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Editorial

Every plant in this world is useful in one way or the other, but the uses of a vast majority of them are still unknown. Even today, there are a number of species whose uses are known to a limited number of people. Often information on their uses is not available/accessible to the scientific world. ENVIS endeavours to gather all available information on such plant species to provide comprehensive information to an array of users.

In this issue of Newsletter, information on various aspects of an important plant like 'Neem' or 'The Wonder Tree', which has been in news recently, is given in details. In addition, information on two less known useful plants of wetlands and two rare medicinal plants have also been given. It is hoped that the information provided in this issue will be very useful to all its readers.

P.K. Hazra

Hon'ble Minister of Environment and Forest, Capt. Jai Narayan Prasad Nishad releasing a BSI publication during his participation in 'Vanamahatsova' of the Indian Botanic Garden.

APONOGETON L.f.

—A POTENTIAL UNDEREXPLOITED WETLAND RESOURCE IN INDIA

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Though a serious consideration at the global level was given for the need of wetland protection and conservation specially on waterfowl habitat at the Ramsar Convention (1971) but before 1990 it was not possible to make detailed investigation for the hunt of less known wetland plant resources with economic potentialities and aesthetic appeals. *Aponogeton* L.f. is such an underexploited wetland resource that some information regarding this plant in India would be very useful.

Aponogeton L.f. (apon=water, getion=near; referring to its habitat) was first discovered by Carolus Linnaeus in the year 1771 from Eastern India (without indicating specific localities). First the genus *Aponogeton* was assigned under the family Najadaceae, later separated into a monogeniric family, Aponogetonaceae, comprising ca.40

species. It is a native to tropics of the old world and South Africa (Cronquist, 1981). In India, *Aponogeton* is represented by 7 species viz. *Aponogeton appendiculatus* Bruggen, *A. distachyus* L.f., *A. echinatus* Roxb., *A. lakhonensis*, *A.Camus.*, *A. natans* (L.) Engler & K. Krause, *A. satarensis* Sundararaghavan and *A. undulatus* Roxb.

Among these 7 species, *Aponogeton appendiculatus* and *A. echinatus* are endemic to Southern India and *A. satarensis* is endemic to Western India. *A. appendiculatus* and *A. satarensis* are rare and vulnerable in India.

Perennial, scapigerous aquatic herbs with tuberous or rhizomatous rootstock, crowned by bunch of root-fibres. Plants are usually monoecious, sometimes dioecious (e.g. *Aponogeton satarensis)* Leaves floating or submerged, oblong or oblong lanceolate, membranous, dimorphic with distinct one or more pairs of parallel main veins connected by numerous cross veins; spikes one or two, enveloped by a caducous or persistent spathe, tepals 1 - 3 , pink, white or pale-blue; stamens 6 or more in two whorls; filaments subulate; carpels 3 - 6, free, style short or absent, stigma discoid or decurrent, ovules 1 - 8 in each carpel, follicles 3 or more, coriaceous, seeds erect, testa thick or rarely thin.

The distinguishing characters of 7 species of *Aponogeton* are given in Table A.

TABLE - A

Name of the Species	Tuber	Inflorescence	Tepals	Fruit	Plumule
Aponogeton appendiculatus	Elongated and creeping ±1 cm.	spike solitary + 15 cm, laxy flowered	Tepals-2, white obovate 0.8 - 1 × 1 - 1.5mm	10 - 12 × 6 - 8mm beak terminal.	Absent (crowned with appendages).
A. distachyus	Elongate or ovoid ±1 cm.	cylindrical spike, bifurcated ± 7.5 cm.	Tepals-1, white lanceolate, 0.5 - 0.7 × 1 - 1.5mm	6 - 8 × 3 - 4mm beak lateral.	Attached at the base of embryo.
A. echinatus	Ovoid ± 5 cm.	dense spike solitary ±13 cm.	Tepals-2, white pink lanceolate 1 - 1.5 × 2 - 2.5mm	10 - 12 × 4 - 5mm beak terminal.	Attached at the base of embryo.
A. lakhonensis	Elongate or ovoid ± 2 cm.	rather laxy spike solitary ± 8 cm.	Tepals-2, yellow Obovate 1 - 2 × 0.9 - 1.5mm.	2 - 3 × 1.5 - 2 mm beak lateral	Absent.
A. natans	Stoloniferous ± 2 cm.	densely flowered spike solitary ± 7 cm.	Tepals-2, white lilac. Spathulate 1.5 - 2 × 0.5 - 1mm.	3.5 - 4 × 2 - 2.5 mm beak terminal.	Absent.
A. satarensis	Globose or Ellipsoid ± 15 cm.	Spikes two ± 7.5 cm.	Tepals-2, purplish white, obovate 1.4 - 1.7 × 1 - 1.4mm.	5.5 - 6 × 3.5 - 4mm beak terminal.	Absent.
A. undulatus	Globose or obovoid, ± 2.5 cm.	laxy flowered spike solitary ± 10 cm.	Tepals-2, white pink spathulate 3.5 - 6 × 1 - 2.5mm	1 - 7 × 3.5 - 4mm beak terminal.	Attached at the base of embryo.

DISTRIBUTION AND HABITAT

Aponogeton L.f. is widely distributed in Australia, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Madagascar, Malayasia, Mauritius, Myanmar, Papua New-Guinea, South Africa, Sri Lanka, Thailand, Vietnam.

Fossil leaves of *Aponogeton* has also been reported from Aral sea of C.I.S. (erestwhile U.S.S.R.).

Wide distribution of the genus Aponogeton in India and throughout the world is shown in Table B.

Aponogeton exhibits a wide range of eco-diversity, being found both in fresh and brackish water conditions from running water streams to stagnant waterbodies. It extends from plains to mountains, olgotrophic to europhic condition and is capable to withstand dessication during summer.

Aponogeton appendiculatus, generally, occurs in brackish water at a depth of 1.5 - 3 m. It flowers during Nov.-April.

A. distachyus is of South African origin, introduced and cultivated in Otcamund Botanic Garden; grows in shallow artificial lake.

A. echinatus grows large quantities in freshwater lakes and ponds between sea level and 1300 m. It flowers throughout the year.

A. lakhonensis grows in slow running streams, flooded rice fields and ponds ca. 240 m above the sea level. Polymorphic in nature and flushing in the months of March, May, September and October.

TABLE - B

Name of the Species	India	Other Countries
Aponogeton appendiculatus	Kerala, Tamilnadu	—
A. distachyus	Tamilnadu	Australia, South Africa
A. echinatus	Andhra Pradesh, Karnataka, Tamilnadu	—
A. lakhonensis	Assam, Nagaland	Cambodia, China, Indonesia, Thailand, Vietnam
A. natans	Andhra Pradesh, Bihar, Delhi Haryana, Kerala, Madhya Pradesh, Tamilnadu, Uttar Pradesh, West Bengal	Sri Lanka
A. satarensis	Maharashtra	—
A. undulatus	Bihar, Kerala, Madhya Pradesh, Tamilnadu, Uttar Pradesh, West Bengal	Bangladesh, Java, Malaysia, Myanmar.

A. natans shows wide range of eco-flexibility from stagnant, shallow, temporary waters to reclaimed rice fields from deep ponds to turbid marshes from sea level to 800 m altitude, flowers during June - February.

A. satarensis is seen in shallow, stagnant puddles at a depth ca. 60 cm; flowers during May - June.

A. undulatus grows in freshwater ponds and ditches from sea level to ca. 300 m. It flowers during July, August and November, but critical observation reveals that it flushed once in 12 years.

USE & UTILIZATION

Aponogeton has prominent economic importance as aquarium plant, as human food and as aquatic fodder for fishes and water fowls.

Among 7 species, *Aponogeton distachyus* is cultivated as aquarium plant for its ornamentation. In South Africa, the farinaceous, starch enriched rhizome is used as food and fodder. The sweet scented inflorescence is also used like spinach in stew, substituting Asparagus (Kunkel, 1984).

A. appendiculatus : Two years old tubers are usually used by local people of Kerala for food.

A. echinatus is widely used as ornamental aquarium plant and is often exported.

A. lakhonensis remains underexploited in India and in Thailand (near Lampang) the whole plant is eaten as salad called "Pak - Kuap".

A. natans has stoloniferous root stock which is edible and considered to be as good as potatoes (Druhy, 1873). It is also cultivated for a good aquarium plant (Van Bruggen, 1970).

A. satarensis is famous for its beautiful purplish bifurcated spike and large sized tuber which is yet to be utilized.

A. undulatus - The starchy tuberous rootstock is edible (Biswas & Calder, 1954). It has immense economic potentiality as it is used as aquarium plant in India and abroad (e.g. Van cleef aquarium, Singapore). Ducks, geese, Swans and water fowl use it as good food.

Aponogeton undulatus in the Indian Botanic Garden, Shibpur, Howrah

SOCIO – ECONOMIC ASPECTS OF APONOGETON UNDULATS

The mature plants, plantlets and tubers of *A. undulatus* are sold as aquarium plants together with coloured fishes, fishfood, glass aquarium etc. at two major places - Hatibagan (Calcutta) and Dasnagar (Howrah). The market price of *A. undulatus* varies, depending upon its size. In the wholesale markets, the selling price of 100 plantlets of smaller size (10-12 cm; tuber 0.5-0.3 cm) varies from Rs. 30.00 to Rs. 110.00 and 100 plantlets of larger size (15-18 cm; tuber 1-1.5 cm) varies from Rs. 125.00 to Rs. 150.00 In different retail outlets of coloured fishes in Calcutta, Howrah, North 24 Parganas, Nadia each plantlets of those different size can be purchased by Rs. 2.50 to Rs. 4.00 and Rs. 3.50 to Rs. 5.00 respectively. the cost of 100 nos. of matured dried tubers, used as propagules varies from Rs. 25.00 to Rs. 30.00. The average rate of selling of

Marketing of *Aponogeton undulatus* with coloured fishes

A. undulatus varies from 250 - 300 pieces per week in Calcutta. It is evident from the data gathered from Calcutta and Howrah market that the plant is an essential ornamental aquarium plant and thus has a crave in domestic market. Van Bruggen (1970) stated that yearly many thousands of corms are exported from Thailand (Bangkok) to U.S.A. and Europe (and aquatic ornamental plant useful for aquarium). Hence, it may be treated as potential wetland resource to earn foreign currency. *A. echinatus* is also exported (V. Bruggen, 1970) sometimes from Southern India. Not only *A. undulatus*, A echinatus but *A. lakhonensis*, *A. appendiculatus*, *A. satarensis* have the potentiality to be exported, if those species are cultivated in large scale on a profit earning basis.

A. natans (being widely distributed species throughout India) and *A. satarensis*. (having the largest tuber) can be proposed as cheap raw material for starch and beverage industry.

CULTIVATION

Aponogeton is practically a selfsown stoleniferous or tuberous perennial herb. Under natural condition it is multiplied vegetatively by tuberous rootstock, growing from mother rootstock and detouched after maturity.

There is no advance method of cultivation, adopted known so far, for it's multiplication but 2-3 years mature tuber is generally used as propagule of different species of Aponogeton viz. *Aponogeton natans*, *A. echinatus*, *A. undulatus*, *A. distachyus*, *A. satarensis*, by means of which these species are cultivated in watertanks, shallow ponds.

In some species (which flushed in a long interval) vegetative propagation takes places by runners, e.g. *A. undulatus* after first year of maturation of plant, plantlets which grow on tip of runner like peduncle; it tipped off and sown upon freshly prepared sandy beds in submerged condition.

THREAT

By the year 2000, one million species (out of a grand total of some 5 to10 million) may have been pushed into extinction by human activities and Aponogeton may be one of them. The population size of Aponogeton is shrinked due to :

1) Wetland encroachment to enhance different developmetal process without proper assessment of its potentiality.

2) Over-exploitation of its tuber for human consumption and commercial purposes.

3) Pathogens, in stagnant pools and water fowl, ducks, large fishes clear up Aponogeton population with other aquatic weeds.

CONSERVATION STATUS

A number of policy instruments can and must be adopted to warrant to conserve the germplasm of *Aponogeton* in India. Conservation measures have been already adopted for the following species :

Aponogeton undulatus – Conserved ex-situ at Indian Botanic Garden, Botanical Survey of India, Howrah.

A. natans – Conserved ex-situ at Indian Botanic Garden, B.S.I. Howrah.

A. distachyus – Conserved ex-situ at Ooty Botanic Garden, Nilgiri.

A. satarensis – Conserved ex-situ at Experimental Garden, Pune; Royal Botanic Garden, Kew; U.K.; and Heemskerk, Netherlands.

Conservation measure should be adopted for the following species also :

A. appendiculatus – As it is endemic and rare species, should be conserved properly.

A. lakhonensis – Though it is widely distributed in South-East Asia, it is restricted in distribution in North-East India. So, it deserves in-situ as well as ex-situ conservation.

A. echinatus – Endemic in Southern India, but not rare, hence, in-situ conservation measure will be enough to protect its population.

It is high time to conserve the germplasm of 7 species of *Aponogeton* L.f. in India. Its proper cultivation method, pathogenecity, improvement through genetic manipulation and further broadening its distributional access and scientific exploitation can prove its socio-economic potentiality. Aponogeton is a biotic component of wetland ecosystem and wetland ecosystem itself is in danger. So, proper environmental management can save only, the wetland ecosystem with its wealth from verge of extinction.

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DUCKWEEDS

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Duckweeds are tiny, fragile, free floating or submerged fresh water aquatic plants which have many economic potentials if properly managed. Several applications of the duckweeds for technological development can be achieved ranging from manures, biogas, medicines, feed for aquatic birds and fishes, waste water treatment, maximum concentration of metals and for the removal of excess inorganic fertilizers from the surroundings. They are the simplest and most vigorously growing flowering plants on earth. They are so ubiquitous, promising as well as so neglected as crop plants that they invite curiosities to the botanists.

Duckweeds belong to the family Lemnaceae which is derived from the Greek word "Limne" that means pond. The family Lemnaceae includes 6 genera, 29 species and 1 variety (Hartog & Plas, 1970). None have distinct stems or leaves, many lack roots and flowers are so small as to be nearly visible to the naked eye. The six genera are : *Spirodela* (L.) Schleid., *Lemna* L., *Pseudowolffia* Hartog & Plas, *Wolffia* Horkel ex Schleid., *Wolffiopsis* (Hegelm.) Hartog & plas, and *Wolffiella* Hegelm., among which *Spirodela* (L.) Schleid., *Lemna* L., *Pseudowolffia* Hartog & Plas and *Wolffia* Horkel ex Schleid. are only found in India.

Distinction between the six genera of the Duckweed family are shown in Table 1.

Duckweeds are found clustered in colonies, forming scum on the water surface. They are not distinguished into leaves and stems but consist of minute, flattened, leaflike 'fronds' of various

TABLE - 1

Characteristics	Lemna L.	Spirodela (L) Schleid.	Wolffia Horkel ex Schleid.	Pseudowolffia Hartog & Plas	Wolffiopsis (Hegelm.) Hartog and Plas	Wolffiella Hegelm.
Habit	Floating	Floating	Floating	Floating	Submerged	Submerged
Frond	2 - 10 attached, 1 - 6 × 0.5 - 5 mm symmetric or asymmetric, round, elliptic oblong, obovate or lanceolate, swollen or flat with or without pigment cells.	2 - 5 attached, 3 - 10 × 1.2 - 8 mm symmetric or asymmetric, reniform to obovate, flat or inflated, underside red pigmented.	0.4 - 1.8 × 0.3 - 1.2mm symmetric, thick, globular, ellipsoid or ovoid, sometimes dorsally flattened.	1.5 - 1.8 × 1.0 - 1.2mm 1.2 mm symmetric, slightly swollen, round.	5 - 6 × 3 - 4mm elliptic to ovate, thin membranous flat symmetric, slightly curled brown pigment cells in the epidermis.	3.5 - 9.0 × 0.4 - 4mm solitary or 2-3 attached, symmetric, flat, thin, membranous, linear, oblong strap like.
Root fibres	Single	5 - 10 clustered	Absent	Absent	Absent	Absent

forms. Simple roots may or may not be present. Flowers are very small and rare in many species, male and female flowers are borne on the same plant. The inflorescence consists of two male flowers and one female flower, but in *Wolffia* there is one male and one female flower. The flowers are naked or surrounded by spathe. The fruit is an utricle and the seeds are smooth or ribbed. Vegetative reproduction is very rapid and usually by buds or turions.

The Duckweed family shows a reduction series from *Spirodela* through *Lemna* to *Wolffiella* and *Wolffia*. Phylogenetic studies confirm the relationship of water - lettuce *(Pistia)* of Araceae & *Spirodela* (Daubs, 1965).

The fossils of Duckweeds were first found in the Upper Cretaceous deposits of the Rocky Mountain area (Hillman, 1961). but the fossil record of these is a meagre one and possibly overlooked due to their small size (Daubs, 1965).

The Duckweeds are distributed worldwide in fresh water conditions. About half of the species are found in tropical and subtropical regions and others are concentrated in temperate regions (Hillman, 1961). They are generally found to grow in stagnant, fresh or less brackish water lakes, or pools, ditches, drains, ponds, sluggish streams, irrigated crops, slow flowing canals and small hydroelectric facilities.

Duckweeds are most vigorously growing plants on earth and it is reported that some species e.g. *Spirodela punctata, S. polyrhiza* and *Lemna minor* may grow double the numbers within 2-3 days. It has been found that if *Lemna minor* occupy 6.4 cm^2 initially, it may cover almost 1/2 a hectare within 50-60 days (Hillman, 1961). Due to their high growth rate they exhibit eutrophic conditions and their growth is favoured by organic pollutants and inorganic nutrients. They occur either in pure form or associated with *Salvinia, Azolla, Ricciocarpus* or *Riccia* species.

Various physico-chemical parameters of water supporting the growth of different species of Lemnaceae

TABLE - 2

Name	pH	Free CO_2 (mg/l)	Carbonates (mg/l)	Bicarbonates (mg/l)	Dissolved O_2 (mg/l)	Chloride (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
Wolffia arrhiza (L) Horkel ex Wimmer	6.1-8.3	A-10	29-93.75	51.85-744.0	7.7-14.4	30.14-83.75	22.45-39.6	5.34-16.76
Lemna minor L.	6.1-8.3	3-14	A-140.62	51.85-744.0	7.70-16.85	16.45-83.75	17.24-59.45	5.34-26.72
Lemna perpusilla Torr.	7.3	10	—	186.5	14.4	62-67	29.6	16.76
Lemna gibba L. Torr.	7.3-8.0	12-16	26-100	500-700	6.0-15	22-65	58-62	7-8
Lemna trisulca L.	8.3	10-26	A	930.0	11.10	16.45	69.45	10.13
Spirodela polyrhiza (L) Schleid.	6.1-8.9	A-28	A-28	36.67-930.2	2 . 8-14.4	16.45-104.4	18.0-69.45	5.34-18.4
Spirodela oligorhiza Hegelm.	7.4-1.6	7-10.5	25-124	110-800	9-17.5	25-56	25-65	7-16.6

A = Absent; — = Data not available

TABLE - 3
CHEMISTRY OF LEMNACEAE GIBBS, R.D. 1974

Name	Carbohydrates (Apiose)	Raphides	Maganese	Saponins	Tannins	Cyano-genesis	Leuco-antho-cyanians	FLAVONOIDS		
								Antho-cyanins	Flavones	Flavonols
Lemna	+ (2 sp.)	+	+ (3 Sp.)	—	—	—	+ *(L.minor)*	0	0	0
Spirodela	+ (1 sp.)	+	+ (1 sp.)	—	—	—	—	Petunidin-3 glucoside	Saponarin & Isosaponarin	+

are shown in Table-2 (Anand & Sharma, 1994).

CHEMISTRY OF LEMNACEAE

Chemically, the family Lemnaceae is little known. The flavonoid associations of each species of Lemnaceae are unique in the family except *Spirodela polyrhiza* and *S. biperforata* which produce identical flavonoids (Mclure & Alston, 1966). The great range of morphological variation within a species of Lemnaceae can be classified by flavonoid chemistry (Mclure & Alston, 1966).

USES AND SOCIO ECONOMIC APPLICATIONS

Recent analyses suggest that duckweeds have more nutritive values than agriculfural crops. Protein of the duckweeds is rich in certain aminoacids that are normally lacking in plant protein. They are traditionally collected in vast quantities and used as manure and good fodder for cattle and pigs. They appear most promising for use of human food, animal feed, biogas and in recovering nutrients from waste water. If properly managed, the duckweeds can enhance socio-economic structure in several ways :

i) Manure : The duckweeds are very rich in mineral contents, such as nitrogen, phosphorus, potassium and calcium, consequently they are potentially used as manure. Recent research at Louisiana State University (Report - Nat. Ac. Sci., Washington, D:C. 1976) reveals that waste waters which become rich in nutrient, due to growth of duckweeds can yield plants with high protein contents. Typical analytical figures of the duckweeds are shown in Table 4.

Due to high nitrogen value (6-7%) many duckweeds especially *Spirodela* have become attractive as fertilizer.

ii) Feed for aquatic birds & fishes : Being rich in minerals and proteins duckweeds serve as food for herbivorous fishes, ducks, geese, swans and other wild fowls and also as mentioned earlier for cattles and pigs. Feeding of duckweeds to poultry is under study. The nutritional value of Lemnaceae can be compared favourably with that of alfalfa in lysine and arginine, two aminoacids in animal feed (Hillman, 1961). Table 5 shows the sample feeding rates including duckweeds for Chinese carp Fry (Bardach et al, 1972).

iii) Medicinal applications: Duckweeds have some important medicinal applications, such as, use of Lemna in traditional medicine as practised in China. It is considered to be a cooling potion, diuretic, antiscorbutic, astringent and alterative. It is used as a wash for opthalmia (Watt, 1893). The mixture of *Lemna, Spirodela* and *Wolffia* are administered in cases of haemorrhagic

TABLE - 4

Constituents	Percentage (dry wt.)
Nitrogen	6-7%
Phosphorus	1.4-3
Potassium	1.5-3
Calcium	1
Ash	8-14
Fibre	7-10
Fat	4-6
Metabolised Energy	1958 cal/kg.

TABLE - 5

Country	Species Area	Depth of Pond	Size of Pond	Feed Pond	Feeding	Rate
China	Grass carp.	1 ha.	1.5 m	4-10 mm	Duckweeds	3.5% of weight of fish per day
Malaysia	All Species	50 m^2	40-60 m	upto 5-7.5 cm	Wheat flour and *Wolffia*	Enough to cover surface twice daily
	All species	15 m^2	60 m	5-7.5 cm 12-15 cm	Duckweeds	—

Ducks feeding on *Lemna perpusilla*

TABLE - 6

Pests	Duckweeds affected	Kinds of damages caused
1. Weevils (Curculionidae)	*Lemna, Spirodela*	Drill holes into the fronds, but do not go right through, the fronds die off
2. Moth *(Nymphula responsalis)*	*Lemna, Spirodela*	Larvae make their cases of the fronds and feed on them
3. Ephydrid fly *(Lemnaphila scotlandae)* & rhyncophorus beetle *(Tansyphyrus lemnae)*	*Lemna*	Both larvae & adults feed on the fronds
4. Flatworms (Euplanaria) Snails (e.g. Physa), Hydra	*Spirodela*	Feed and oviposit on fronds.

loss. *Lemna* mixed with pepper are applied to the eyes in cases of typhoid when the patient is unconscious (Mc Cann, 1942).

iv) Production of biogas : Since they are biodegradable & contains cellulose they can be used for generation of biogas. The pulp mixed with cow dung can be made into a slurry for initiaing biogas generation through methane bacteria from the cowdung.

v) Waste Water Treatment : Species of *Spirodela, Lemna* and *Wolffia* can absorb nutrients like nitrogen, phosphorous and potassium through the roots and lower surface of the frond. Since they grow vigorously as stated earlier, a colony of duckweeds absorb considerable quantity of nutrients from the waste water.

vi) Other uses : Duckweeds are also useful in removing excess inorgnic fertilizers from stagnant water bodies through abundant growth. *Spirodela, Lemna* & *Wolffia* are well -known to aquarists (Muhlberg, 1982).

Duckweeds are used in plant physiological experiments because of their small size, rapid growth by vegetative reproduction and relative structural simplicity (Hillman, 1961).

vii) Ability to concentrate metals : Duckweeds play an important role in absorbing various metals like boron, alluminium, manganese, iron, copper, cobalt and titanium from the water (Silvey, W.D. 1967) *Lemna minor* with commercial potential can be used for the ability to concentrate all the metals from water.

viii) Deterimental Effects : The duckweeds if not properly managed constitute a serious pollutant in stagnant water bodies due to their prolific growth and choke in water surfaces and drains etc. acting as a breeding ground for mosquitoes. The prolific growth of duckweeds inhibit light penetration and gaseous exchange into water which cause serious threat to phytoplanktonic and submerged macrophytic populations. The low oxygen tension associated with high organic contents favour the growth of blue green algae (Hillman, 1961).

ix) Cultivation : Floating weeds without attachment to the soil, are very easy to harvest by skimming the surface with a net and transfer to another water body for regeneration. Sexual reproduction is rare in duckweeds; almost all reproduction is vegetative.

x) Human food : In some parts of Myanmar, Laos & North Thailand, *Wolffia arrhiza* the smallest flowering plants on the earth resembling a pinhead is used as vegetable egg which usually contains 20% protein, 44% carbohydrate and 5% fat.

xi) Common threats :- The common pests affecting duckweeds and the kind of damages caused by them are listed in Table-6 (Mc Cann, 1942; Hillman, 1961).

Other kinds of threats to duckweed population include both natural causes like draught, subsidence, erosion, biotic effects and human actions like filling for solid waste dispersal, discharges of pesticides and herbicides, mining of wetlands for peat, coal, gravel etc., subsidence due to extraction of ground water, oil, gas and other minerals

Fronds of *Spirodela polyrhiza* – cultured in laboratory of I.B.G.

(Global biodiversity, Edited by : Brian Groombridge, 1994).

xii) Conservation : Since duckweeds have many uses and socioeconomic aspects if properly managed along scientific principles, they are also in need of conservation, which can be done by conservation of wetlands.

Creation of protected areas, prevention of siltation from soil erosion in the watershed, prevention of pollution from industrial or urban areas, may be helpful. (Global Biodiversity, Edited By : Brian Groombridge, 1994).

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PICRORHIZA KURROOA Royle *ex* Benth

— FROM VALLEY OF FLOWERS, GARHWAL HIMALAYAS

MOONMOON MUNSHI
Botanical Survey of India, C.N.H. Howrah

Picrorhiza kurrooa Royle ex Benth. **(Scrophulariaceae)** has a wide range of distribution in the Alpine Himalayas from Kashmir to Sikkim & Nepal and extending to the mountains of Yunnan in China at the altitudes 2700-5000 mts.This perennial plant is known as 'Kuruwa' in Garhwali, 'Kutki' in Northern India and Nepal, & by its derivated names in local dialects in the Southern and Western states of India. In Malaya it is known as 'Oowong lin' and in China as 'Hu Huang Linn'. It is popular for its medicinal drug values in Persian and Arabian countries. In Sanskrit it has got a special mention under various names. Due to commercial export, population of this plant species has become threatened therefore, a brief information regarding this plant is high lighted for strengthening its security before extinction.

The plant is a hairy, scapigerous, low, perennial herb with transversely striated, hollow rhizomes that apparently look- like the rhizomes of ***Gentiana kurrooa*** Royle. Flowers are profused, whitish blue with protruding anthers. The plant was first reported from Kumaun hills and subsequently located in different areas of Himalayas.

Picrorhiza (Greek : 'picros' means 'bitter'; 'rhiza' means 'root') **kurrooa** ('kuruwa' in Punjabi means 'bitter') Royle ex Benth, is a highly potential medicinal herb extensively used in various ailments and diseases both in India and abroad since ancient times. It conforms an important component of Ayurvedic & Yunnani medicines.

In the Garhwal region (eg. Valley of Flowers & adjacent pathway areas), the tribal hill people use its rhizomes and roots in crude form. A fairly large number of the plant is collected from the Himalayas and regularly exported to the plains. It is made out as a good adulterant to Indian Gentian ***(Gentiana kurrooa)***.

CHEMICAL CONSTITUENTS

The rhizome and root of the plant contain glucosidal bitter principles called 'Picrorhizin' and 'Kutkin' and a non-bitter product named 'Kurrin' and a sterol named 'Kutki sterol' which are extracted from the dried rhizomes and roots and used for the manufacture of medicines and drugs.

MEDICINAL USES

Both the white and black varieties of ***P. kurrooa*** Royle ex Benth. have their multiple usages in herbal medicines

and drugs. These are provenly cooling stomachic, cardiac and cerebral tonic, antipyretic, anthelmintic, laxative, anti-emetic, cathartic; useful in bilious fever, dyspepsia, urinary trouble, asthma hiccough, blood circulation, burns, leucoderma, jaundice, paralysis, liver complaints, epilepsy, gouts, ringworm infection, scabies & piles. The root is also prescribed for snake bites and scorpion stinging, but is not an antidote to snake & scorpion venom.

For its vast multipurpose potential medicinal values & drug properties, *P. kurrooa* Royle ex Benth. attracted in a large way both local ethnic users in the hills and big manufacturers in the plains, tending to procure and hoard the merchandise in large quantities beyond the capacity of utilisation and necessity. Huge bunches of uprooted plants in donkey loads are found being carried in those regions. This species is regulary exported from India and according to IUCN experts reports 10-24 tonnes are exported per year from the range countries. The roots & rhizomes being the most sought after portion, the entire plant body gets deported due to uprooting, restricting natural regeneration. Such of uninterrupted human act of destruction may gradually cause the already vulnerable plant species becoming rare and endangered and even ultimately extinct. Recent trend in globalisation of trade and economic liberalisation boom may have its impact on the demand and supply of this apparently export oriented medicinal plant species.

CONSERVATION MEASURE

However, one cannot overlook the large amount of foreign exchange earned via the export of these plants of medicinal value. Hence, alternative methods like collecting seeds from the wild condition and propagating them in tissue culture laboratories and finally formulating a protocol for their growth can be undertaken so that the exporters can cultivate the plants and then export them from the cultivated population. This will serve the dual pupose of gaining a steady access to foreign exchange as well as conserving the plants in their natural habitat. This is perhaps the best method to date to avert the slow but steady rate of extinction that these plants are looking to.

Recent exploration trips to the "Valley of Flowers" National Park by the author has shown an increase in the population of these plants and as many as 50 plants have been found growing in one sq. .metre area on open hill slopes.

Management in the propagation of the plant, and control in its by- products formation at Government level seems to be the call of the day. Restricted human activities and prohibitive cordoning of the growing areas of the plant as has been done for'Valley of Flowers' may find the right way for conservation of *Picrorhiza kurrooa* Royle ex Benth.

Dried specimen of *Picrorhiza kurrooa*

ACKNOWLEDGEMENT

The author expresses her gratitude to Dr. P.K. Hajra , Director, BSI, Dr. L.K. Banerjee, Dy. Director and Dr. M.S Mondal, Dy. Director, BSI for their encouragement, guidance and valuable suggestions.

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DIOSCOREA PRAZERI Prain and Burkill

— A RAPIDLY DEPLETING MEDICINAL PLANT

AKRAMUL HOQUE* & P.K. MUKHERJEE**

The genus ***Dioscorea*** is attributed to a renowned Greek Physician Dioscorides Pedanius & the specific epithet ***prazeri*** after the name of J.G. Prazer, a collector of Sir George King, the then Director of Royal Botanic Garden, Calcutta. ***D. prazeri*** Prain & Burkill is known from India, Nepal, Bhutan, Vietnam, Cambodia, Laos, Myanmer, Thailand and Malesia (Malaysia, Singapore, Indonesia and Philippines). In India, this species has been reported from tropical – sub-tropical region of West Bengal, Bihar, Sikkim, Arunachal Pradesh and Nagaland.

The plant belongs to the conserved family **Dioscoreaceae** which was first described by Robert Brown in his Prodr. on 27th March 1810 and is based on the type genus ***Dioscorea*** L. According to Cronquist (1981) and Goldberg (1989) the family consists of 6 genera and 600 species.

Several species of ***Dioscorea*** collectively known as Yams have great economical value. Their tubers contain a large content of starch and has long been used as a famine food. In recent years this genus has aroused interest as it is an excellent source of raw materials for the manufacture of steroids like cortisone. Yam tubers contain different types of chemical compounds such as carbohydrates, proteins, alkaloids and tannins. The most important compound extracted from these tubers is "Saponin". On hydrolysis "Saponin" yields "Sapogenins". Chemically "Saponins" are glycosides. These compounds are so named because they form a soapy solution when dissolved in water. For this reason it is used as detergent for washing clothes by the villagers. There are different classes of "Sapogenins" found in different species of Yams viz. "Diosgenin", "Yamogenin", "Botogenin", "Kryptogenin" etc. Different steroid drugs have been synthesized from "Diosgenin" e.g. Corticosteroids, Sex hormones, Anabolic steroids and Oral contraceptives. However, "Diosgenin" is used as a reliable source of corticosteroids only. For the production of sex hormones, oral contraceptives etc. there are other potent precursors at present. R.N Chakravarty (1953) of the School of Tropical Medicine, Calcutta, discovered that *D.* ***deltoidea*** and ***D. prazeri*** contained appreciable amount of Diosgenin in the rhizome. ***Dioscorea prazeri*** Prain & Burkill is an economically important plant and has become rare due to over exploitation from

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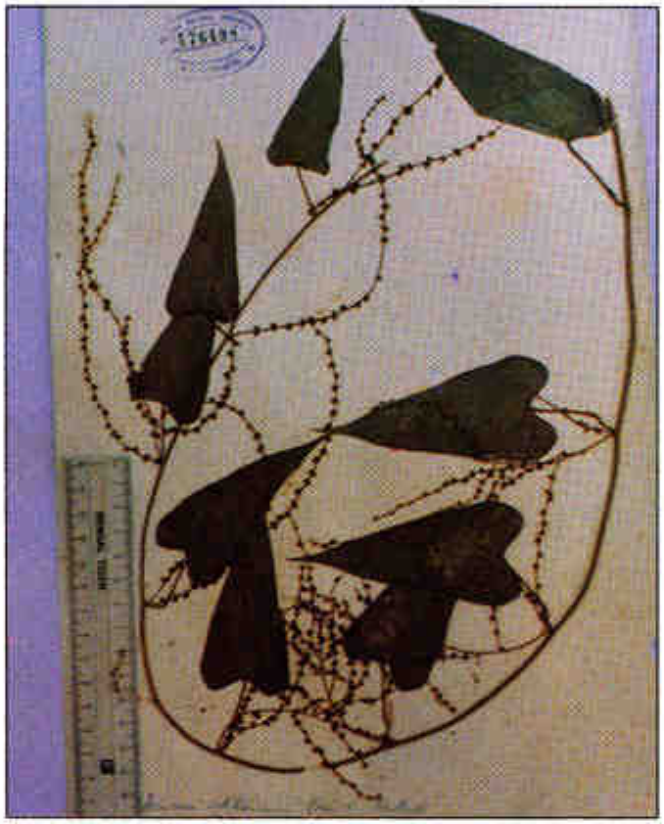

Dioscorea prazeri
– Twig of Male Plant with Inflorescence

Dioscorea prazeri
– Twig of Female Plant with Inflorescence

the natural habitat. Therefore, information regarding this vulnerable and commercially important plant would be of very usefull for rescureing its security in the natural habitat.

Dioscorea prazeri is a rhizomatous plant. The rhizomes are branched, stout, gray-brownish or black with fibrous roots scattered all over the surface. The stem 2mm in diameter, glabrous, unarmed, smooth or slightly ridged, green or brownish speckled, twining to the left. The leaves are alternate or rarely opposite at the base of the stem, cordate, gradually acuminate or with a short acumen at apex, the lobes at the base of the leaves are rounded. The Leaves are up to 20 cm long from petiole to acumen and the same is in breadth. But more commonly only about 12 cm long and 10-16 cm in breadth; usually 7-nerved but sometimes with 9 and even 11 nerves. The upper surface is glabrous, shining and smooth, lower surface glabrous with prominent nerves. Petioles shorter than the blade, glabrous 4-8 cm long; the tip and the base pulvinous. Male flowers in racemes, axillary, with 1-3 rachis from each axil or sometimes in terminal panicle; rachis weak, 10-20 cm long, bearing 40-45 male flowers, 1-3 at each point, glabrous. Flowers 3 mm long, bracteate; bract 1, broadly ovate and very abruptly long-acuminate; bracteoles 2, ovate, apex short acuminate, papery, 1 mm long and 1 mm broad; pedicelled, pedicels 1.5 mm long; perianth lobes 6, in single whorl, united at base forming the perianth cup. Stamens 6, all fertile, 0.5 mm long; anthers 0.2 mm broad, bilobed; filaments weak, twisted. Female flowers bracteate, in spike, glabrous, 4-5 mm long, 2.5 mm broad, sessile at immature state and during fruiting it becomes short pedicelled; bracts 2, lower single bract 0.7 mm long, 0.7 mm broad. Perianth lobes 6, in 2 whorls of three each, leathery, united at the base, glabrous, flat; apex acute, 1.25 mm long, 0.7 mm broad. Ovary inferior, 3 ridged, trilocular, each locule containing 2 ovules, style short, stigmas 3-bifid curved downward, 0.5 mm long. Capsules 3-winged; wings broadly half cordate-obcordate-obovate or sub-rhomboidal. Wings 1.2 cm broad. Seeds albuminous, ovate-oblong or "D" shaped, winged all round, 2-2.2 cm long and 1.3 cm broad. Embryo spoon-shaped, placed at a corner of the seed, 1.5 mm long and 0.8-1.0 mm broad, with small stalk like radicle outward and flat cotyledon inserted within albumen of seed.

The Lepchas of Sikkim use its rhizomes as fishpoisoning and killing hair-lice and the Lepcha Vernacular name for this plant is "Kukurtoral" or "Kencheong"

Dioscorea prazeri growing in Darjeeling (W.B.) is a good source of Diosgenin. Plantation of ***D. prazeri*** has been undertaken by the Medicinal Plants Directorate of West Bengal in an area of about 25 ha in Gairibas and produces ca 12.5 to 17.5 tonnes of green rhizomes per hectare, in which the diosgenin content is found to be about 2.5 to 3.5% on dry wt. basis. (Asolkar, L.V. & Chadha, Y.R. 1979).

D. prazeri is being propagated by CIMPO, Lucknow, on an experimental basis. Rhizomes containing about 4.5% diosgenin has been introduced here. After 8 months the yield was 95 gm of fresh tubers per plant, with ca 3% diosgenin content on dry wt. basis. (Asolkar, L.V. & Chadha, Y.R. 1979)

Some desirable growth characters of *D. prazeri* :

* Easy to propagate from rhizome pieces.

* Rhizome hardy and grows just beneath the surface of soil and horizontal, leading to easy harvesting. (Asolkar, L.V. & Chadha, Y.R. 1979).

Usually the rhizome is free from pests due to the presence of saponins. For similar reasons, root-boring animals do not destroy this species. Yet it is disappearing rapidly from its wild due to destruction of habitat. ***Ex-situ*** conservation by cultivation and propagation is practised by certain organisations. However, the need of the hour is the ***in situ*** conservation of the plant to save it from possible extinction.

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The authors express gratitude to Dr. P.K. Hajra, Director B.S.I and Dr. L.K. Banarjee, Deputy Director I.S.I.M for their encouragement and usefull help.

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TAXONOMY & PHYTOGEOGRAPHY OF "NEEM TREE"

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Azadirachta indica A. Juss. a promising Neem tree is well known in India and neighbouring countries for more than 2000 years. In Sanskrit, its name is "Arishtha" means "reliever of sickness" and many parts of the plant were used in Unani and Ayurvedic medicine. Use of different plant parts and Azadirachtin, the main chemical ingredient for integrated pest management was first reported in India as early as in 1928. In the present era comprehensive studies on several aspect of Neem tree have been completed but little information is available regarding its taxonomy and phytogeography, therefore, the authors have tried to highlight the possible information as follows :

TAXONOMY

Carl Linnaeus in 1757 described the

Neem tree as *Melia azadirachta* from North Western India towards Himalayas in his species Plantarum. In 1830, Adrien Henri Laurent De Jussieu found that the fruit of the genus Melia contains 3 – 5 seeds in a very hard endocarp whereas the fruit of the genus ***Azadirachta*** contains as a rule, only one seed in a thin endocarp. This basic differences probably enable A. Juss. to separate the Neem tree from the genus Melia to the genus Azadirachta and he described in 1830 the Neem tree as *Azadirchta indica* in Memoires du Museum Nationale d' historic Naturelle Paris. Taxonomically it belongs to the order, Rutales, suborder, Rutineae, family Meliaceae sub-family Melieae, genus, *Azadirachta* and species *indica*.

Distinguished characters of ***Melia azadirachta*** L. and ***Azadirachta indica*** A. Juss. are as follows :

1) Leaves 2-3 pinnate, glands orbicular at the base of petiole; ovary 4-8 locular; drupe 3-8 seeded covered by stony endocarp.....*Melia azadirachta.*

2) Leaves simple, pinnate, orbicular glands at the base of the petiole is associated with another pair of linear glands. Ovary 3- Locular, drupe one seeded covered by thin endocarp .....*Azadirachta indica.*

The genus ***Azadirachta*** A.Juss (1830) comprises three species of Indo-Malayan origin and the type species is ***A. indica***. It has been studies in detail by Penningtan and Styles (1975) and Penningtan in 1981. the name ***Azadirchta*** is said to be derived from the Persian azaddirakht meaning ash tree. Jacobs ia 1961 referred three synonyms of ***A. indica*** namely ***Melia azadirachta*** L., ***M. indica*** (A. Juss.) Brandis and ***Antelaea azadirchta*** (L.) Adelb. owing to frequent confusion of the genus ***Azadirachta*** with somewhat similar nature of berry of the genus ***Melia***.

A. indica L. is a fast growing, 20-50 m high tree. Tap root strong, deep rooted with well developed lateral roots associated with vesicular- orbuscular mycorrhiza. Stem straight, 1.5-5.5 m in girth; bark hard, fissured; whitish grey or reddish-brown, leaves simple, pinnate 20-30 cm long, leaflets usually 13-21 in number, varies from region to region each 5-6 × 2.5-3 cm., sub-opposite, lanceolate, asymmetric, glossy green, young ones reddish purple, dentate with the exception of the base, accuminate at apex inequilateral at base. Flowers polygamous, 5-6 × 9-10 mm, white fragrant, arranged in axillary 20-23 cm. long, drooping panicles. Calyx 5-lobed, imbricate, Petals 5, free, 4.5-5 × 1.5-2 mm. Staminal tube cylindrical, slightly expanded at the mouth, terminated by 10 rounded truncate, emarginate or bilobed appendages often partially united to form frill. Anthers 10 yellow, glabrous tapering to a short point inserted at the base of and opposite to appendages. Disc annular, fused to the ovary. Ovary 3-locular, each with 2 collateral ovules. Style head expanded to form a ring bearing 3, partially fused, papillose stigmatic lobes. Fruit 1.4-2 × 0.1-1.3 cm, elongated oval or roundish, drupe, glabrous, green when young and yellowish when mature, exocarp thin, mesocarp pulpy, seed 0.7-0.15 cm long, elongated, one or very rarely two with white, hard endocarp.

"Neem Tree" – *Azadirachta indica*

FLOWERING AND FRUITING

Neem exhibits a wide pattern of phenological behaviour in natural condition. Flowers start with the arrival of new leaves during the month of February and March in many parts of the country. Along the southern and northern parts, flowering spreads over from January to April. In Kerala, it starts from early January. In West-Bengal, Orissa, Tamilanadu and Karnataka, it is from February to March. In the central India, some parts of Northern India, Punjab and sub-Himalayan areas, it is delayed by the end of April, to early May. In the plains of Uttar Pradesh, it is seen to have a restricted blooming during August to September. Fruiting starts usually from May-July. Sometimes, it extends upto October.

ECOLOGY

Neem tree shows greater ecological diversity in its habitat condition in different parts of the world, compared to other tree species growing in the mixed deciduous forests. Though it is well known for its drought resistance, it is usually found in subarid and subhumid condition of the tropical and subtropical zone extending from the sea level upto the

TABLE - 1

ECOLOGICAL FACTORS	RANGE	
	Normal	Adaptive
Rainfall	200 - 1200 mm	90 - 120 mm
Temperature	21°C - 32°C	36°C - 48°C
Soil	Well drained sandy loam, clay loam, or black cotton soils	Coastal sand, saline, alkaline or low acid soil. Not in water lodged or trial silty soil.
Water Requirement	150 litres per young tree	50 litres per young tree
Soil pH	6.2 - 7.0	5.4 - 5.9
Salinity	Fresh water condition	Very little salinity 0.80 - 2.25 ds/m.

altitude of 700-800 m. Beyond 1000 m. it is reported that the tree shows very slow growth and less production of fruits.

Neem tree is never seen to form a pure stands under natural condition. It may be due to its high photosynthetic rate which needs more light energy and sufficient space for production of numerous flowers and fruits.

Major ranges of ecological factors which are found suitable for the growth of Neem tree are shown in Table 1.

PHYTOGEOGRAPHY

Though there are many confusions regarding the exact locality of origin of ***A. indica*** but several published work revealed that it has originated from the old world and there are three possible consideration regarding its origin, such as, 1) From Karnataka in southern India (Troup, 1921; Vartak and Ghate, 1990), 2) from Myanmar and 3) from Indonesia to Iran, South-Eastern and Southern Asia.

It's distribution is pantropical and spreads throughout the tropical and subtropical regions of the world. In India, it is known from West Bengal, Assam, Meghalaya, Manipur, Bihar, Orissa, Andhra Pradesh, Tamilnadu, Karnataka, Maharashtra, Goa, Pondichery, Rajasthan, Gujarat, Uttar Pradesh, Punjab, Madhya Prades, Tripura, Sikkim, Himachal Pradesh, Lakshadweep and Andaman & Nicobar Islands. It is found in Pakisthan, Bangladesh, Sri Lanka, Myanmar, Thailand, Malaysia, Indonesia and planted in middle East and tropical Africa, Australia, America and South Pacific Island.

About 15-20 million trees are reported from India of which Uttar Pradesh having more than 77,44,000 trees and in Tamilnadu its number is 24,70,000 (Ketkar, 1976). In the South Pacific region, it occurs in the figi, Hawai and other Islands and they are introduced from India by the Indian workers working in sugarcane field. In Indonesia and Phillippines, It is reported that this plant was introduced from India. In the subtropical insland of Hainan in China, the Neem tree probably introduced from India. In Central Vietnam, many parts of Thailand, Malaysia and in Malacca, Neem trees were also introduced from India.

In Nepal, Neem trees are found in southern sub Himalayan terai regions and in Sri Lanka it grows mostly in northern dry parts.

In Iran, Neem trees grow along the coast. It is planted in Arabian Peninsula, Qutar, Saudi Arabia, on the Arafat plain and southern part of Yemen, Abyan valley and east of Aden.

In Africa, Neem was introduced from India. It is found along the coastal Somalia, Tanzania, Madagascar, Mauritius and northern Mogambique. It is planted in Egypt, Sudan, Ethiopia, Addisababa, Nigeria, Ghana and in Ivory Coast.

Probably, Neem tree was introduced in the Islands of Trinidad, Tobago or Guyana in America from India. Many parts of Haiti, Jamaica, Cuba, Puerto Rico, Virgin Islands, Mont Serral and Antigua are well covered by Neem trees. In North America, Miami, Florida, California, Arizona and Oklahoma are also found covered with Neem trees. In Mexico, Guatemala, Elsalvador, Costarica, Panama, Colombia, Venezuela, Bolivia and Ecuador many neem trees are planted along the coastal regions. In Surinam and Guyana, it is growing as a roadside tree.

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SCIENTIFIC AND TECHNICAL ACTIVITIES IN BRIEF

The ENVIS Centre on Plant diversity, of the Botanical Survey of India, Ministry of Environment & Forests, is situated at the Industrial Section, Indian Museum, 1, Sudder Street, Calcutta - 700016. The main activities of this Centre is to provide useful information on Plant Diversity with the help of publishing Newsletters and disseminating the information to all ENVIS Centres, Universities, Research Institutes, Scientists and Scholars in India and abroad. The Centre has developed application Software on Database for Rare & Threatened Plants in India. The ENVIS Centre Database presently holds data on Mangroves, Coastal Plant Diversity, Flora of Arunachal Pradesh and Wet-lands.

Shri D.K. Banerjee, Botanist, incorporated the statistical data for the Centre.

The Centre has received more than 150 National and International queries during the period under report in the field of Plant Diversity, Ecology, Economic & Medicinal plants, Wetlands, Mangroves, Rare & Threatened plants, Biosphere Reserves, National Parks, Information on less known agricultural products, Chemical alkaloids of plants, Plants and animal interaction and their relationship in sustainable effects on Environment.

International Queries from different countries :

USA	**2**
Germany	**1**
Japan	**1**
Canada	**2**
Czechoslovakia	**1**
Italy	**1**
Brazil	**1**

Statistics of Queries and Replies during 1996-1997 (in part) :

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PAGE	INCORRECT	CORRECT
3, 5, 8	CHESNUT	CHESTNUT
3, 5, 6, 7	Karnels	Kernels
3	latter	later
3	allussion	allusion
4	maximowczii	maximowezii
5	muds	mud
5	Biologically	Biochemically
6	Vitamine	Vitamins
6	'Holy'	'Holi'
6	Pastris	Pastries
7	shoot up	shoot rises up
7	yeild	yield
8	begining	beginning
8	croap	crop
8	simultaniously	simultaneously
8	transfered	transferred

IMPORTANT MEETINGS & CONFERENCES

National Seminar on Developmental Biology and Commercialization of Orchids and Orchid Show, held on April 12-13, 1997, organised by the Orchid Society of India. Director, Botanical Survey of India delivered lecture on Orchid Conservation and acted as one of the Judges of Orchid Show

International Seminar-cum-Workshop on the Flora of Nepal, April 14-16, 1997, organised by Trivuban University, Department of Plant Resources and WWF, Nepal. Director, Botanical Survey of India gave a talk on Flora of India. He also discussed regarding the format of Flora of Nepal.

Indian Delegation in 10th Meeting of the Conference of the Parties to CITES, June 9-20, 1997, Harare, Zimbabwe.

Participants attending the XII All India Conference, Botanical Survey of India at Shilong

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