Introduction
"Any system, however complex its structure, can and must be subject of scientific investigation."

Konrad Lorenz

The family Compositae is a remarkable example for "variations on a theme" and its homogeneity in having basic type of inflorescence, flower and fruit (Wagenitz, 1976). While stressing the research opportunities which Asteraceae offer, Carlquist (1976) remarked "Those frightened by research in such a large family of plants should take note of the fact that studies on particular groups of Asteraceae are an integral part of our understanding of evolution of flowering plants..... within the baffling complexity of Asteraceae, still lie the rewards of phylesis". In his pioneer study of the pollen peculiarities of tribe Vernonieae, Wodehouse (1928a) observed, ".....Simplicity of form is not a universal rule among pollen grains. In some groups the pollen-grain pattern is sufficiently complex to permit as wide a play of expression that closely related species can easily be distinguished from each other. Such a group is the genus Vernonia". It is assumed

that the evolution of complex things is an intricate process and
great complexity results from simplicity (Wright, 1985).

Asteraceae is generally acclaimed to be one of the few well-known
families among the Dicotyledons, when viewed from several stand-
points. While scanning through the voluminous literature on this
large family, one derives the impression, many a time that it has
been a veritable repository providing ample materials and scope
thereof, for the specialists of different botanical disciplines.
Nevertheless it still seems to be replete with materials for many
to work upon along different lines for years to come. Many
specialists such as taxonomists, biosystematists, chemotaxonomists,
cytologists, cytogeneticists, anatomists, synantherologists etc.
have been actively playing their investigatory role in the fertile
court of Compositae thereby achieving fruitful results. This family
unlike other families has been attracting the attention of a cohort
of large number of specialists because of its certain unique features
in general and floral evolution and organisation in particular.
These generalisations are vouchsafed by substantial subscriptions
made by the stalwarts of the symposium on Compositae (cf. Taxon
34; 1985 and the literature cited therein).

In such a large family consisting of 900 genera and 13-15000
species, 5 genera and 45 species representing the South Indian
Vernonieae, distinguished by its homogeneous purple-flowered capitula, have been selected with a view to study its palynology for which no complete or satisfactory information is available and to understand the putative value of types of crystals occurring in anthers and achenes, the vestiture of corolla, and achenial trichomes, carpopodium and pappus. Employing such histological data thus obtained on a comparative basis, an attempt is made to draw the taxonomic inter-relationship.

It is obvious that the majority of the available palynological work is based mostly on the LM observations. The results of which clearly indicate that the pollen grains exemplify unique model of their own by manifesting certain structural complexities. In addition to what little is available on the palynological aspects, particularly of the South Indian Vernonieae many ultrastructural details of nexine, apertural intine and complexities of aperture and exine are also brought to light.

PALYNOTOLOGY

a) Compositae: The utility of pollen morphology in respect of characterization of taxa above and at the rank of order and in delimitation of certain families, genera and species has been briefly discussed by Erdtman (1969). Thanikaimoni (1978 & 1980) has listed out all the available references dealing with Compositae
Carlquist (1976) and Wagenitz (1976) have discussed in detail the palynotaxonomic significance of Compositae. Tribal groupings on the basis of pollen morphology was attempted by Wagenitz (1976), Skvarla et al. (1978) on the basis of TEM observations have recognized Helianthoid, Senecioid, Arctotoid and Anthemoid representing four types. According to their findings these types have been found to be restricted to a given tribe although more than one type was also observed within a tribe.

Many works earlier to Skvarla et al. (1978) based on LM observations have shown the taxonomic value of pollen morphology at different levels of Compositae. To cite a few examples: The specific determination of Barnadesia (Mutisieae) with the aid of morphology of their lophate pollen was attempted by Wodehouse (1928b). The tribe Anthemideae has received the attention of Wodehouse (1935) who concluded that the spine-length, number and arrangement and size were constant for a given species. The very natural genus Stevia of Eupatorieae has been found to be palynologically heterogeneous (King & Robinson, 1987). Over 800 taxa of the tribe Inuleae were palynologically investigated with LM (Liens, 1968, 1971 & Besold, 1971) and their pollen characters in conjunction with other characters such as chromosome number and stylar morphology were utilized to comprehend the tribal groupings. Liens (1971) has
established three subtribes namely Inulinae, Gnaphalinae and Athrixiinae.

b) **Vernonieae**: The preliminary work of the pollen of this family was initiated by Fischer (1899) who worked on *V. anthelmintica*. Wodehouse (1928a) in his work included 61 species of the tribe Vernonieae (*Vernonia*-57; *Pacournia*-1; *Stockesia*-1; *Struchium*-1; and *Lychnophora*-1) and concluded that the pollen grains had attained the structural variations and complexity and such complicated patterns in American Vernonieae seemed to follow the genetic lines proposed by Gleason (1906). Wodehouse (1935) while evaluating the lophate character as of high phylogenetic value, has attempted to differentiate the lophate pollen of Vernonieae from those of Cichorieae and further emphasized the mechanics and harmomegathic adaptations of *Vernonia* pollen. Stix (1960) has recognized three pollen types within the Vernonieae namely *Vernonia*, *Lychnophora* and *Elephantopus* which were often adopted by subsequent workers. LM observations of South African species of *Vernonia* by Smith (1969) although inadequate, were shown to be of taxonomic value. In phylogenetic and taxonomic discussion on Compositae, Skvarla & Turner (1966) and Jones (1971) have briefly mentioned about the variations in the pollen morphology of the Vernonieae. The study of Keeley and Jones (1977) covering the 39 species of *Vernonia* in West Indies
has shown that the three types of pollen recognized by them help in the confirmation of subsections of the genus. Skvarla et al. (1978) have provided some information on the pollen ultrastructure of New World Vernonieae: SEM - Elephantopus (1 sp.); Vernonia (3 spp.) and TEM - Harleya (1 sp.) and Vernonia (2 spp.). Kingham (1976) recognized six pollen types based on the examination of surface features of 85 species belonging to 22 genera of mostly African Vernonieae. Bolick (1978a) has made electron microscope study of 38 genera of Vernonieae excluding the palnologically most interesting genus Vernonia and recognized eight types based on four characters only, such as absence or presence of microspores, colpi, complete tectal cover and echinae. Out of these 38 genera only one South Indian taxon Lamprashaenium microcephalum Benth. has been included. The recent palynotaxonomical classification of Old World Vernonia by Jones (1981) which includes only 12 South Indian species, is critically analysed in this work under Discussion.

MICROCHARACTERS: Experience on comparative morphological studies on other families has shown that diverse kinds of microcharacters when prudently employed in combination with macromorphological characters have helped establishing inter-relationships among the taxa concerned, solving problems in taxonomy and drawing phylo-
genetic conclusions (Bailey & Nast, 1945; Heintzelman & Howard, 1948; Dormer, 1961; Govindarajalu, 1962 a & b; Ayensu, 1970; Stern et al., 1970 and Stace, 1970). King and Robinson (1970), the champions of new synantherology have advocated the usefulness of characters pertaining to the morphology of the style base and carpopodium, surface structure of corolla lobes, cellular structures of the style branches, anther appendages and collar and endothecium.

a) **Pappus** : The scales, hairs, setae, spines, bristles borne on the achenes around the base of the corolla of Compositae have been collectively described as pappus. The characters of pappus are being used in all taxonomic works. These structures aiding seed dispersal are regarded as equivalent to sepals or modified calyx or trichomes and they invariably lack vasculature (Manilal, 1966). The macromorphological nature of the pappus has been dealt with in detail by Manilal (l.c.) but the present work reveals certain of its histological aspects.

b) **Carpopodium** : The abscission zone between the receptacle on the one hand and the achene on the other is called "carpopodium" (Mattfield, 1923) which was known earlier as "callus" and "podocarp" (Robinson, 1913) and recently named as "separation tissue" (Roth, 1977). The importance of this zone which has not been understood
so far from its functional and taxonomic standpoint, has been well-discussed by Haque and Godward (1984). In this respect Haque and Godward (l.c.) have recorded the occurrence of carpopodium for the first time in 40 species of Compositae, out of which only two species of Vernonia (V. glabra Vatke; V. altissima Nutt.) belonging to Vernonieae have been described. On the other hand, in the present study which involves 41 out of 45 species of South Indian Vernonieae shows clearly the presence of carpopodium under the light microscope. It is not developed in four taxa only (Adenoon indicum, Lamprachaenium microcephalum, Vernonia comarinensis and V. salvifolia) and not known in the remaining 4 taxa (V. pulneyensis, V. meeboldii, V. setigera and V. recurva) for which materials were not available. Three out of four taxa which lack carpopodia and eight species out of 33 species of Vernonia possessing carpopodia have been examined with the help of SEM and the results thereof seem to be not only interesting but show differences among them.

c) Corolla vasculature: The information on the corolla vasculature of Compositae is meagre and fragmentary. Small (1917a) has studied the vascular anatomy of the flowers in certain species of Compositae. Koch (1930, a, b) worked mainly on the venation of corolla and explained the presence of marginal veins and the
absence of mid-veins from the lobes of the corolla on the basis of the fusion of the adjacent marginal bundles of the adjoining petals. Manilal (1966, 1971) has made elaborate studies in the floral anatomy of several members of this family. In 1976, Carlquist has explained the absence of a mid-vein in the corolla lobes of most of the Asteraceae from the functional standpoint. In the present work, a cursory attempt has been made with regard to the vasculature of corolla of the South Indian Vernonieae.

d) Trichomes: Carlquist (1961, 1976) has reported the occurrence of two basic types of trichomes namely uniseriate non-glandular and biseriate glandular types and their respective variation and elaboration to a considerable extent in all the tribes. Ramayya (1962 a, b) has studied the vegetative and floral trichomes in respect of their structure, development, pattern of distribution and their variations. As a result of this extensive study, he was able to recognize 35 types of trichome out of which 13 were reported to be new. Roth (1977) has reported the frequent and very characteristic occurrence of twin hairs on the pericarps of most of the Compositae. Faust and Jones (1973) have studied the foliar trichomes in North American species of Vernonioa. Narayana (1979) has made observations on the trichomes of different organs of 21 species of South Indian Vernonieae. The leaf trichomes of
Centratherum and Phyllocephalum have been studied by Kirkman (1981). Metcalfe and Chalk (1950) have mentioned the universal occurrence of two-armed hairs with uniseriate stalk and unicellular head in the Vernonieae and shaggy and glandular hairs in Vernonia.

In the present work, the trichomes of involucral bracts, corolla, anther, stigma and fruits have been studied uniformly in all the South Indian Vernonieae unlike the method followed by earlier workers. Furthermore the achenial trichomes of 12 species have been studied under SEM for the first time.

e) Crystals: The crystals are supposed to be rare for the family as a whole. However, raphides, styloids (acicular) crystals, prismatic crystals and clustered crystals have been reported in a few taxa (cf. Metcalfe & Chalk, 1950). Carlquist (1966) has reported the occurrence of prismatic crystals in a few Compositae. The pericarpic walls of only two taxa are said to contain calcium oxalate crystals (Roth, 1977), Dormer (1961), Nordenstam and El-Ghazaly (1977) and Nordenstam (1978) have reported not only the presence of crystals in the ovary wall but emphasized their importance in taxonomic studies. But in the subsequent work El-Ghazaly (1979) has failed to appreciate any taxonomic applications of the crystals in Hypochoeris. As far as the South Indian Vernonieae is concerned, the
stamens and the pericarpic walls, which have been examined from this standpoint, yield interesting information and suggest their value in taxonomic considerations.

SYSTEMATICS OF THE INDIAN VERNONIEAE: Bentham (1873) has recognized 13 tribes for the whole of Compositae and under the tribe Vernonieae, Euvernonieae, Lychnophoreae as two subtribes the former containing 29 genera and the latter 11 genera. Clarke (1875) has also maintained the same number of tribes and subtribes. The total number of Indian genera included under Vernonieae is six and out of which Ethulia does not belong to South India. In Euvernonieae 5 genera (Ethulia, Centratherum, Lamprachaenium, Adenoon and Vernonia) and in Lychnophoreae only one genus Elephantopus had been accommodated. All the genera in Euvernonieae are distinguished by their fruit characters and pappus while the single genus in Lychnophoreae by the characters of corolla and pappus. All the subsequent workers have accepted this system of classification of Vernonieae (Gamble, 1921; Koster, 1935). The reasons for adopting this system in the present work, disregarding the nomenclatural changes proposed by Kirkman (1981) and a few others in respect of Centratherum and Vernonia are discussed in this work (see Discussion).

De Candolle (1836) divided the 300 species of the genus Vernonia
into 9 sections. Bentham (l.c.) recognized 16 sections in *Vernonia*. but Hooker (1882) disfavoured his sectional divisions and underscored their impracticability because of the vagueness of the characters used in the classification. Bentham (1973) nevertheless pointed out the existence of wide intergradation of the diagnostic features, characterizing many of the genera of Vernonieae. The remark of Ekman (1914) saying that the delimitation of all taxonomic units in *Vernonia* was extremely difficult, lends support to the contention of Hooker (l.c.). However, Koster (1935) upon recognizing the unmistakable relationship in certain groups of the species of *Vernonia*, has preferred to maintain the sections of *Vernonia*.

It is interesting to note here that it has become possible to arrange 41 taxa of the South Indian Vernonieae which are treated by Clarke (1876) in Compositae Indicae under 9 pollen types. Clarke (l.c.) organized the Indian *Vernonia* under 9 out of 16 sections, following Bentham. It may be observed that out of 9 pollen types recognized in this work, six types of pollen occur in the 7 sections of *Vernonia* of series Euvernioniaceae and none of these types are found Adenoon (series Ethulieae of subtribe Euvernioniaceae) nor in Elephantopus (subtribe Lychnophoreae).

Jones (1981) redefined the subgenus Orbivestus of Old World
Vernonia on the basis of his pollen typication and other characters into 4 sections namely Orbivestus, Stengelia, Tephrodes and Azurea. The section Orbivestus is further divided into nine and Tephrodes into five subsections. The reasons for disagreeing with his classification in terms of palynological findings are dealt with under discussion.

The disagreement with nomenclatural changes proposed for all the species of Centratherum Cass., Vernonia monosis Cl. and Vernonia anthelmintica Willd. is considered under discussion.

SCOPE OF THE STUDY: The South Indian Vernonieae consisting of 5 genera and 41 out of 45 species have been critically studied primarily from the standpoint of palynology for which no complete and satisfactory information is available. Besides this certain histological aspects of florets, achenes, pappus, carpododium, corolla vasculature, trichomes and crystals have also been studied in order to find out the correlations if any, between palynological data on one hand and the latter on the other and also the availability of characters of diagnostic value and for taxonomic considerations. As far as the South Indian Vernonieae is concerned, the utilization of Scanning (SEM) and Transmission Electron micro-
scope (TEM) has been attempted for the first time. An attempt is made here correlate the pollen characters of the South Indian Vernonieae with the major systems of classification (Bentham, 1973; Clarke, 1876; Hooker, 1882; Jones, 1981).