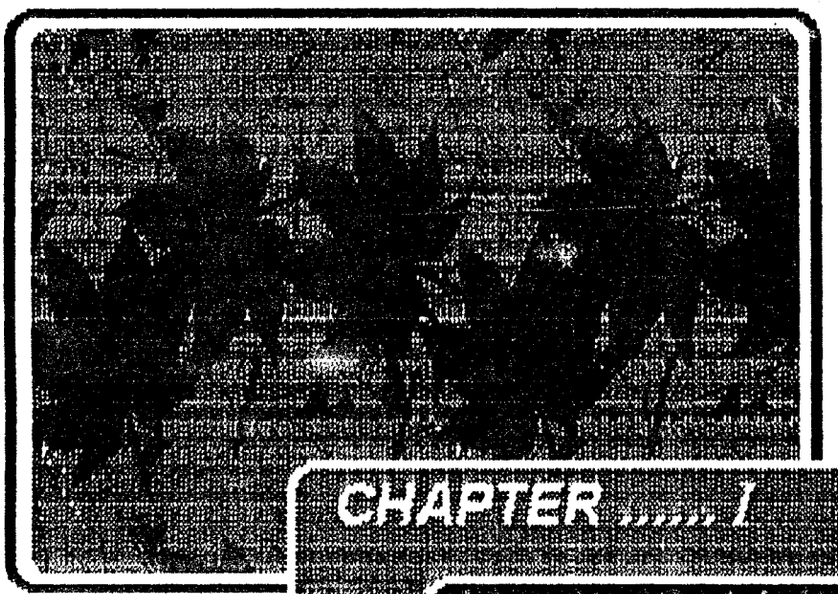

CHAPTER I

Review of Literature on Leguminous Halophytes.

1. Introduction

Leguminosae is one of the three largest families of the flowering plants, exceeded only by The Compositae and Orchidaceae. There are about 16,000 to 19,000 species in about 750 genera of this family (Allen and Allen, 1981). According to the International code of Taxonomic Nomenclature a new name Fabaceae has been given to this family in recent years.

The fossil record does not shed much light on the beginning of the family and in particular its ancestral relationship with the Rosaceae. It is believed that the

family originated in the Cretaceous and there are records of less specialized tropical legumes of the Mimosoid and Caesalpinioid type in the upper Cretaceous and Eocene in the Northern hemisphere. Papilionioid types are also recorded in the early Eocene and in the Oligocene.

According to Hutchinson (1926) some of the diagnostic characters of this family are as follows.

1) Distribution is world wide.

2) Tree, shrubs, woody vines, annual or perennial herb forms are present.

3) Leaves are simple to bipinnate usually alternate and compound. Stipules are present or absent.

4) Flowers are arranged in different types of inflorescences such as simple racemes, panicles, spikes or head.

5) Flowers are actinomorphic to zygomorphic. Petals are free or some partially united. Stamens are numerous to few, free or variously connate, often diadelphous. Carpel is solitary and superior.

6) Fruit is often a legume or indehiscent, sometimes winged and seeds are without endosperm.

2. **Taxonomic Divisions.**

Taxonomists have divided the family into three clearly distinct subfamilies Mimosoideae, Caesalpinoideae and Papilionoideae; division has been based mainly on floral

differences.

De candolle (1825) mentioned a worth giving account of the family and he recorded the swatzieae as a fourth subfamily which was adopted later by Corner (1951), Hooker (1865). He treated the Leguminosae as a vast order and divided into three suborders (equivalent to subfamilies today) Papilionaceae, Caesalpinieae and Mimoseae by adequately defined characters. Tanbert (1864) recognized three subfamilies like Bentham but in a different sequence and the tribal arrangement showed some difference in sequence and contents. Mimosoideae, Caesalpinoideae, papilionatae.

Hutchinson (1926) maintained the three groups as separate families. Again Hutchinson (1964) has given full family status to each of the three subdivisions as Mimoseae, Caesalpiniaceae and Fabaceae in order leguminales. Whatever may be their rank, the distinctions between the three basic groups are clear and universally accepted.

On the basis of flower structure the three subfamilies are separated from each other. Following are some important distinguishing characters of the three subfamilies.

I) Caesalpiniaceae

1) Habit - Trees, shrubs, rarely scandent, rarely herbs.

2) Leaves - Pinnate or bipinnate, rarely simple, some with translucent dots.

3) Flowers - Mostly irregular (zygomorphic), usually in showy racemes or panicles, calyx lobes 5, overlapping or separate,

petals usually 5, sometimes rudimentary or absent, slightly unequal, the upper petal distinctive and innermost in bud; Stamens free or joined, 1Ø or fewer, some may be staminodes; anthers dehiscing by lateral slits or terminal pores.

4) Fruits - Pod, sometimes indehiscent, some with winged sutures (samara), or fleshy or druplike.

II) Mimoseae.

1) Habit - Trees, shrubs, woody vines a few perennial herbs.

2) Leaves - Pinnate or bipinnate, often with glands on the rachis, leaflet pairs many. Stipules in some genera reduced to spines.

3) Flowers - Regular (actinomorphic). crowded into globose heads, or cyclindric spikes, rarely recemose, some inflorescences monoecious, calyx lobes 5, usually valvate; petals 5, equal, valvate in bud, usually united above the base, stamens mostly 1Ø or multiples thereof free, joined at the base, or united, forming a tube.

4) Fruit - a pod, straight curved or spirally twisted, usually 2 - valved, dehiscent some breaking transversely into 1-seeded segments.

III) Fabaceae.

1) Habit - Trees, shrubs, herbs, annual or perennial.

2) Leaves - mostly palmately 3 -or more foliate or odd or evenly pinnate, not bipinnate, rarely simple, some with tendrils or spines.

3) Flowers - Very irregular (papilionaceous) in 1 to many

flowered terminal or axillary inflorescences; calyx tubular, regularly 5 toothed or lobbed; petals 5, unequal, overlapping; standard uppermost and outermost; the 2 wings lateral, intermediate; the 2 keel petals lowermost, inside, usually joined along the lower margin, hiding the ovary and stamens; Stamens 1Ø, rarely fewer, usually united into 2 bundles (diadelphous) of 9+1 or 5+5 or in one tubular bundle (monoadelphous) rarely free.

4) Fruit - a variously shaped pod, straight, curved, winged or moniliform usually 2-valved and dehiscent, some transversely joined (loments), ripe joints separating .

3. Economic importance of Leguminosae.

In economic importance, Leguminosae is second only to the grasses, Gramineae. It provides a wide range of food sources mainly from seeds, fodder, timber, oil and flavour,dyes and tannins, gums and resins, medicines, insecticides etc. Legume seeds are second to cereals as a source of food and provide the much needed proteins. The relatively high protein content is attributed, in part, to the presence of nitrogen fixing bacteria present on the roots of many legumes tubercles or nodules. These microorganisms are capable of using free atmospheric molecular nitrogen to produce ammonia which can be readily used by the plants, thus increasing the supply of nitrogenous material.

Ecologically members of this family play a major role in the vegetation in many parts of world. They are

present in variety of soil, temperature and water conditions. As many members are capable of fixing nitrogen they play important role in soil improvement. In this respect, Fabaceae and Mimoseae members are more effective than the Caesalpiniaceae members. (Allen and Allen,1981). They are also used for green manuring in the cereal crop fields.

4. Halophytic Legumes.

Halophytes occupy environments ranging from the marine though predominantly wet maritime marshes, including tropical mangrove swamps, to arid salt deserts. In most of these, the origins of the salt can readily be traced to an ocean, past or present. The oceans now occupy about 71% of the world surface area and contain 97% of all World's water. At the same time 25-40% of the irrigated land is affected by salinization out of 220 million hectors of irrigated land, has been recorded by the Institute for Environment and development and the world Resources Institute's latest assessment (1987). Hence halophytic plants which successfully grow and complete their life cycles in such saline environment are of great importance.

The taxonomic list of halophytes includes about 1560 species in 550 genera and in 117 families (Aronson, 1989). About 50 genera from a single family Leguminosae are found naturally present in saline environment. These are capable of tolerating relatively high soil and water salinity. Hence their utility in agriculture, horticulture

and industry is worth considering.

The taxonomic list of Halophytic legumes includes the following species : [Allen & Allen (1981), Aronson (1989), Rudulier et al. (1982)]

1. Caesalpiniaceae

Caesalpinia bonduc (L) Roxb

C. crista (L)

Cassia acanthoclada Griseb.

Cumingla philipinensis Vidal.

Cynometra iripa Kostel.

C. ramiflora L.

Inocarpus edulis Forster.

Intsia bijuga (Cobebre) O. Kuntze.

I. retusa (Kurz) O. Kuntze.

Mora oleifera Ducke.

Pithecellobium lanceolatum Duck.

P. umbellatum (Vaili) Brh.

2. Mimoseae.

Acacia cornigera (L.) Willd.

A. cyclops. G. Don.

A. jacquemontii Benth.

A. leucophloea (Roxb.) Willd.

A. nilotica (L.) Del.

A. rostellifera Benth.

Mimozyganthus carinatus (Griseb) Burk.

Prosopis articulata. S. Watson.

P. chilensis (Mol.) Stuntz.

P. cineraria (L.) Durce.

P. Faxta (Sol. ex Rus.) Macber.

P. juliflora (Swartz) DC.

P. nigra (Griseb.) Hier.

P. pallida (Willd.) H.B.K.

P. reptans Benth.

P. ruscifolia Griseb.

P. strombulifera (Lam.) Benth.

P. tamarugo F. Phil.

P. torreyana L. Benson.

P. velutina Wooton.

3. Fabaceae.

Aganope heptaphylla (L.) Pohill.

Alhagi maurorum medil.

Anthyllis vulneraria.

Baphia pubescens. (Hook. f.).

Canavalia carthartica Thw.

C. lineata DC, Prodr.

C. maritima (Aubl) Thouars.

C. obtusifolia (Sw).

C. rosea (Sw) DC.

Dalbergia ammerimmion Benth.

D. candenatensis (Dennst) Prain.

D. ecastophyllum (L.) Benth.

D. menoides Prain.

D. Sisso Roxb.

D. spinosa Roxb.

Daviesia hakeoides. Meissn.

Derris indica (Lam) Benn.

D. scandens Benth.

D. trifoliata Lour.

D. umbelatum DC.

Erythryna herbacea L.

E. verigata L.

Halimodenbron halodendron (Pall) Vass.

Hedysarum carnosam Dest.

Indegofera argentea.

I. spinosa L.

I. uniflora Buck. Ham.

Inocarpus fagifar (Park.) Fosb.

Lathyrus littoralis (Nutt.) Endl.

L. palustris L.

Lotus Corniculatus.

L. Cytisoides L.

L. Garcini. DC. Prodr.

L. halophilus Boiss.

L. nultalianus Greene.

L. palustris Willd.

L. preslii Cen.

L. tenuis White and Kit. ex Willd.

Medicago litoralis Rodhe ex. Loisel.

M. lupulina.

M. marina L.

M. officinalis.

Meliotus officinalis.

Onnuis repens.

Ormocarpus verrucosum Beaur.

Pongamia pinnata (L.) Pierre.

P. velutina (White) Verd.

Psoralea paten Lindl.

Pterocarpus draco L.

P. indicus Willd.

P. officinalis Jacq.

P. Sontelinoides (L.)

Sesbania tomentosa H. and A.

Sophora tomentosa L.

Tephrosia purpurea (L.) Pers.

Trifolium maritimum Hudson.

T. rapens.

T. resupinatum L.

T. tomentosum L.

T. wormskioldii Lehm.

Vigna marina (Burm) Merrill.

5. Economic Importance of Halophytic Legumes.

Food - At present due to over-population, the available agricultural land is many times got acquired by housing colonies or by industries. This is going to worsen the food problem situation in developing countries. Hence the plants growing in otherwise non productive saline area and

having food value are of immense importance. Tanaka (1976) reported that the following halophytes are being utilized as the source of food or in manufacture of food products.

Acacia jacquemontii - The gum obtained from the bark is used in confectioneries.

A.leucophloea The young pods and seeds are eaten. At the time of scarcity the bark is ground and mixed with flour. Usually it is utilized as a flavouring agent for spirit brewed from sugarcane and palm juice.

Anilotica - The young tender pods are used as vegetable. The seeds are roasted and used as a flavouring agent in wines. The gum obtained from the bark when fried in ghee, is used in the preparation of certain sweet meats.

Alhagi maurorum - Sweet manna is obtained from its branches.

Canavalia lineata - It yields edible fruits.

Derris heterophylla - Young leaves are eaten raw or cooked.

Inocarpus edulis - Seeds are eaten, boiled, baked, or grated for making bread and pudding.

Intsia retusa - It is actually a poisonous plant but when the fruits are heated, shelled and soaked in water for 3-4 days,they can be used as a famine food as in E.

Malaysia.

Lathyrus palustris - It is also called as `Marsh pea´, the seeds are used as a food in Minnesota.

Medicago lupulina - Boiled herbs are eaten as a food. seeds are also edible.

Pterocarpus indicus - Young leaves and the fragrant flowers are eaten in Thailand.

Prosopis chilensis - Pods are used for making cake, bread and beverages.

P.cineraria - Pods are eaten raw or cooked. The bark powder is used for making cakes.

Tephrosia purpurea - Seeds are used as a substitute for coffee.

Vigna marina - Leaves are used as vegetable. In addition to above plants Acacia cornigera herb is also utilized as food. (Aronson, 1989) .

Forage - According to Aronson (1989) the leguminous halophytes which are utilized as forage are - Caesalpinia bonduc. Inocarpus edulis. Prosopis articulata. P.chilensis. P. strombulifera. P. tamarugo. Similarly Cynometra iripa. Geoffroea decorticans. Lotus preslii. Trifolium maritimum. plants are utilized by grazing animals. Besides the above plants many legumes like Dalbergia sissoo.

Derris trifoliata, Hedysarum carmosum, Prosopis cineraria, P. juliflora, P.nigra, P.pallida, P. reptans, P. tamarugo, P. torreyana etc. are used as fodder.

Timber plants - Many halophytic legumes are used as timber plants for different purpose. Wood of Cumingia philippinensis, Cynometra iripa, Dalbergia sisso, Intsia bijuga, I. retusa, Mora oleifera, Pongamia pinnata, P. velutina, Pterocarpus indicus, is used for construction purpose. Mora oleifera wood is specifically used for making the boats. Wood of Pterocarpus officinalis and Mora oleifera is used for carpentry work. Musical instruments are prepared by using the wood of Pterocarpus officinalis.

Many plants like Intsia bijuga, I. retusa, Acacia cyclops, A. jacquemontii, A. leucophloea, A. nilotica, A. rostellifera, Mimozyganthus carinatus, Prosopis articulata, P. chilensis, P. cineraria, P. juliflora, P. nigra, P. pallida, P. reptans, P. torreyana, P. strombulifera, P. tamarugo, P. torreyana and P. velutina, Dalbergia sisso, Geoffroea decorticans, Inocarpus fagifer, Ormocarpum verrucosum are used as fuel.

Ornamental - Following plants are used for plantation in saline habitat for decoration purpose Acacia leucophloea, Prosopis pallida, P. reptans, P. torreyana, Canavalia maritima, C. obtusifolia, C. rosea, Dalbergia ecastophyllum, D. sisso, Erythrina variegata, Lathyrus littoralis, Lotus creticus, L. cytisoides (Aronson, 1989).

Similarly Canavalia maritima, C. obtusifolia, C. rosea, Indigofera cretacea and L. cytisoides plants are used for sand stabilization.

Medicinal plants - Aronson (1989) reported only two plants Erythrina herbacea and Pterocarpus draco which have medicinal value but Kirtikar and Basu (1975) reported that the following plants are having medicinal value. Acacia leucophloea, Caesalpinia bonduc, C.crista, Cynometra ramiflora, Derris scandens, D. trifoliata, Dalbergia sisso, Erythrina varigata, E. herbacea, Pongamia pinnata, Pterocarpus indicus, Sophora tomentosa.

Other uses - Some other uses of halophytic legumes are also noticed (Wealth of India.)

Derris trifoliata - is used as a fiber plant for cordage making. This plant is also reported to have insecticidal value.

Dalbergia ecastophyllum plant is used as a fish poison. Roots of Derris scandens and D.trifoliata also yield fish poisons. Ormocarpum verrucosum is a tannin yielding plant. Erythrina herbacea yields essential oil used in cosmetics. Pongamia pinnata seeds yield oil in very large amount.

6. Physiological studies in leguminous halophytes

Very little information is available about the

physiology of leguminous halophytes. In Canavalia obtusifolia Scholander (1968) noticed that the xylem sap tension was more than -2Ø atm. He further suggested that the xylem sap formation of roots involves essentially an ultra filtration of the sea water combined with an ion transport.

Woods and Mac Donald (1971) found an interaction between temperature and osmotic stress in germination of Lotus corniculata seeds. Germination was buffered against temperature and osmotic stress at 1Ø^{o} to 25^{o}c and Ø to -4 bars.

Salt tolerance of seeds collected from three Prosopis farcata populations from Iraq has been investigated by Bazzaz (1973) who noted that interpopulation variation exists in the response of seeds to salinity stress.

Characters of disseminules of Canavalia obtusifolia were examined by Waisel (1972) and that of Pongamia pinnata and Canavalia maritima by Nakanishi (1988). He also performed the buoyancy test and germinability test of the disseminules and found appreciable potential of the pods to float on sea water.

The effect of sodium chloride on a tropical halophyte Canavalia obtusifolia in relation with the growth and distribution of sodium and potassium in the plant parts has been studied by Brum (1988). Salt tolerance of Pongamia Pinnata and Dalbergia sisso trees has been studied by Singh

et al (1991) and found that P. Pinnata and D.sisso can grow well at E.Ce. 16.3 and 8.1 d Sm^{-1} respectively and relatively low uptake of Ca due to high concentration of Na in soil.

Walsh (1974) mentioned the inorganic constituents present in the leaves of Derris uliginosa. Chemical composition of Derris heterophylla leaves was studied by Kotmire and Bhosale (1979). They have noted relatively lower Na^+ and Cl^- levels than in the other halophytes present in the vicinity of Derris. Similarly seasonal variation in the heavy metals cobalt, nickel, copper lead, iron and manganese from D. trifoliata leaves has been studied by Untawale et al (198Ø). They found that iron, copper and cobalt were in higher amounts and lead, nickel and manganese in lower amounts comparatively.

The levels of methylated onium compounds and other amino acids such as aspergine, glutamine, serine, alanine and proline from different parts of Anthills vulneriaria, Medicago sativa, M. lupulina, Meliotus officinalis, Lotus corniculatus, Onionis rapens, Trifolium rapens and Vicia sativa were analysed by Rudulier et al. (1982). They found accumulation of certain compounds for protection against saline environment in which these plants are growing. Accumulation of proline in root nodules as a possible response to stress condition is also reported by them.

Nodulation and nitrogenase activity of mangrove perennial legumes Dalbergia ecastophyllum, Drepanocarpus lunatus and Pterocarpus santalionoides from Nigeria were studied by Ogan (1990). He noted the wide variation in nodule size, number and weight between vegetation and between sites of the same vegetation. Total nodule fresh weigh ranged from 0.11 to 9.80 g/m^2, highest value being observed for Drepanocarpus. Low rates of nitrogenase activity in Dalbergia and Drepanocarpus were also noted.

7. About Caesalpinia

The genus Caesalpinia L. is named for Andreas Caesalpinia (1519 - 1603) of Arezzo, Italian who was botanist, Professor of Medicine in Pisa and Chief Physician to Pope Clement VIII. His taxonomic system was based solely on reproductive structures. The genus is one of ancient origin. Fossil plants closely resembling Caesalpinia species were found in the Tertiary period The genus is also called Poinciana in some localities.

There are about 200 species of Caesalpinia distributed throughout the tropics and subtropics, primarily in America and Asia. They are now widely dispersed and common on dry, sandy, uplands, rocky area and sea shores. Only two species of Caesalpinia are halophytic. These are Caesalpinia crista and C.bonduc .

8. About *Caesalpinia crista* L.

A. Synonyms

There is a long standing nomencleatural confusion between *C.bonduc*, *C. bonducella*, *C.crista* and *C.nuga*.

According to Hattink (1974) the synonyms for *Caesalpinia crista* are

1) *Caesalpinia nuga* (L.) Aits.
2) *Guilandina nuga* L.
3) *Ticanto nuga* (L.) Medik
4) *Genista scandens* Lour
5) *Butea loureirii* Spreng.
6) *Guilandina paniculata* (Lam.)
7) *Caesalpinia paniculata* (Lam.) Roxb.
8) *Caesalpinia laevigata* Perr.
9) *Caesalpinia scandens* Heyne.

B) Morphology

According to Hattink (1974) the morphological characters of *Caesalpinia crista* are as follows.(Fig 1a)

Liana up to 15 in all vegetative parts glabrous. *Branchlets* glossy, black, more or less armed with recurved prickles. *Stipules* wanting. *Leaves*: rachis 1Ø-3Ø cm; prickles sometimes absent,recurved, at the base of the pinnae and scattered ones in between; pinnae 2-4(-5) pairs, 21/2-8-

(12)cm, often armed. Leaflets opposite, 2-3(-5) pairs, 2-4 mm stalked; blade coriaceous, widest at the middle, index 2-2.5, 2-1Ø by 1-5cm, base acute, subequal, top acute to obtuse, sometimes accuminate or rounded, margins curved, nerves prominent, surface above shining, below dull. Racemes axillary and terminal, combined into a 2Ø-4Ø cm long panicle, short - hairy when young; bracts very early caducous, ca 1 mm long; pedicels 7-15mm jointed ca 1 mm below the top. Flower buds glabrous; receptacle oblique, ca 2 mm long, 5mm wide; Sepals : the lowest one cucullate, ca 8 by 4 mm, glabrous, the others 6-8 by 2-3 mm reflexed during anthesis, cilite. Petals spreading; standard; claw ca 5 by 2 mm, hairy, limb suborbicular, ca 5mm O, reflexed, glabrous, margins incurved; 7-9 by 4mm. Stamens; filaments ca 1Ø mm, woolly to over the middle; anther ca 1.5 by 1 mm. Pistil ca 12 mm long, hairy to glabrous; ovary ca 1 m stalked, ca 2-3 by 2 mm, ovules 1-2(-3); style ca 1Ø mm stigma somewhat wider as the style, ciliate. In fruit the pedicel as long as in the flower, receptacle shed, the remnant ca 3 mm wide; pod 2-6 mm stalked above the receptacle, when ripe somewhat swollen, indehiscent ca 1-2 times as long as wide, 4-7 by 2.5-3.5 cm base cuneate, top obtuse to acute, beaked at the upper angle or at the top. Seeds 1, rarely 2, orbicular to ovoid to reniform in outline, flat, ca 2-2.5 by 1.5-2 by 1.5-1cm, when dried black; albumen none.

C) Ecology

C. crista is common on the banks of river Fig. 1 b, on sandy beaches, in and behind mangroves (but only on the sandy part), forest margin near seaside or mangrove associate, on chalk rocks and lime stones. It is present at low altitude, rarely upto 350 m.

D) Distribution

It is distributed throughout the coastal parts of south east Asia from India to the Runkyu Is. Australia (Hattink , 1974), in Malaysia in all parts except east Sumatra, China, Java, Burma, Philippines, Polynesia, Malayisles, N. America , Bangla Desh etc.

In India C. crista has been reported from Maharashtra, Malbar, Andhra Pradesh, Orrissa, East and West Bengal. According to Blasco et al.(1975) it is extremely common on east coast of Andaman and Nicobar islands. Mall et al. (1985) also reported C. crista as non exclusive mangrove species (associated) along with other leguminous members like Derris scandens, Pongamia pinnata and Afzelia bijuga.

It is also common along the riversides along Krishna and Godawari delta, Mahanadi delta, Dharma and Gangatic delta (Indian only). Naskar (1983) reported its common occurrence as a mangrove associate along the river

slopes in Sundarban's Mangrove swamps.

In Konkan it is frequent along back water areas in salty and sandy soil, on west coast, it is located at Deogad port road, Kudal - Kochre coast, Malvan Achre creek and Kalawli creek (Kulkarni 1988). In Savantawadi at Satarada its common occurrence has been reported by Almeida (1990) In Ratnagiri it is reported to occur at Sakhartar swamps (Cook, 1969). We have also observed its occurrence along Kolambe and Bhatye creeks.

E) Economic importance.

C. crista is medicinally very important. The roots of this plants are said diuretic, they have been reported as useful in gravel and stone in the bladder and the juice of the stem has been used externally and internally in eye diseases. For the same purpose roasted fruits which have a bitter taste, are also used. The finely powdered leaves are given to women immediately after delivery as a tonic to the uterus. (Chopra and Badhwar,1940)