REVIEW OF LITERATURE
REVIEW OF LITERATURE

Extensive works on Indian medicinal plants have been done by Chopra et al. (1956); Nadkarni (1976); Kirthikar & Basu (1981). There were some studies on medicinal plants in Kerala (Aiyer et al., 1957; Aiyer & Kolammal, 1960-1966; Mooss, 1976 & 1978; Kolammal, 1979; Nambiar et al., 1986; Nesamony, 1986; Iyer & Kolammal, 1993; Warrier et al., 1996).

*Bala* enters into the composition of several Ayurvedic preparations (Nadkarni, 1976). In ancient Sanskrit medical texts under the denomination of *Panchabala*, five or more kinds of *Bala* are mentioned viz., *Bala, Nagabala, Mahabala, Atibala, Rajabala* and *Bhumibala*. In addition to such names *Balabala, Brihannagabala, Suganthabala* and *Pitabala* are also mentioned. Whether these terms are mere synonyms of one drug or different kinds of the same drug or different drugs having slightly or distinctly different medicinal properties is not clear and has to be investigated upon (Iyer & Kolammal, 1993).
In addition to the species of *Sida*, species of *Abutilon* such as *A. indicum*, *A. asiaticum* and *A. graveolens*; species of *Urena* such as *U. lobata* and *U. sinuata*; species of *Pavonia* such as *P. odorata* and *P. zeylanica* and one or two species of *Grewia* were also indicated as the botanical source of *Bala* in books on Indian Materia Medica (Iyer & Kolamma, 1993).

In the present study the selected taxa were identified based on its morphological characters with reference to standard floras, Hooker (1875); Gamble (1915): Mathew (1983); Paul & Nayar (1988). The concept of *Sida* species was held by Clement (1957), Waalkes (1966), Ugborogho (1980) and Fryxell (1985 & 1988). Paul & Nayar (1988) revised Indian Malvaceae which is now included in the revised flora of India (Paul, 1993). In their recent revision, Paul & Nayar (1988) had divided Malvaceae into five tribes – *Abutileae*, *Decaschisteae*, *Hibisceae*, *Malvaceae* and *Ureneae*. Sivarajan & Pradeep (1996) revised Malvaceae of Southern Peninsular India.

Several monographs and revisions dealing with selected genera of Malvaceae appeared during the dawn of the 20th century. Significant contribution has been made by Clement (1957). Genus *Sida* was revised by Burandt (1992). *S. cuneifolia* complex and *S. rhombifolia* complex have been analysed by Vollesen (1986) and Sivarajan & Pradeep (1994) respectively. Sivarajan et al. (1992) described the significance of mericarp morphology of the species of *Sida*.

Theophrastus introduced the generic name *Sida*. Sivarajan & Pradeep (1994) stated that genus *Sida* was a difficult group and several authors had
attempted sub generic classification of the genus. Based on the number of carpel and seeds per carpel, De Candole (1824) recognized three sections in *Sida* namely, Malvinda Medik.; Abutiloides Kunth. & Medik.; Abutilon Kunth.

The genus *Sida* has about 200 species distributed in tropical and subtropical regions of the world. *Sida* showed wide range of morphological variability (Fryxell, 1985). 18 species were known to occur in India falling under 6 sections of *Sida* Linn., viz. Sidae, Cordifoliae, Nelvagae, Spinose, Malachroideae and Stenindae (Sivarajan & Pradeep, 1996).

Fryxell (1985) in his treatment of North and Central American species of *Sida* recognized 11 sections, based on leaf anatomy, characters of calyx and mericarps. Out of the 11 sections, six are represented in India.

*S. rhombifolia* is one of the most variable and widely distributed species of the genus and has been denoted by over thirty binomials by different taxonomists (Ugborogho, 1980). Studies on the vegetative features and reproductive characters especially mericarp morphology, Sivarajan *et al.* (1992) revealed that in India at least 4 distinct species are included in the *S. rhombifolia* complex viz., *S. rhombifolia, S. alnifolia, S. scabrida* and *S. rhomboidea*.

Rao & Saibaba (1987) have studied the petal venation of some species of *Sida*. Durandt (1991) has studied the secretions of glandular trichomes of some species of *Sida*. Cytological and cytogenetical investigations have been carried
out on species of *Sida* by different research workers (Adhikary, 1963; Ugborogho 1982 a & 1982 b).

Kumar *et al.* (2001) recorded *S. unicornis* Marais. for the first time from India. Sivarajan & Pradeep (1990) have recorded a new species of Malavaceae, *S. frxellii* Sivar. et. Pradeep from Peninsular India. Pradeep and Sivarajan (1993) have recorded *S. linifolia* Cav. (Malvaceae), another record from India. Pharmacognostic studies on *S. acuta* were conducted by Mohideen *et al.* (2002). Badami *et al.* (2002) reported the pharmacognostical evaluation of *Grewia tiliarafolia* bark. Lakshmayya *et al.* (2003) revealed the phytochemical and pharmacological evaluation of leaves of *Abutilon indicum* G.Don.

2.1. Vegetation analysis

Methods for the study of vegetation by quadrats have been given by Puri (1954); Misra & Puri (1954) and for grasslands by Pandeya (1950-51). Abundance in quadrats gives an idea of the distribution pattern of the species while the density represents the number of individuals per unit area. The density and frequency taken together are of prime importance in determining community structure and have a variety of cases far beyond those of other quantitative values (Oosting, 1958).

2.2. Seed germination and reproductive capacity

Species of *Sida* are the medicinal plants of great commercial value because of their ever-increasing demands in preparation of indigenous drugs as well as for their export. Poor seed germination was recorded in many medicinal
plants namely *Glycyrrhiza glabra* (nil) (Kerishibaev, 1989); *Psoralea corilifolia* (5-7%) (Shukla, 1971); *Chlorophytum borivilianum* (11-23%), (Boardia, 1991); *Rauwolfia serpentina* (5-30%) (Gupta, 1968). In *S. rhombifolia* and *S. acuta* the rate of germination was 8 percent and 4 percent respectively at 35°C in the dark (Seal & Gupta, 1998).

Though the *S. spinosa* is medicinally important, only a little information is available pertaining to its germination characteristics (Mott, 1980 & Smith *et al.*, 1992) and cultivation practice (Chaudhary, 1976 & Dmitrashko *et al.*, 1971). A detailed study on the problem of germination is necessary for raising good numbers of uniform seedlings in nursery beds for their introduction into successful cultivation practice.

Seed coat impermeability to water is an important factor in the dormancy of seeds of *Sida* (Egley, 1976). In *S. spinosa*, the removal of the dormancy is done by various methods (Egley, 1976; Egley & Paul, 1993). In hard coated seeds of *S. spinosa* pretreatment with high temperature followed by low temperature proved to be successful for germination (Baskin & Baskin, 1984).

Seed is the reproductive unit in the taxa under study. Hence the number of seeds produced by a plant gives a rough estimation of its potentialities for increase. It also shows the amount of energy passed by a species to the next generation. Seed output in a plant is dependent upon a number of environmental factors, of which light, moisture conditions, biotic influences, diseases and physiological status are more important.
2.3. Leaf Architecture

Histological features find practical application in pharmacognostic investigations (Dutta & Mukherji, 1952). Carlquist (1961) & Van Cotthem (1970) stated that leaf epidermis is one of the few anatomical characters of systematic and phylogenetic value. Krishnamurthy & Sundaram (1967) re-emphasized the importance of foliar epidermis as a diagnostic feature of taxa.

The angiosperm leaf venation has been extensively studied by many researchers viz. Foster (1950, 1952, 1959, 1961, 1963, 1966, 1968 & 1970); Hickey (1973); Melville (1976); Hickey & Wolfe (1975). Shehgal & Paliwal (1974) classified leaves as uni–bi- and triveined on the basis of the number of strands entering the base of the petiole. Hickey (1973) classified the vein endings into simple and branched. Strain (1933) reported that vein ending types in angiosperms were highly variable and could not be used to distinguish major taxa such as families.

Leaf architecture of South American Nottofagus was studied by Andrea & Premoli (1996). Hareven et al. (1996) studied genetic manipulation of leaf architecture in Tomato. Wang et al. (2001) studied leaf architecture and epidermal characters in Zelkova coming under the family Ulmaceae and revealed that leaf venation in a genus is relatively uniform while leaf size and shape are highly variable. Characters such as epidermal cells, trichomes and stomata provide useful specific distinction. Calvillo-Canadell et al. (2002) studied the fossil leaf architecture.
2.4. Epidermal aspects

2.4.1. Stomatal Index

In India, a detailed study of stomata has been done on angiosperm families such as Magnoliaceae (Paliwal & Bhandari, 1962; Avita & Inamdar, 1981); Piperaceae (Pant & Banerji, 1965); Celasteraceae (Pant & Kidwai, 1966); Ranunculaceae (Pant & Mehra, 1963); Capparidaceae (Aleykutty & Inamdar, 1978); Lauraceae and Paeoniaceae (Avita & Inamdar, 1980 & 1981); Acanthaceae (Simon, 1993)

From the 1920s onwards pharmacognosists have successfully attempted to use the number of stomata per unit area of leaf surface as a diagnostic character for fragmentary materials (Wilkinson, 1979). Salisbury (1932) introduced the term Stomatal Index to express stomatal frequency independent of the size of the epidermal cells. Though many of the botanists criticized the reliability of stomatal frequency and Stomatal Index (Stober, 1917; Timmerman, 1927) careful observations made by Rowson (1943 a, 1943 b & 1946) re-emphasized the use of Stomatal Index in pharmacognosy. The pharmacognostic studies on *S. acuta* were done by Mohideen *et al.* (2002). Studies on the cellular morphology of the epidermis of angiosperms have provided features of taxonomic and phylogenetic importance (Stebbins & Khush, 1961). Leaf epidermal micromorphology of *Grewia* species was studied by Chung (2002).

2.4.2. Palisade ratio

The relationship between the cells of the epidermis and those of the subjacent mesophyll might be of taxonomic interest (Zorning & Weiss, 1925).
Wallis and Dewar (1933) introduced the term palisade ratio for the average number of palisade cells beneath a single cell of adaxial epidermis. Zorning & Weiss (1925) indicated that palisade ratio which remained as constant for a particular species was used as a diagnostic character. Brown (1958) & Bensen (1962) have found this character to be of diagnostic value. The palisade ratio of species of _Digitalis_ was recorded by Dewar (1933, 1934a & 1934b). Palisade ratio of species of _Atropa_, _Datura_, _Scopolia_ and _Solanum_ were established by Wallis and Forsdike (1938). Studies of George (1943); Edward & Charles (1972) have re-emphasized the pharmacognostic value of palisade ratio. Teresa (1989) has pointed out that this criterion is of taxonomic significance on the basis of her studies on eighteen species of _Polygala_ Linn. Simon (1993) revealed the significance of palisade ratio in taxonomy by studying 117 taxa coming under Acanthaceae and also emphasized that the palisade ratio varies from species to species but is constant for each taxon. Thus palisade ratio may provide a criterion to detect the adulterant.

Studies of Nambiar _et al._ (1998) on _Saraca asoca_ (Roxb.) de Wilde. and its adulterant _Polyalthia longifolia_ pointed out that palisade ratio and other microscopical characters help to detect the correct raw drug from the adulterant. Mohideen _et al._ (2002) studied the palisade ratio of _Sida acuta_ and revealed its significance in pharmacognosy. Scanning Electron Microscope studies of pollen grains of Malvales revealed that the differences of pollen grains can be used to detect a particular taxa (Lakshmi, 2003).
2.5. Medicobotanical aspects of the taxa investigated

*Sida* is a wonderful magic herb used for many diseases. In Ayurveda, the drug *Bala* is derived from *S. cordifolia*. (Nadkarni, 1976; Kirthikar & Basu, 1981). Traditionally in Kerala *S. retusa* is used for medicinal purpose (Iyer & Kolammal, 1993). *Bala* along with other ingredients is used to cure rheumatism.

In addition to the species of *Sida*, species of *Abutilon* such as *A. indicum* Linn., *A. asiaticum* Linn., *A. graveolens* Roxb.; species of *Urena* Linn. such as *U. lobata* Linn., *U. sinuata* Linn.; *Pavonia odorata* Willd.; *P. zeylanica* Linn. and one or two species of *Grewia* Linn. are also indicated as the botanical source of *Bala* in books on Indian Materia Medica (Iyer & Kolammal, 1993). Chopra *et al.* (1958) included varieties of *Sida rhombifolia* such as *S. microphylla* Cav., *S. obovata* Wall., *S. retusa* Linn., *S. rhomboidea* Roxb. and *S. scabrida* W & H. as the botanical sources of *Bala*. *Sida spinosa* Linn. is equated to *Nagabala* (Kirthikar & Basu, 1981: Chopra *et al.*, 1956). *S. cordifolia, S. acuta, S. retusa, S. rhombifolia*, and *S. spinosa* are equated as *Bala* (Khory & Khatrak, 1980). Five varieties *Bala, Mahabala, Nagabala, Atibala*, and *Rajabala* are mentioned in the Ayurvedic texts. *S. veronicaefolia* as *Bhumibala, Urena lobata* and *Urena sinuata* are occasionally used as *Atibala* in some parts of Kerala (Iyer & Kolammal, 1993).

According to Shastri (1968) *Bala* is one of the ingredients of famous Ayurvedic formulations such as *Aravinda Asava*, *Bala Arishta*, *Kumary Asava*, *Amrita Prasha Ghrita* (Sahasrayoga), *Agastya Rasayana* (Charakasamhita), *Chavana Prasha Lehya* (Charakasamhita). Bhavaprakasa
revealed that the four varieties (Bala, Nagabala, Athibala and Mahabala) are cool, sweet, and produce strength and beauty. Powder of Bala root bark with milk and sugar stop polyuria. Properties mentioned by Dhanvantari nighantu and Raja nighantu prove that bala promotes sexual vigour. Mahabala cures heart diseases, Vata type of piles, oedema and irregular fevers (Aiyer & Kolammal, 1962). Nagabala is sweet, sour, astringent and hot, heavy, pungent and bitter. It cures skin disease such as leprosy (Aiyer & Kolammal, 1962). This drug has been equated with S. spinosa (Kirthikar & Basu, 1981; Nadkarni, 1976).

**Atibala** with milk and sugar cures urinary diseases with increased flow of urine in the case of diabetes mellitus. It destroys worms, burning sensation, thirst, poison, vomiting, and cures cough (Chunekar, 1982). This is equated variously with Abutilon indicum (Nadkarni, 1976; Kirthikar & Basu, 1981; Chunekar, 1982) and Urena lobata (Aiyer & Kolammal, 1962), all belonging to the family Malvaceae.

**Sida rhombifolia**

The root and leaves are sweetish and aphrodisiac. They remove 'tridosha' and are good in urinary complaints. They are also useful in fever, heart disease, burning sensation, piles and all kinds of inflammation (Ayurveda). The plant in combination with other drugs is prescribed as an antidote to snake venom (Charaka). In Lakhimpur (Assam) the roots are taken internally to help childbirth and the herb is also tied round the abdomen for the same purpose. In Europe the plant has been regarded as available remedy in pulmonary tuberculosis and rheumatism. In Madagascar the plant is mostly used an emollient. An infusion of
the root is given as a cure for dysentery; the leaves are pounded and applied to tumors or chewed and applied to boils (Kirthikar & Basu, 1981). Seeds are used to cure gonorrhoea (Nadkarni, 1976).

*Sida retusa*

The roots are used for treatment of rheumatism. Chemists used mucilage of the plant in oxidizing mercury and also in scorpion sting (Nadkarni, 1976; Kirthikar & Basu, 1981)

*Sida acuta*

Roots are sour and sweet, removes *tridosha*, useful in fever, burning of the body and urinary discharges (Ayurveda). The root is regarded as cooling, astringent tonic, useful in nervous and urinary diseases. It is also used in disorders of the blood and bile. The plant in combination with other drugs is recommended for the treatment of snake bite and scorpion sting (Kirthikar & Basu, 1981). Root of this plant is made into a smooth paste with sparrow's dung and water and applied for bursting of boils and abscesses. Leaves warmed and moistened with a little gingelly oil and applied to abscesses hasten suppuration. The drug is used as diuretic in rheumatic affections and as a demulcent in gonorrhoea and chronic dysentery (Nadkarni, 1976).

*Sida cordifolia*

The plant is slightly bitter and sweet, tonic, astringent, emollient, aphrodisiac, removes *Vata* and *Pitta*, used to cure cough. The bark cures urinary troubles and discharges. The fruit is acrid and sweet, digestive, cooling, useful in
blood diseases, bleeding piles, diseases of the throat, and insanity (Kirthikar & Basu, 1981).

A decoction of the root with ginger is given as a remedy for intermittent fever. The powder of the root bark is given with milk and sugar for the relief of frequent micturition and leucorrhoea. In diseases of the nervous system the root is used alone or in combination with other medicines. The bark of the root with sesame oil and milk is used in curing facial paralysis and sciatica when caused by the inflammation of the nerves (Nadkarni, 1976; Kirthikar & Basu, 1981). One of the ingredients of Parkino is S. cordifolia which is used to cure Parkinson’s disease (Singh & Newton, 2002).

*Sida veronicaefolia*

The flowers and unripe fruits are given together with sugar for burning sensation in micturition (Kirthikar & Basu, 1981). The roots sweet, sour, astringent, bitter, acrid and are useful in fever, uropathy and arthritis. The bark of the root is used to cure leucorrhoea, gonorrhoea and hyperdiuresis. The leaves are good for curing diarrhoea. The flowers and ripe fruits are refrigerant and are useful in relieving burning sensation, hyperdiuresis, pectoral lesions, and promoting strength (Warrier, et al., 1996).

*Abutilon indicum*

It is efficacious in the treatment of leucoderma. Infusion of the leaves and root is used as a cooling agent in fevers. Decoction of the leaves is good as mouthwash in cases of tender gums (Chopra et al., 1958). The flowers and leaves
are applied to boils and ulcers. The bark and root are good diuretics (Trivedi, 1999). *Siddha* physicians use leaves as a food in piles. Decoction of seeds is used in piles and coughs. They are distinctly useful in gonorrhoea, and chronic cystitis. Seeds finely powdered can be given as laxative and expectorant (Chopra et al., 1958). Seeds are burnt on charcoal and recta of children affected with thread-worm are exposed to the smoke. Infusion of root is used to cure leprosy (Nadkarni, 1976).

**Urena lobata**

Root is used as an external application for lumbago and rheumatism (Nadkarni, 1976). In Chota Nagpur the root is employed as an external remedy for rheumatism. In La Reunion the leaves and roots are made into poultices and used as an emollient. The flowers are used as an expectorant in dry and inveterate coughs. In Guiana an infusion of the flowers is used as a gargle for sore throat (Kirthikar & Basu, 1981).

**Urena sinuata**

Root is applied for lumbago (Nadkarni, 1976). In the Philippines the root is considered as emollient. The leaves are prescribed in inflammation of the intestines and the bladder. The plant is considered as emollient in Brazil and a decoction is given in colic. Infusion of the flowers is used to treat bronchitis (Kirthikar & Basu, 1981).
**Triumfetta rhomboidea**

Fruit, flowers and leaves are used in medicine. Bark and fresh leaves are used for diarrhoea. Flowers rubbed with sugar and water are given in gonorrhoea to stop the burning caused by urine (Nadkarni, 1976).

**Grewia microcos**

The plant is used for indigestion, typhoid fever, dysentery, syphilitic ulceration of the mouth, in small-pox, eczema and itches (Chopra et al. 1958; Nadkarni, 1976).
Plate 1. Field view of five species of *Sida*
A. Grewia microcos

B. Urena simuata

C. Urena lobata

D. Triumfetta rhomboidea

Plate 2. Field view of taxa investigated