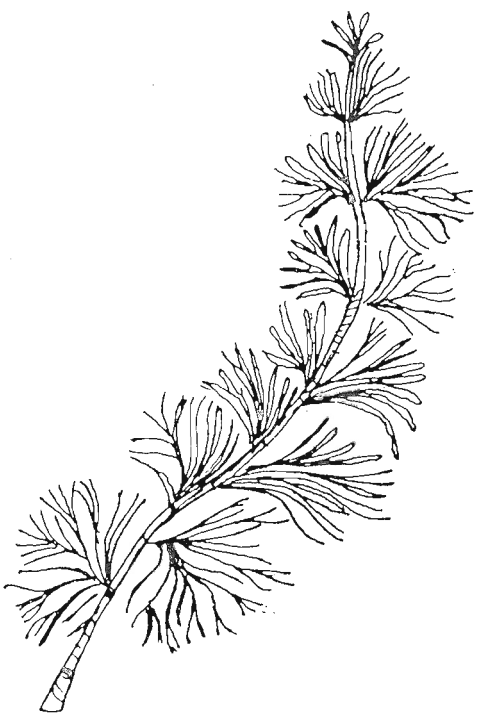

Figure 3 : Genus - CABOMBA

Figure 4 : Genus - CARDAMINE

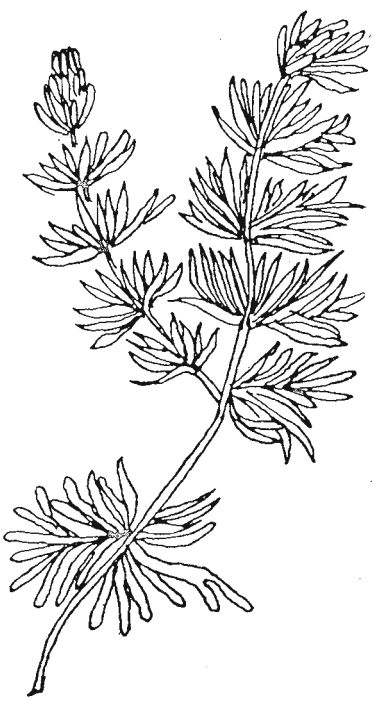

Figure 5 : Genus - CERATOPHY

Figure 6 : CERATOPTERIS

Figure 7 : Genus - CRYPTOCORYNE

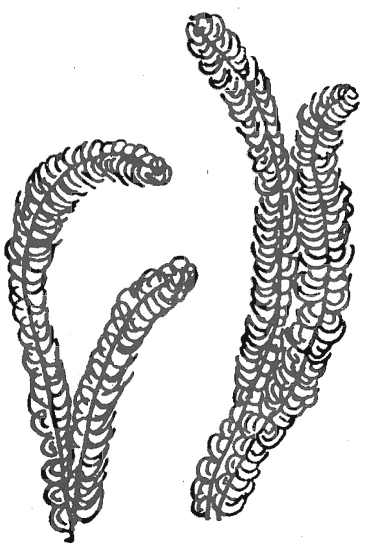

Figure 8 : EGERIA

Figure 9 : EICHHORNIA

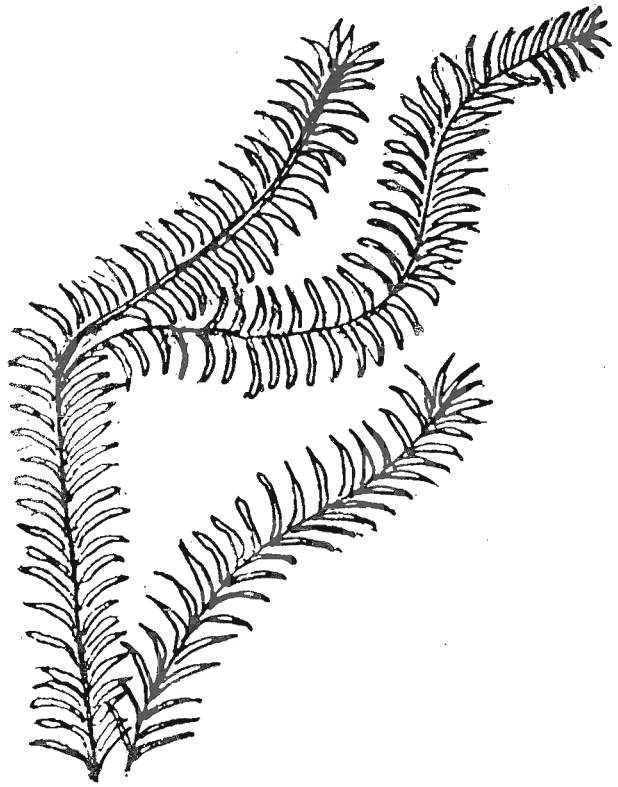

Figure 10 : Genus - Hydrilla

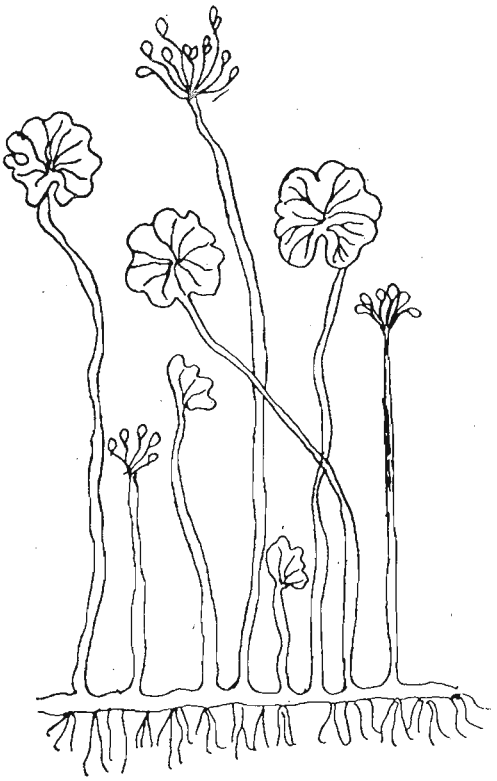

Figure 11 : HYDROCOTYLE

Figure 12 : HYGROPHILA

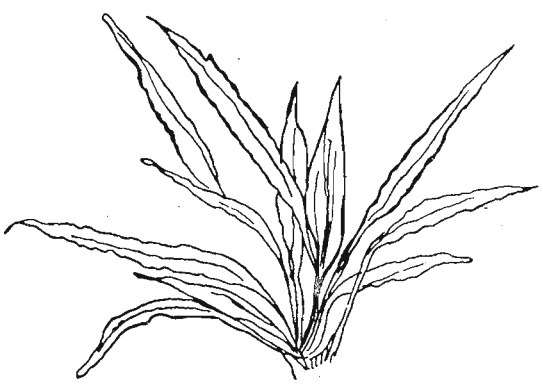

Figure 13 : LAGENANDRA

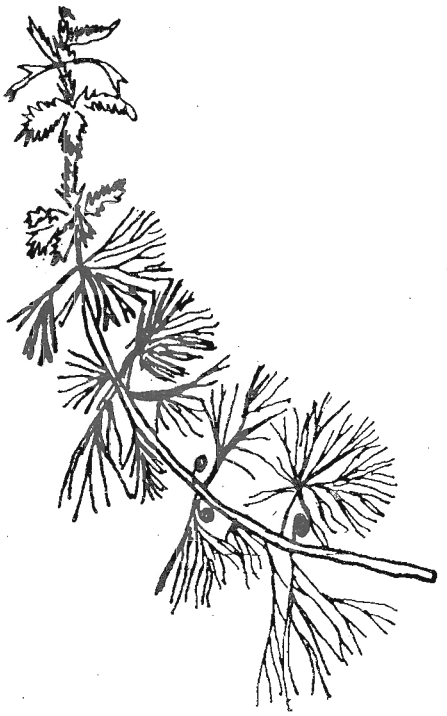

Figure 14 : Genus - LIMNOPHILA

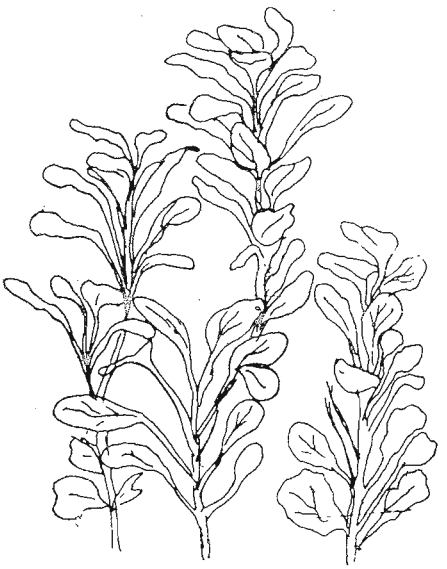

Figure 15 : Genus - LOBELIA

Figure 16 : Genus - LUDWIGIA

Figure 17 : MARSILEA

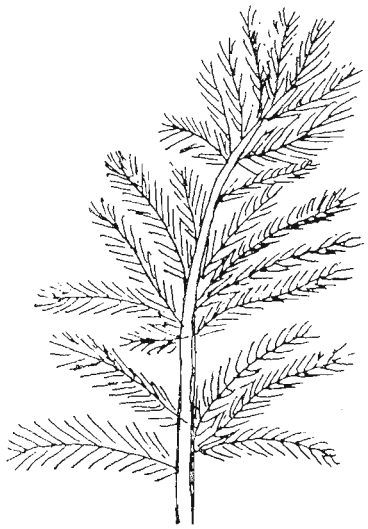

Figure 18 : MYRIOPHYIIUM

Figure 19 : Genus - NAIAS

Figure 20 : NECHAMANDRA

Figure 21 : NELUMBIUM

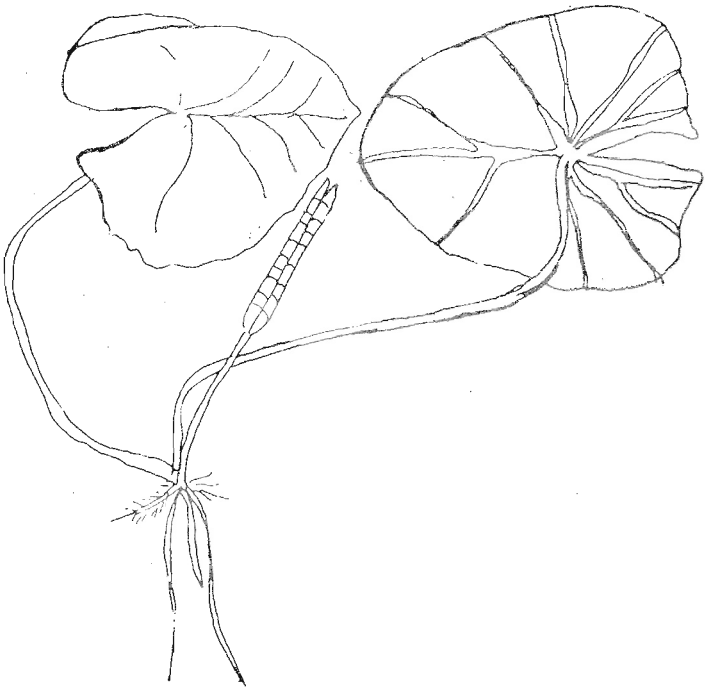

Figure 22 : Genus - NYMPHAEA

Figure 23 : Genus - NYMPHODES

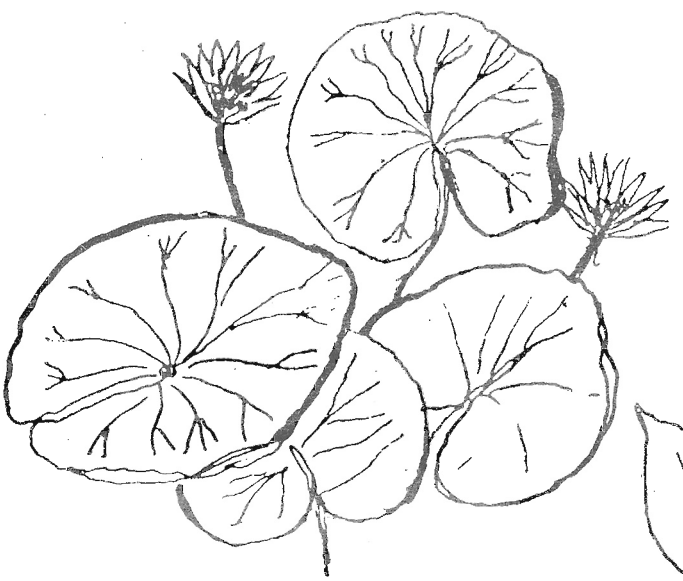

Figure 24 : Nympoides

Figure 25 : OTTELIA

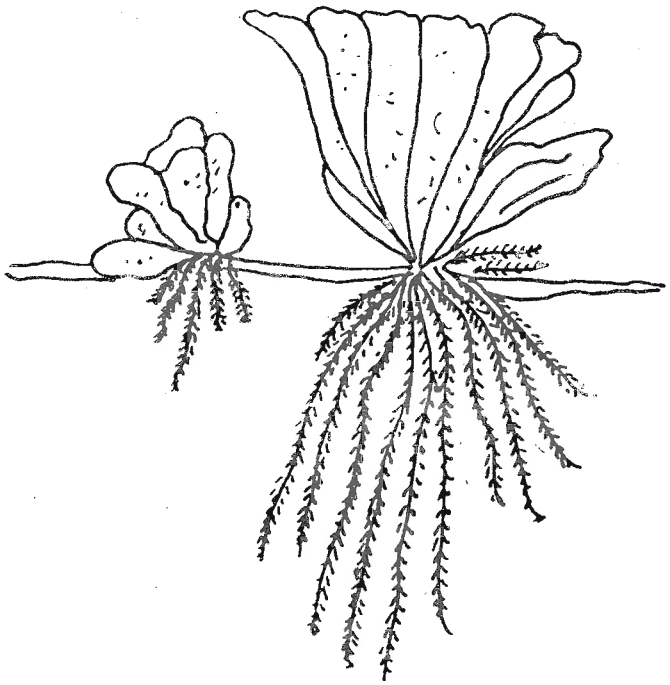

Figure 26 : PISTIA

Figure 27 : POTAMOGETON

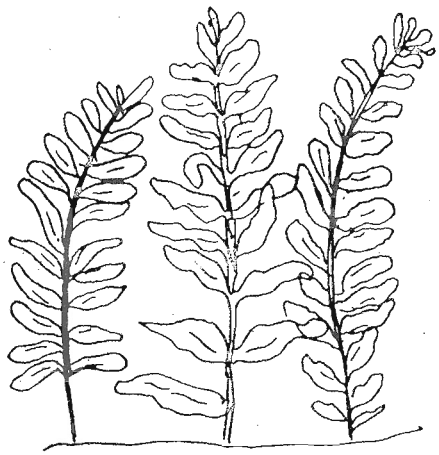

Figure 28 : Genus - Rotala

Figure 29 : SALVINIA

Figure 30 : TRAPA

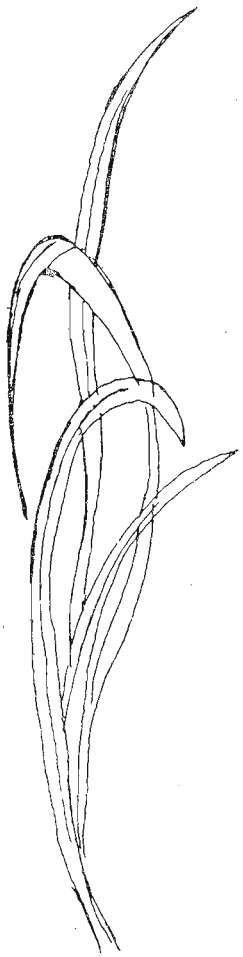

Figure 31 : VALLISNARIA

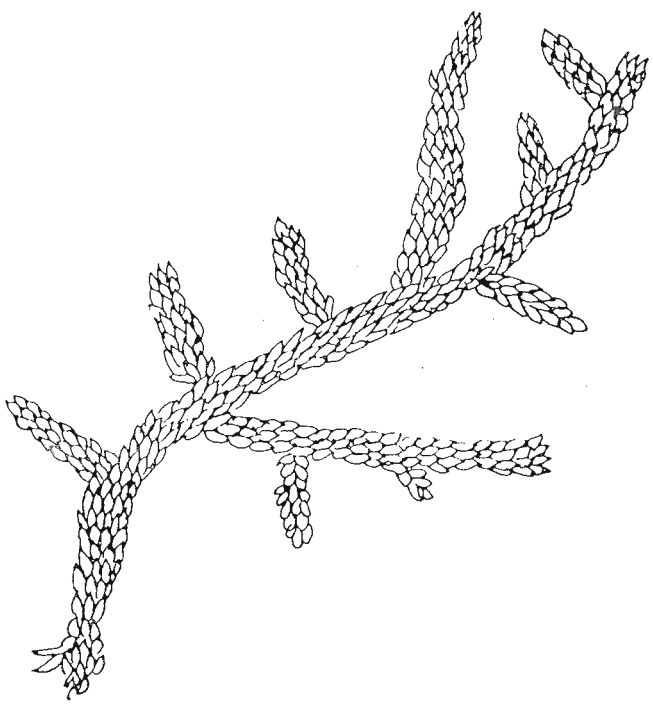

Figure 32 : VESICULARIA

Acknowledgements

I am thankful to Miss. Indunil Divigalpitiya of the Department of Zoology, University of Sri Jayewardenepura for drawing the figures.

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SOME POSSIBLE USES OF WATER HYACINTH

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Water hyacinth (*Eichhornia crassipes)* is, in many ways, the most important of the floating aquatic weeds native to tropical South America.

Other floating weeds native to Central and South America include another *Eichhornia* species (*E. azurea), Pistia stratiotes, Azolla caroliniana* and species of *Salvinia.*

E. crassipes, E. azurea and *Pistia stratiotes* usually reproduce asexually although they, also, do reproduce sexually; which is of importance for spreading into new areas or those, where clearing has already been carried out. Water hyacinth has a rapid rate of proliferation and, depending on conditions, may double in anything from 6 days or more.

Over the years, water hyacinth has become widespread in other continents and over fifty two countries in the tropics and is often thought to constitute a major "nuisance", where it occurs. Attempts to "control" it have usually taken the form of mechanical clearing or spraying with herbicides. Insufficient emphasis has been given to biological control methods or on gainfully utilizing water hyacinth. Work has often been experimental in nature and, though the results have been promising, insufficient action has been taken in many countries including Sri Lanka to translate them into practical use. The present article attempts to no more than indicate some directions in which work has been progressing with this aquatic plant, in finding uses for it.

Some Uses of Water Hyacinth

a) Improvement of quality of polluted waters

Water pollution is frequently due to human sewage, animal manure and chemicals used as agricultural fertilisers. Although these sources of pollution contain a variety of chemicals, it is principally the content of assimilable nitrogen and phosphorus that results in eutrophication or the growth of the algae which gives green the colour which has developed, for example, in recent years in the Beira Lake in Colombo.

Another type of pollution of waters is that from industrial effluents. These effluents may contain metal ions, anions and organic compounds. Some of these may pose hazards to human health if present in quantities above certain levels.

Water hyacinth is now advocated in some parts of the world to improve the quality of water contaminated with sewage, animal manure, fertilizers and wastes from households and food processing plants. The waste water is released into shallow ponds in which water hyacinth is growing. The nitrogen and phosphorus content of the dilute waste water is reduced by the water hyacinth, part of which is harvested periodically to allow new growth to take place. It was shown during trials in Texas and Florida in the United States, that around twenty to forty tons (wet weight) of water hyacinth can be removed from each hectare of pond surface each day. This quantity is equivalent to the nitrogen content of the sewage of more than 2000 people and the phosphorus content of the sewage of more than 800 people.

Water hyacinth also has the capability of absorbing metal ions, such as magnesium, zinc, lead, mercury, nickel, chromium and cadmium, many anions and organic compounds. Some of these pollutants may reach levels, 4,000 to 20,000 fold concentrated in the plants than in the solution in which they are growing. While this is a valuable and relatively low-cost method of improving the quality of waste waters after initial treatment, care should be taken in the disposal

of water hyacinth containing toxic compounds. Similar precautions should, also, be taken in the disposal of water hyacinth, which may have come in contact with raw sewage as the root system may harbour pathogenic micro-organisms. It has been recommended that water hyacinth containing low levels of metal ions could be used as a raw material for the manufacture of boards.

b) Biogas production

Water hyacinth has been used as a raw material for biogas digesters. For this, it does not require dewatering,i.e. reducing the water content of freshly harvested plants. Studies by the National Aeronautic and Space Administration (NASA) of the U.S.A. indicated that using the water hyacinth from one hectare could result in the production of over 70,000 cu. metres of biogas.

One integrated scheme developed in Assam makes use of the roots to improve the soil, the petioles (leaf stalks) for paper manufacture and the remainder of the plant (rhizome, leaf and stolon) for biogas generation. The waste black liquor from the paper manufacturing process is also added to the biogas digester and the sludge from it is partially sun dried and sold as fertilizer. It was reported that the project was economically viable, although funds would have to be obtained to meet initial capital costs.

c) Paper and board

Early work on the possibility of using watr hyacinth for the production of paper gave disappointing results. However considerable research efforts subsequently succeeded in improvements which indicated that water hyacinth could be used for the manufacture of certain grades of paper and board. The process would be economically viable if abundant supplies of the plant were available at no cost and close to the production plant.

For the production of paper, it has been found that the roots should be discarded as they are somewhat dark and stiff. The leaves are brittle and only the stalks should be used for the production of paper. However, the leaves could be added if desired for the manufacture of certain paperboard products such as file covers, greeting cards, visiting cards and album papers. While bond or other high quality papers were not economically viable to produce from water hyacinth stalks, the characteristics of the pulp were satisfactory for the manufacture of grease proof paper. The water hyacinth pulp could also be blended with pulp from waste paper, bamboo, jute,rag etc.,when necessary.

d) Livestock feed

While water hyacinth is not considered suitable as food for human consumption, research conducted overseas has indicated that it may be of value as a feed supplement for certain livestock. In some cases, such as cattle, bufffalo and goats, it is beneficial to sun dry the water hyacinth in order to increase the nutrient content of the bulk consumed. Rabbits and pigs may be fed with fresh material as feed supplement. Experiments to examine whether leaf protein concentrate from water hyacinth can be used as a supplement in poultry feed have been reported to give encouraging results. However, fresh water hyacinth may not be suitable as a feed supplement for ducklings. In Malaysia, fresh water hyacinth is cooked and used as a feed supplement for pond fish.

The above are only indications of what has been achieved. Further experimentation under local conditions will be necessary to determine what is, in fact, achievable and economic. For instance, different methods of dewatering water hyacinth should be tried as sun drying may not be the optimal method in some areas.

Water hyacinth, growing in polluted waters should not be used for animal feed as the material may contain toxic pollutants. Also, it may be advisable to select the plants at the right stage of growth, e.g. tall-stemmed plants and to remove the roots. Water hyacinth with a high mineral content may, even if non-toxic, be unpalatable to livstock.

e) Soil improvement or use as compost or mulch

The roots of water hyacinth can be composted and tried out as a potting material for pot plants.

The various parts of the plant have been used in making compost for use as a cheap fertilizer and soil conditioner. This is most beneficial in areas where the source of water hyacinth is close to where the compost is to be used. This would eliminate transport costs. Care should also be taken not to use plants growing in certain polluted waters as they may contain toxic pollutants.

The effluent and sludge from biogas digesters may also be beneficial for improving soils.

Attention should be paid that the parasites and pathogens which may be present in the water hyacinth are destroyed during composting processes, etc.

f) Mushroom bedding material

Dried water hyacinth has been successfully used as bedding for cultivating *Volvaria* mushrooms.

g) Carbon black production

Encouraging results have been reported on carbonising dried leaf stalks of water hyacinth at 350^0 C to produce carbon black. Carbon black is used in the manufacture of paints, printing inks, carbon paper, tyres and tubes, black paper etc. Further experiments were indicated.

h) Activated carbon

Successful experiments have been conducted in Bangladesh on the production of activated carbon from dried stems of water hyacinth which had been carbonised at 350^0C. Further experimentation is required and economic evaluation of the advantages over existing production methods.

i) Handicrafts

Visitors to Thailand have remarked on the attractive handicrafts, e.g. handbags and household decorations, made from dried water hyacinth leaf stalks, which are offered for sale. These handicrafts could be turned out locally as a cottage industry in rural areas.

j) Furniture

Furniture made by using water hyacinth is also now manufactured in Thailand and exported to France. The technical details are said to be a closely guarded secret but experiments carried out locally should eventually yield a product of comparable quality.

Conclusion

The foregoing account outlines briefly the directions in which work has been carried out overseas on utilization of water hyacinth as a resource. Much money has been spent over the years in trying (unsuccessfully) to eradicate water hyacinth. While agreeing that it poses problems if allowed to spread unchecked, more attention should be paid now to this plant, whichgrows luxuriantly without the need for soil preparation, added fertilizer, pesticides, weeding etc. It uses, instead, a natural system of hydroponic, without the use of fertilizer and pesticides. Assistance in overcoming any difficulties encountered could be sought from the relevant authorities in the area who would have at their disposal facilities and sources of information, which may not be available to private individuals. It would be a pity if the sole significant use of this plant continued to be made in Sri Lanka was to be the gathering of its beautiful flowers.

Further reading

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SEAWEED RESOURCES AND THEIR USES IN SRI LANKA

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Introduction

Seaweeds are macroscopic algae, which form an important component of the marine living resource. Based on their pigmentation, the seaweeds are broadly grouped into green, brown, red and blue green algae. Sri Lanka has a coast line of approximately 1700 km along which many varieties of marine algae are found. About 340 sea weed species belong to different families have been identified in Sri Lanka by several Scientists (Durairatnam, 1961). Few species belong to the groups of red, brown and green algae are economically important as food and as a source of industrial chemicals such as agar - and alginates.

Several surveys were carried out along the coastal areas of the island on seaweeds with a view to utilizing those of economic importance. These investigations revealed that there were many species of algae in the west coast of Sri Lanka (Figure 1) but very few in the east coast since the coast is made up of long sandy beaches and sheltered bays.

The common genera native to Sri Lanka that could be of economic importance are *Gracilaria, Gelidium, Sargassum, Turbinaria, Ulva* and *Caulerpa*. The first two genera are belong to the red algae group and they are important as a source of agar - agar. *Sargassum* and *Turbinaria* belong to the brown algae and they are also valuable sources for alginates which will be used mainly in the textile industry. *Ulva* and *Caulerpa* are in the group of green algae and they can be directly used as human food since they have high nutritive values.

Gracilaria spp. and Their Utilization

Two varieties of seaweeds known as "Ceylon moss" namely *Gracilaira edulis* and *Gracilaria verrucosa* are common in Kalpitiya, Mannar and Trincomalee areas. *Gracilaria* spp. have been exported from Sri Lanka since 1800 s. Exports to England of dried bleached "Ceylon moss" (*Gracilaria* spp.) has approximated to 5,700 1bs in 1831 and 15,000 1bs in 1840 where it was sold at 09 dollars/1b. In 1930' s Ceylon moss was reported from gulf of Mannar, Puttalam lagoon and from Ponparippu to Kallar. During that period people used to gather it by means of hooks attached to lines. It was dried in the sun, left over night in the dew which is said to bleach it more effetively than the sun.

During 1941 to 1944 an estimated 20,000 1bs. of seaweed was exported to India annually. After the war this export trade ceased but a few people in those areas continued to collect bleach and supply small quantities to the local market. In 1950's trade of exporting *Gracilaria* picked up again because of the strong demand from Japanese buyers.

In late 1960's due to a drop in quality standards of these Sri Lankan *Gracilaria* exports, mostly due to the deliberate adulteration of the product the trade was completely stopped for some time.

In the 1970's annually about 50 to 100 tons of dried *Gracilaria* were exported from Sri Lanka. The quantity exported in 1972 was around 50 tons and in 1986 this was increased up to 100 tons.

At present the *Gracilaria* industry is geared to the export of dried weed without any processing. The fishermen living in Kalpitiya and Trincomalee areas are mainly involved in collecting these *Gracilaria* plants. Seaweed collecting start as when orders are received from the local agents who represent export companies based in Colombo. Two collectors can collect a boat load of fresh sea weed weighing around 200 kg with dry weight of around 30 kg. These collected seaweed are unloaded on the beach and is allowed to sun dry for 4-5 days. Even though some

cleaning is done by the collectors during sun drying, further cleaning is carried out at the purchasing centers. Here the weeds are sifted through a table model wire mesh sieve to remove particulate matter such as sand and seashells. The dried weed is further cleaned by the exporters prior to bailing for shipment.

A very small percentage of the dried weed is sold locally. Retail packs. weighing 50 or 100 gms. are sold at most supermarkets pharmacies and groceries in Colombo and suburbs. According to most Colombo traders, packeted *Gracilaria* is a "slow moving" item except during the islamic festive season, when there is a good demand for the weed. Most people use this weed to make a drink or to make a kind of jelly.

Gracilaria is a popular item of food among fishermen in producer areas. A recent socio-economic survey carried out by NARA has revealed that 9 out of 10 people living the Puttalam lagoon area use *Gracilaria* for domestic consumption. The most popular preparation is a porridge made out of this weed. The dried weed is washed several times cooked in water for 5-20 minutes and the thick soup obtained is sieved using a cloth strainer. Coconut cream and lime is added to taste. The villagers believe this porridge to be highly nutritious and is considered a must during the fasting season. The porridge is sold at kiosks in the Kalpitiya area at Rs. 2.50 a glass.

Seaweed "Jelly cube" is another common food in this area. Seaweed is washed several times till it becomes lighter in colour and is cooked in a little waters with some lime juice sieved through a cloth strainer. Sugar, vanila and colouring are added to the syrupy mass obtained which is then allowed to set for about an hour to a jelly like mass. The jillly is then cut in to cubes.

Sargassum spp. and Their Utilization

In Sri Lanka interest in brown seaweeds grew in the 1960's. *Sargassum* and *Turbinaria* are the economically important genera of brown seaweed found in Sri Lanka.

A quantitative survey carried out by Dr.Durairatnam on *Sargassum* revealed that about 800 tons of wet weed could be harvested along the south west coast.

During this survey the following species of *Sargassum* and allied genera were identified.

Sargassum cervicone (Grev) Grun.
Sargassum cristaefolium J. Ag.
Sargassum cinereum J. Ag.
Sargassum ilicifolium (Turn) J. Ag. forma
Sargassum swartzii (Turn) J. Ag.
Sargassum wightii (Grov.)
Sargassum tenerrimum J. Ag.
Cystophyllum muricatum (Turn) J. Ag.
Turbinaria ornata J. Ag.

The first two species were found between Ambalangoda and Galle while the others were found between Manner and Jaffna. The dominant species in the southern coast is *Sargassum cervicone* (Graville).

The main economic use of brown algae is the production of alginic acid. The main use of alginic acid in Sri Lanka is in the textile industry.

In 1973 Industrial Development board of Sri Lanka commenced a pilot project to produce liquid sodium alginate. The product was meant to be used by the National Textile Corporation as a mordant in dyes for textile finishing. The total investment and cost for this project was estimated and the annual production of alginic acid was estimated at around 3000 kg.

This project had to be abandoned due to the limited availabilities of natural stocks of raw material, *Sargassum cervicone* which gives the highest yield, and difficulties in finding the required quantities of the weed in shallow areas. This weed is generally found in deeper areas of the reef.

At present *Sargassum* based products are not manufactured in Sri Lanka inspite of the availability of fairly large quantities of the weed.

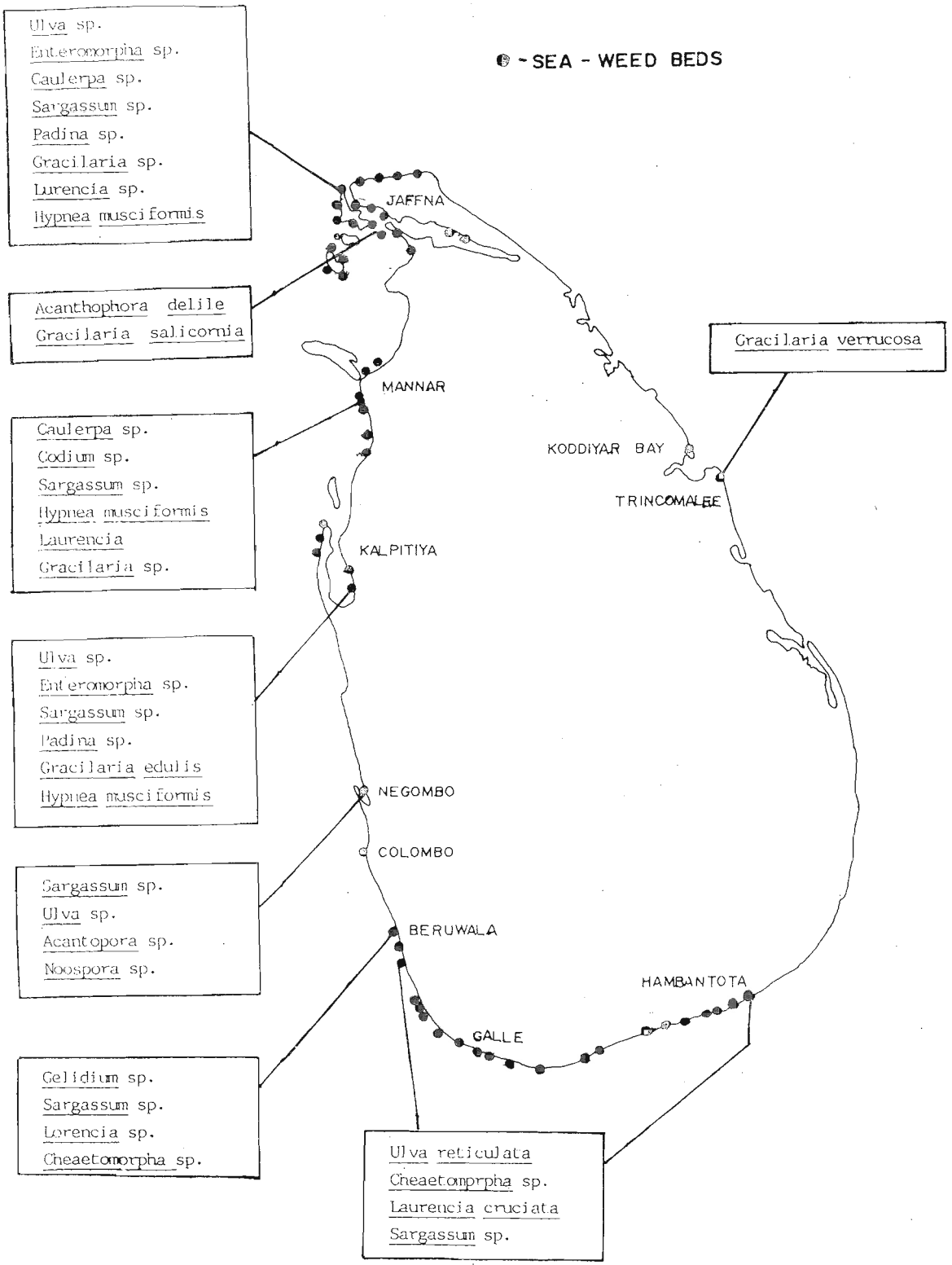

Figure 1: Distribution of seaweed beds of commercial importance in Sri Lanka.

Sea Weed as a Source of Food

Fresh, dried and processed seaweeds are utilized for human consumption. Some green and red seaweeds such as *Ulva fasciata*, *U. rigida* and *Acantohopora* contain very rich proteins. These algal proteins have many essential amino acids including iodine containing amino acids. Studies revealed that these seaweeds contain 16-30% of protein on dry weight basis and this amount is somewhat higher than that in other food materials such as cereals, eggs and fish. Among the green algae the sea lattuce or green laver (*Ulva lactuca*) used to be eaten mainly in Scotland area as a salad, but it has also been used in soups (Chapman, 1970).

Some of the edible seaweeds occurring along the coast of Sri Lanka are species of *Ulva, Chaetomorpha, Caulerpa, Codium, Gracilaria, Hypnea, Turbinaria, Acanthopora* and *Laurencia*. Species of *Ulva* and *Caulerpa* can be eaten raw as salads by adding some sauce and lime juice. Some of the people in the southern coastal areas in Sri Lanka used to consume *Ulva lactuca* as a curry with other green vegetables.

Seaweed can also be used as animal feed for cattle, poultry and other farm animals. Seaweed meal can be obtained by grinding cleaned and washed seaweeds such as *Ulva, Enteromorpha, Sargassum, Padina, Gracilaria* and *Hypnea*. In 1970's attempts were made to popularise the incorporation of dried powdered *Ulva* spp. as a green supplement for poultry feed in place of imported alfa-alfa preparations. Laboratory studies gave encouraging results with seaweed preparations showing promising results. However the research and developmental activities on this subject was abandoned with the influx of cheaper feed material.

Limiting Factors and Constraints for Utilization

Even though there are 340 species of seaweed growing in the coastal waters of Sri Lanka nearly 20 species are of commercial interest. Out of these only two species of *Gracilaria* (Ceylon moss) are of commercial importance at present.

The under utilized nature of the country's seaweed resources could be attributed to several limiting factors and constraints such as lack of resoure data and difficulties in collecting and marketing of seaweed resources and as well as the low popularity exists for seaweeds as food among Sri Lankans.

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AQUATIC WEEDS

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Introduction

When man was a hunter-gatherer there were no such plants called weed. The concept of weed was introduced with the begining of agricultrue. When man first started growing plants he came across with certain plants which interfered with his crops. These plants, he considered as weeds. With the increase in complexicity of his life new and insidious weed situations arose.

It is very difficult to define the term weed because neither a single plant could be considered as all bad nor all good. The most convenient definition of a weed is "a plant growing where it is not wanted" (Roberts *et al.* 1982). With this definition an aquatic weed could be described as an unwanted plant growing in a water body.

Therefore, a plant having some use may turn into a weed when its presence becomes troublesome. For example, a Hydrilla plant (Diya-Sarpa) in an aquarium has an aesthetic value. But when it grows vigorously and choke water ways, it is considered as a weed. Hence, "weediness" of a plant depends on the way man looks at it.

Classification

Aquatic weeds could be classified in the same way as other aquatic plants.

i. Amphibious plants: These plants can grow in the presence as well as in the absence of water.
e.g. *Cyperus* sp. (Pan)
Alternanthera sp. (Mukunuwenna)

ii. Submerged plants: This group includes three types of plants.

a. Rooted plants with floating and/or aerial leaves.
e.g. *Nymphaea sp.* (Olu, Manel)
Limnanthemum sp. (Hin-andala, Maha-andala)
b. Rooted plants with submerged leaves.
e.g. *Blyxa* (Diya-hawariya)
Vallisneria (Patta-tana)
c. Submerged free floating plants
e.g. *Hydrilla* (Diya-Sarpa)
Utricularia (Nil-monaressa)

iii. Plants freely floating on water surface
e.g. *Pistia* (Diya-gowa)
Eichhornia (Japan-jabara)
Salvinia (Japan-pasi)
Azolla

In Sri Lanka, *Pistia stratiotes, Eichhornia crassipes, Salvinia melastoma, Azolla and Hydrilla* are common aquatic weeds.

Special Characteristics of Aquatic Weeds

Weeds possess special characters that are responsible for their wide spread and troublesome occurance. Usually these plants could establish themselves easily. They also show efficient reproductive methods. They produce seeds in masses. Colonization by means of vegetative structures such as rhizomes, runners, offsets, stolons and by fragmentation are very common.

Furthermore, they show adaptations to their special habitat which is water. Numerous air spaces in their tissues help the weeds to float on water.

Since exchange of material occurs through the epidermis, there is no need to have a well developed root system or a vascular system. To facilitate

exchange of material, submerged parts do not have a cuticle. Such parts do not have stomato too.

As mentioned earlier, some aquatic plants lack roots. Some rooted plants have them for anchorage while some others have them for buoyancy.

Problems Caused by Aquatic Weeds

Due to their rapid growth and efficient regeneration methods some aquatic plants spread widely and become a nuisance. In Sri Lanka this problem is aggravated by the favourable tropical climate.

These plants grow rapidly and cover the water surface resulting many agricultural and irrigational problems.

Aquatic weeds choke lakes, irrigational and drainage canals. They block water regulating structures and irrigational equipments too.

They also bring about undesirable flavours, ordours in water together with other health hazards such as providing breeding grounds for mosquitoes.

Increased surface area due to leaves increases loss of water by evapotranspiration.

Reduced velocity of water flow increases siltation and reduces carrying capacity of water bodies. High water levels in canals result in flooding, seepage loses, breaking of canal banks and causes inadequate delivery of water to farms located at a distance from the main canal. This leads to the need of more frequent dredging.

They also interfere with fishing, swimming, boating and navigation in lakes and waterways.

Beneficial Effects

As mentioned earlier these plants are not always problematic. In some ways they are useful to man.

When grown along shore lines and canal banks they reduce erosion.

Some plants provide food and protection for fish and fowl. In addition certain plants are used by man for food and medicine.

In aquaria some of these plants are used as ornamentals.

Some of the aquatic weeds are under experimentation to utilize their beneficial effects for various purposes.

E. crassipes is found to remove wastes from polluted water. Then the plant could be used for the production of bio gas, paper, ink, and fertilizer.

Azolla which has a symbiotic relationship with the nitrogen fixing blue green bacterium Anabaena is tested to be used as a fertilizer for nitrogen poor soil.

Control and Eradication

The best way to protect water bodies from weeds is to prevent initial introduction. This could be attempted by plant quaratine laws.

Eradication of a plant implies elimination of that species from the natural region or drainage basin. This is costly and may not be economically practical.

The control of a plant means the reduction of the area it covers so that it does not offer a serious problem when duly controlled.

Control of aquatic weeds could be done in several ways. Proper construction of ponds so that as much water as possible is at least two feet deep is one way of controlling rooted aquatic weeds, which are not easily established in deep water. Pasturing, mowing, hand cleaning and burning could be used to control amphibious weeds that grow in ditchbanks. Drying is a simple way to control many submerged aquatics. For rooted aquatic plants dredging and chaining are effective.

Another way of controlling weeds is by using herbicides. For this a thorough knowledge of biology of weeds that are to be treated, appropriate

chemicals, recomended rates, time of treatment and amount of water or area which has to be treated should be known.

The control of submerged aquatics in bodies of water that are used for fishing and other forms of recreation presents one of the most difficult problems in the entire field of weed control, because safety of persons using these facilities as well as of the fish and other wild life is most important.

Biological control of weeds, the control or suppression of weeds by the action of one or more organisms accomplished either naturally or by the manipulation of the weed, control organism or the enviroment is the third way of controlling aquatic weeds. Control of *Salvinia melastoma* by the insect *Cyrotobagous singularis* is an example comming from Sri Lanka.

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SOME COMMON WEEDS AND THEIR MEDICINAL USES*

D. M. A. Jayaweera

GOTUKOLA - *Centella asiatica* Linn.

Distribution Occurs in India, Ceylon and other tropical and subtropical countries. It is a very common weed in Ceylon growing in waste grassy places from sea level to the highest elevations.

Composition This herb contains the alkaloid, hydrocotyline and volatile oil, vellarine obtained principally from the roots. It is a good source of phosphorus, iron, calcium and other mineral constituents. It has a high percentage of vitamin B. A yellow neutral gum, centelloside has been isolated from local material. This resembles asiaticoside.

Uses This herb is said to have a direct action on lowering the blood pressure and is often referred to as a rejuvenating medicament. The leaves are eaten raw or finely cut and roasted with scraped coconut. They are believed to purify the blood and cure indigestion, nervousness and dysentery. In some parts of India, the leaves are dried, powdered and taken with milk, to improve the memory.

The plant is useful both internally and externally for skin diseases, chronic and obstinate eczema, secondary and tertiary syphilis with ulceration, enlargement of glands, leprosy, abscesses and chronic rheumatism It has a special influence on the urino-genital tract and set up urinary and ovarian irritation. It has been employed as a diuretic in several diseases.

An ointment prepared from the liquid extract of the plant with ghee is used as an external application on elephantiasis, enlarged scrotum, while the liquid extract is given internally. The expressed juice of the leaves with cow's milk and powdered root of *Glycyrrhiza glabra* L. is given as an alterative tonic.

HULANTALA - *Ageratum conyzoides* Linn.

Distribution A native of tropical America and now naturalized in all tropical countries including India and Ceylon. It is a vexatious weed in Ceylon.

Composition The leaves contain an alkaloid, a volatile oil containing sesquiterpenene and a vegetable principle known as "co umarin". The vegetative and reproductive organs of the plant yield hydrocyanic acid.

Uses The leaves are commonly used for wounds and sores. In Indo-China, the roots and leaves are a common remedy diarrhoea and dysentery.

The leaves are supposed to prevent tetanus if applied to wounds. In Brazil, a decoction of the plant is given for diarrhoea, intestinal colic with flatulence, rheumatism and vesical catarrh. In Central Africa, the leaves are used for healing wounds especially those caused by burns.It is also a purgative and the roots employed for colic. The plant is a household medicine in Madagascar and La Reunion. The leaves and stems are used as a fomentation in skin diseases particularly

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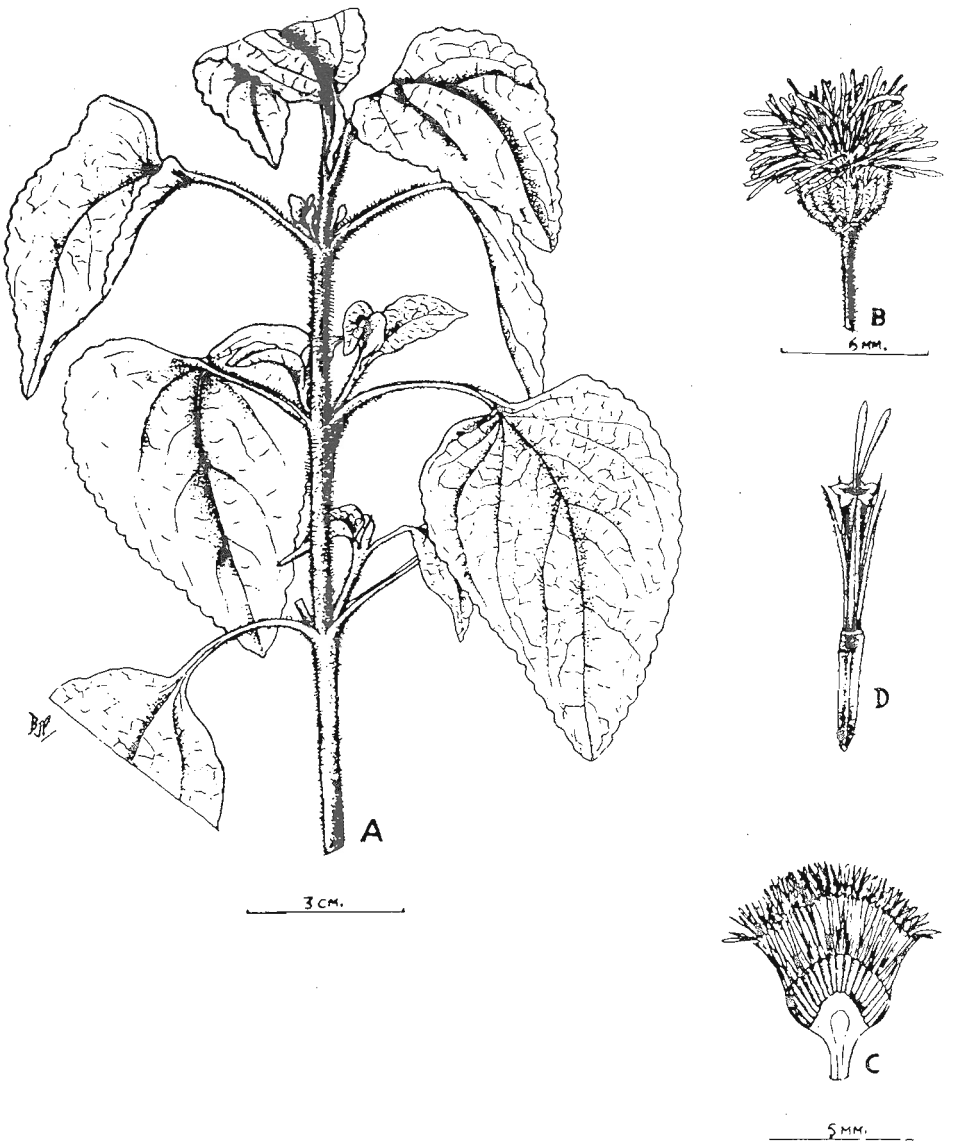
Centella asiatica. A, portion of stem with leaves and fruit. B, flower lateral view. C, fruit.



Ageratum conyzoides. A, top of a plant. B. flower head lateral, view. C, longitudinal section of a flower head. D, flower, lateral view.

leprosy. A poultice of the leaves is applied on boils. A cold decoction of the root is used as a lotion for purulent ophthalmia.

PENELA-WEL - *Cardiospermum* Trim.

Distribution Occurs in India, Ceylon and Malacea in wet places. In Ceylon, it grows in the mid and low- country.

Composition This plant contains saponin and quebrachitol and an alkaloid, a glucoside, resins and tannins. The seeds possess an essential oil.

Uses The whole plant is used both internally and externally in cases of rheumatism, nervous diseases, dropsy and orchitis. The juice of the plant is used as ear drops for earache and discharge from the meatus. It is also used for piles, bronchitis and phthisis. The root is an emetic and laxative and considered an aperient. The leaves are boiled in castor oil and applied externally on rheumatic pains, swellings and tumours. In China, the plant is considered an anthelmintic and anti-blenorrhagic. In Africa, an infussion of the leaf is given as an enema for dysenteries and diarrhoeas and taken internally for general outbreak of sores in the body. It is used as an anti-rheumatic and in digestive and pulmonary disorders. The root is a laxative, demulcent, diuretic and used in nervous diseases. In East Indies, the leaf and root are used as a diaphoretic, diuretic and as a remedy for dropsy, orchitis, amenorrhoea, rheumatism, nervous complaints and lung diseases.

GIRAPALA - *Commelina diffusa* Burm.

Distribution Grows throughout the tropical and subtropical regions of India, Ceylon, Malay Pennisula, China and in the Philippine Islands. It is a very common herb in shady places amongst grass in the low-country in Cylon.

Uses The bruised plant is applied to burns, itches and boils with beneficial results. In Ghana, it is pounded with seeds of *Leea guineensis* G. Don and *Piper nigrum,* made into a poultice in a heated plantain leaf and applied for relief of swellings of the groin. An eye lotion is prepared from it in Nigeria.

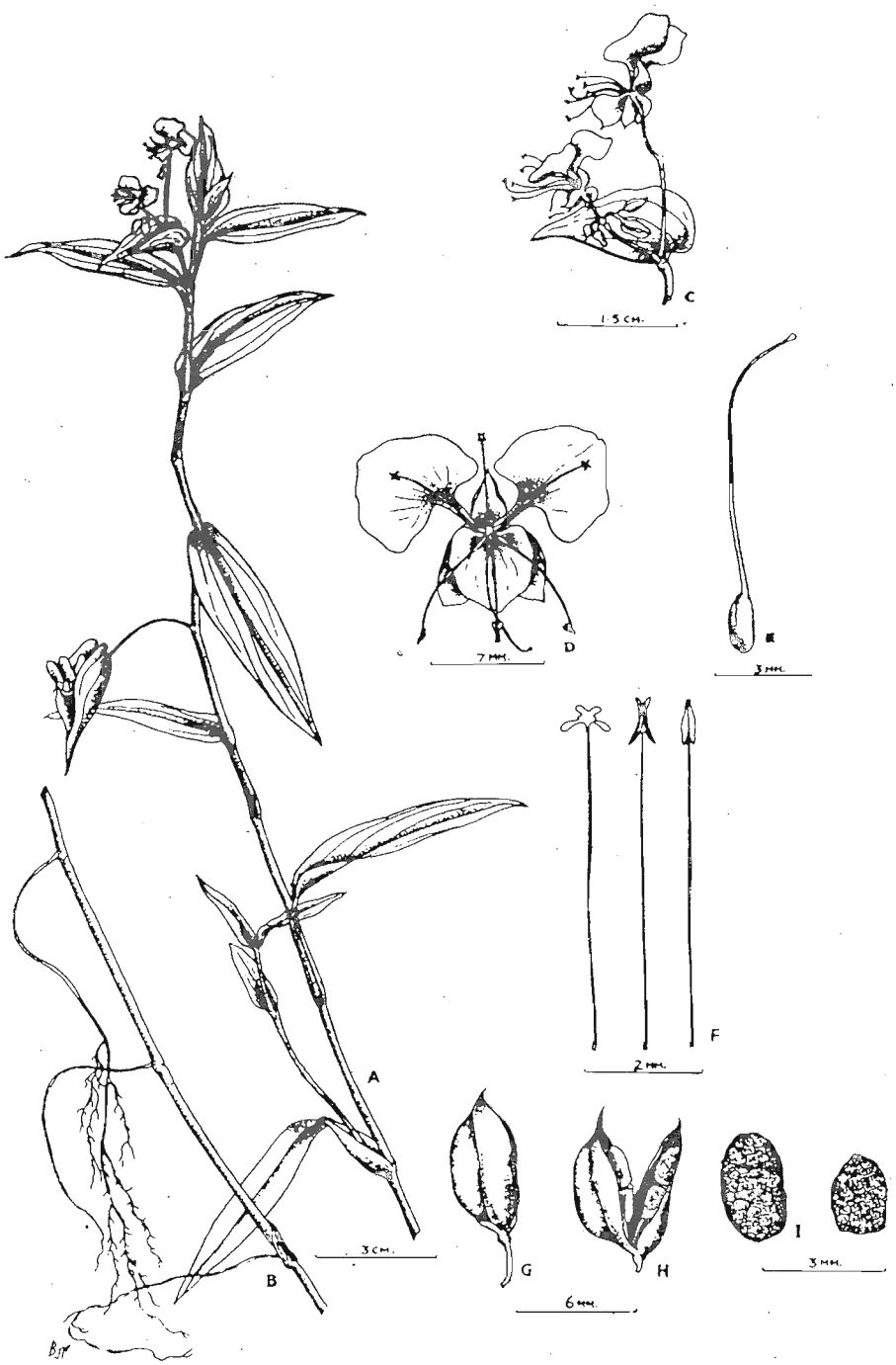
KALANDURU - *Cyperus rotundus* Linn.

Distribution Occurs in all warm countries including India, Ceylon and Philippine Islands In Ceylon, it is a very common and vexatious weed in cultivated ground in the low-country.

Composition The tubers contain an essential oil, fat, sugar, gum, carbohydrates, starch, albuminous matter and an alkaloid. The crude volatile oil contains sesquiterpene ketone α - cyperone and has antibiotic properties.

Uses The tubers are astringent and anti- septic. A paste made with lime juice is applied in acne, scorpion stings and ulcers with beneficial effect. Internally, the tubers act as a stomachic, carminative and cholagogue with astringent properties and used in anorexia, acute dyspepsia diarrhoea, dysentery and congestion of the liver. They are also used in acute laryngitis, bronchitis and pneumonia. In India, they are held in great esteem as a diaphoretic, astringent, stimulant, tonic, diuretic and demulcent. A paste of the tubers is applied on the breasts as a galactagogue. In Indo-china they are given to women in child birth and to infants for indigestion. In Cambodia they are used in liver Complaints with jaundice, for malarial fever, etc. In the Philippine Islands,

Cardiospermum microcarpum. A, twig with leaves, flowers and fruits. B, flower dorsal view. C, flower lateral view with bud. D, dehisced fruit with seeds attached to the axis.



Commelina diffusa. A, branch with leaves and flowers. B, portion of the stem with fibrousroots. C, inflorescence with half the spathe removed. D, flower from front E, ovary, style and stigma. F, stamens. G, fruit. H, dehiscing fruit. I, seeds.

Cyperus rotundus. A, plant with leaves, rubers and inflorescence. B, a spikelet. C, a flower in the acil of a glume.

they are employed in dysentery and in Java for urinary disorders. In Vietnam, the plant is used as a diuretic and emmenagogue and for uterine haemorrhage.

KADUPARA - *Emilia sonchifolia* Linn.

Distribution A weed found commonly growing along with grass in most parts of India, Ceylon, Malaysia, China and other tropical countries. In Ceylon, it is abundant all over the island.

Composition The plant contains an alkaloid.

Uses Used as a salad before flowering, in Malaysia and Indo-China. In India, the juice of the plant mixed with sugar is given for bowel complaints. The pure juice is poured into the eyes, drop by drop, for night blindness and eye inflammations. In Indo-China, a decoction of the leaves is prescribed as an antipyretic. In Ceylon and in the Philippine Islands., the leaves are used as styptic for cuts and wounds and long-standing superficial ulcers. A decoction of the plant is given as an expectorant, anti-haemostatic and in cases of fever. In Malaya, the leaves are used for dressing ulcers and in decoction as a cure for coughs and phthisis and to arrest diarrhoea. The plant is used as an astringent, an anti-asthmatic and vulnerary in African and also to treat sore throat.

BINTHAMBURU, ELA-BINTHAMBURU, RATU-BINTHAMBURU - *Ipomoea asarifolia* (Desr.)

Distribution Occurs in South India and Ceylon. It is very common in moist places in the low-country in Ceylon.

Uses A tonic and alternative and is useful for anaemia, neurasthenia, general debility, chronic rheumatism and tertiary syphilis. It is used for poulticing sores, boils, skin eruptions, leprosy and elephantiasis. Along with other ingredients, it is used on fractures. The pounded leaf roasted in cow ghee is applied as a poultice on injuries of the eye with beneficial results. Medicinal oils, prepared with it are used for removing poisonous substances from the body.
The green variety is frequently used medicinally and so is the red-leaved variety.

HIN-MADU - *Ipomea angustifolia* Jacq.

Distribution A weed found in the tropics of the old World. In Ceylon, it is common in open places in mid and low-country.

Uses Used as an ingredient, along with other drugs, as an application on the scalp for head ailments of people bitten by poisonous snakes. Milch cows fed on this plant are supposed to yield more milk.

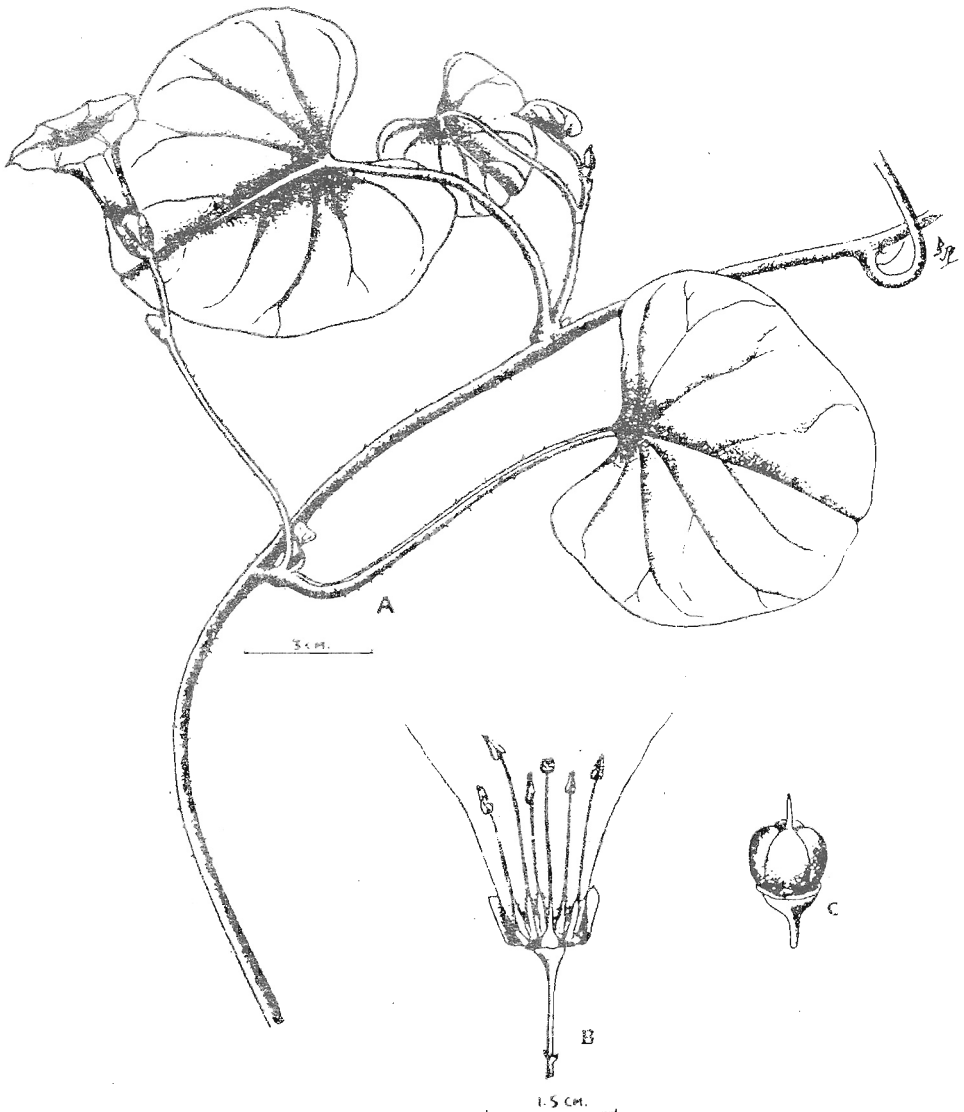
PITAWAKKA - *Phyllanthus debilis* Klein

Distribution Occurs throughout the tropics including the Philippine Islands, except in Australia. In Ceylon, it is a common weed in waste and cultivated ground.

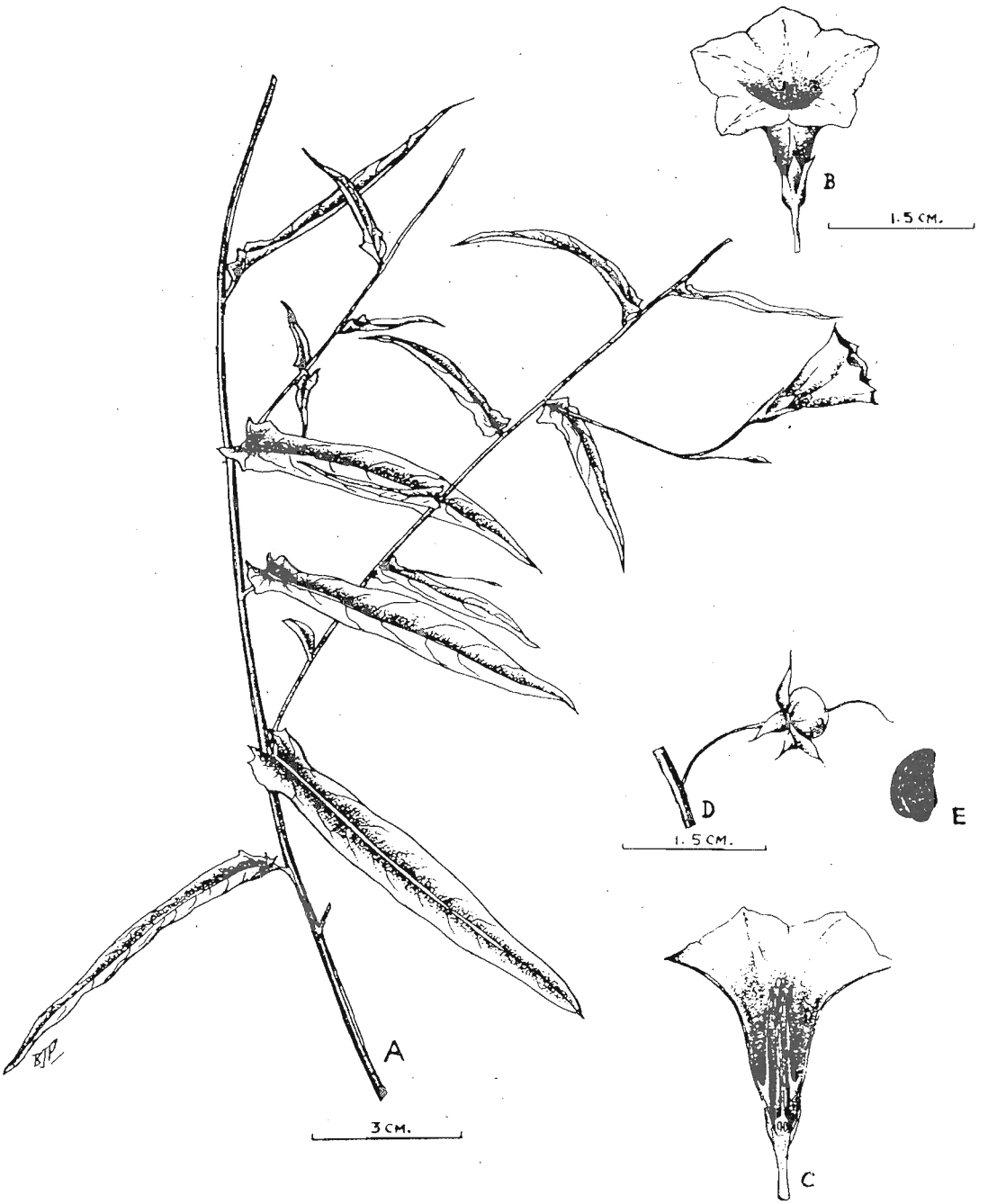
Composition Contains phyllanthin and a considerable amount of potash.

Uses Much used as a diuretic in dropsical affections, gonorrhoea and to allay griping in dysentery and in intermitent fevers. The fresh root is said to be an excellent remedy for jaundice. The milky juice is effective on offensive sores. The fruits are useful in tubercular ulcers, wounds, sores, bruises, scabies and ringworm.

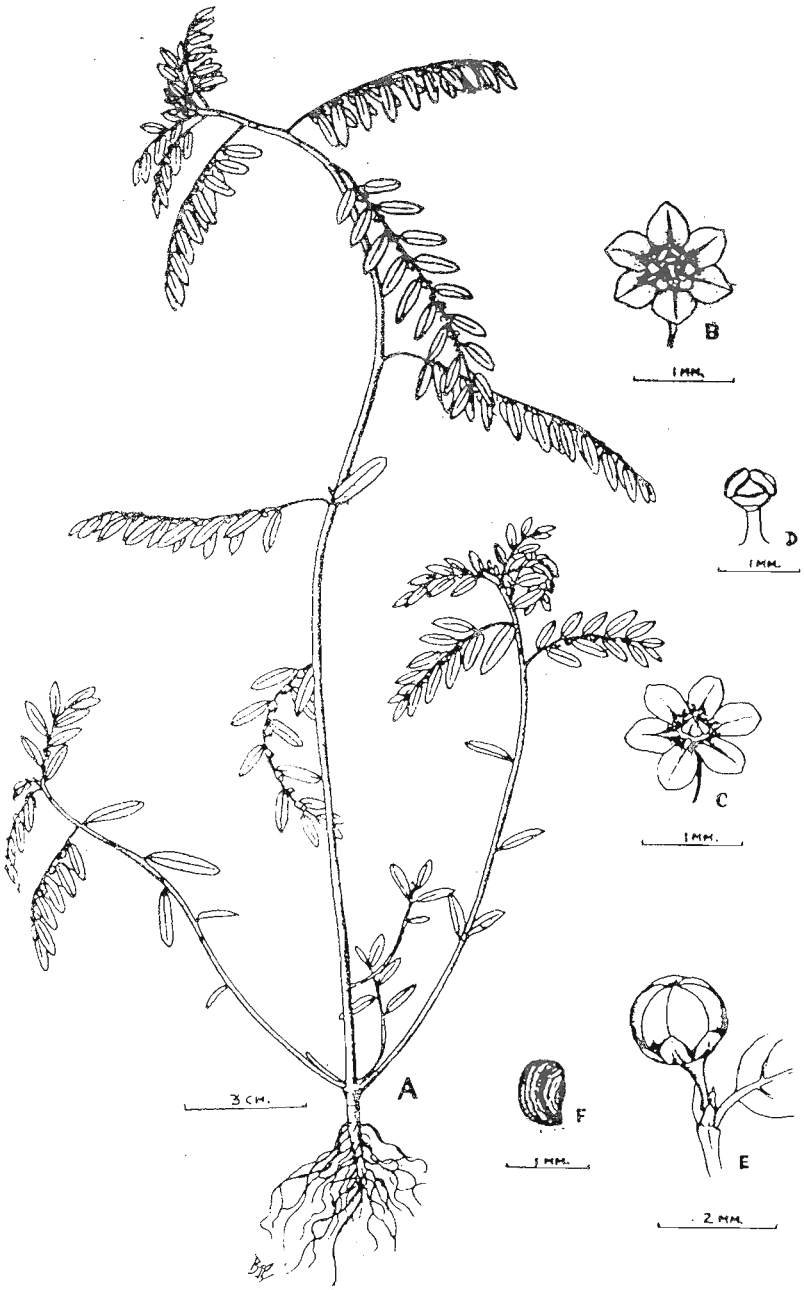
Emilia sonchifolia. A, flowering branch. B, typical leaves on a stem. C, flower head from side. D, flower, side view. E, fused anthers. F, seed.



Ipomoea asarifolia. A, portion of a brancn with leaves and a flower. B, flower with corolla opened out. C, fruit.



Ipomoea angustifolia. A, part of the stem with leaves. B, side view of flower. C, longitudinal section of flower. D, fruit. E, seed, enlarged.



Phyllanthus debilis. A, plant with branches, leaves and flowers. B, dorsal view ov male flower. C, dorsal view of female flower. D, dehiscing anthers. E, fruit. F, seed.

In Ceylon, the expressed juice of the plant is given as a diuretic in gonorrhoea and the root along with other drugs for diarrhoea, while the whole plant ground to a paste is given with cow's milk for jaundice.

MONERAKUDIMBIYA - *Vernonia cinerea* (L.)

Distributions Occurs throughout India, Ceylon, tropical Asia, Africa and Australia. In Ceylon, it is a very common weed everywhere.

Composition The leaves contain an alkaloid

Uses A stomachic and carminative and used for dyspepsia, flatulence and colic. It is said to be a diaphoretic. The fresh juice of the leaves is used in dysentery, piles and colic. The root is given as a vermifuge and also employed in dropsy. The flowers are administered for conjunctivitis and seed as an anthelmintic. The entire plant is used in the treatment of coughs, asthma, bronchitis and consumption. The crushed leaves are applied externally on wounds and sores.

Vernonia cinerea. A, apical portion of a plant with the inflorescenece. B, flower head. c, side view of a flower. D, fruit.