The present endeavour entitled "Systematic studies of Amaranthaceae in southern peninsular India" deals with the study of external morphology, leaf architecture, foliar anatomy, karyomorphology, palynology, seed morphology, phytochemistry and taximetrics embracing in all, forty three taxa belonging to 16 genera spread over 3 tribes viz., Celosieae, Amarantheae and Gomphreneae. As the previous work on the each discipline, study of the Amaranthaceae is very much limited and confined to a few species while the present work has been carried out incorporating data from Light Microscopy (LM) and Scanning Electron Microscopy (SEM).

1. External morphology

This family comprises annual or perennial, erect, rambling or rarely scandent herbs and shrubs. Leaves opposite or alternate, estipulate, simple, entire or obscurely dentate - serrate. Inflorescence of axillary or terminal heads, spikes or clustered flowers; bracts subtending one or more flowers; bracteoles 2. Flowers bisexual or unisexual, rarely polygamous. Perianth calycine, 3-5 segmented, free obscurely connate at base, usually lanate, scarious throughout or only on margin. Stamens as many as and opposite perianth lobes, sometimes fewer, often alternating with pseudo-staminodes, anthers dorsifixed 1-2 celled. Ovary superior, 1-locular, ovules 1-5, erect or pendulous on basal placenta; style short or long, simple or forking into 2-4 stigmas. Fruit a utricle, indehiscent, circumscissile or dehiscing irregularly.

2. Leaf architecture

Leaf architecture which includes not only the venation patterns but also the gross morphological features, has been studied in all the forty three taxa. The leaves are simple, the lamina is always symmetrical and with entire margin. The shape is ovate lanceolate, ovate narrow, obovate narrow or obovate wide. The base and apex are acute in majority of taxa. The texture is mostly herbaceous.

The venation is pinnate semicraspedodromous or reticulodromous, primary vein course is straight or curved. Quantitative parameters like the number of secondary veins, areoles and vein endings per unit area have also been analysed and presented (Table 3).
3. Foliar anatomy

Under this three main epidermal components have been analysed viz. the epidermal cell, stomatal and trichome complexes. Of these, the trichome complex have been investigated on the vegetative as well as floral parts due to their structural diversity and taxonomic importance whereas the epidermal and stomatal complexes have been studied only on the vegetative parts.

a. Epidermal cell complex

Under this the epidermal cell shape, sides, contents, surface, orientation, arrangement and frequency has been presented. The sides of the anticlinal walls were mostly sinuous on leaf abaxial, where as wavy, curved or straight adaxially. However, certain taxa with prostrate habit showed almost similar wall nature on both the surfaces. The epidermal cells are mostly polygonal on the leaf lamina while linear to polygonal on the axiate parts. Based on the orientation and dispersion of different types of epidermal cells on the petiole, six distributional patterns are recognised. On the other hand, their distribution on the stem is uniform in all the taxa investigated.

b. Stomatal complex

The structure and distribution of stomata on all the vegetative parts is studied whereas the development is confined to the leaves. Stomatal frequencies and indices have been determined for the leaves.

In all, six stomatal types are recognised in the Amaranthaceae viz., anomocytic, anisocytic, diacytic, paracytic, hemiparacytic and brachyparacytic, the last two types being in very low frequencies.

Majority of the species presently investigated possess amphistomatic leaves whereas hypostomatic condition is restricted to only three taxa. The petiole is mostly stomatic except for three species whereas the stem is stomatic in all the 43 taxa investigated.

Stomatal ontogeny has been investigated in all 43 taxa belonging to all the three tribes. Ontogenetically, stomata are either mesogenous or mesopeRigenous. In the former, stomata always develop through dolabrate pattern whereas in the latter unilabrate as well as dolabrate patterns are witnessed.
c. Trichome complex

The study of trichomes includes structure and distribution. In all, 17 trichome types are recognised and they belong to four trichome categories. Of these, two belong to the unicellular trichome, six to the uniseriate filiform trichome, eight to the uniseriate macroform trichome and only one to the multiseriate trichome category.

As far as the taxonomic distribution of trichome categories is concerned, the tribe Amarantheae shows all the four trichome categories whereas only two categories each viz., either unicellular and uniseriate filiform categories in the Celosieae or uniseriate filiform and uniseriate macroform trichome categories in the Gomphreneae are witnessed. Thus the three tribes of the Amaranthaceae presently investigated show diagnostic distribution of trichome categories.

The following taxa can be identified on the exclusive presence of trichome types as shown below.

- *Iresine* - Uniseriate filiform ellipsoidal hair
- *Pupalia* - Uniseriate macroform osteolate multifluked hair
- *Nathosaerva* - Uniseriate macroform osteolate cylindrical hair.
- *Achyranthes* - Uniseriate macroform osteolate conical hair and uniseriate filiform cylindric - clavate hair.

4. Karyomorphology

A survey of all these works on the reports of chromosome numbers of this family revealed that these are not adequate and there are discrepancies existing between the findings of different workers. The overall cytological picture in the family Amaranthaceae reveals wide array of basic chromosome numbers $n = 6, 7, 8, 9, 10, 13, 16, 17, 18, 21, 22$ in different genera of the family Amaranthaceae.

In this family Amaranthaceae, while certain small group of genera included under the tribe Celosieae are characterised by a single basic chromosome number, members of Amarantheae and Gomphreneae are found to have heterogenous numbers. During the present study it could be seen
that the chromOsome size in the genus *Amaranthus* in general is smaller than other members of the family.

5. Palynology

Pollograin have been observed with the help of LM and SEM. Pollograin in this family Amaranthaceae are always pantoporate (forate, periporate) except the aberrant grains which may occasionally be devoid of pores or have one to five pores. The pores are generally circular to oval, usually well defined with the pore membranes psillate, granulate or baculariate. In shape the grains are usually spheroidal but the other forms, viz., oblate spheroidal, prolate spheroidal, etc., are not of uncommon occurrence due to the frequent cytological disturbances in the plants belonging to this family.

Four pollen types were distinguished within Erdtman's *Amaranthus* type.

1. *Amaranthus* type 
2. *Achyranthes* type 
3. *Cyathula* type and  
4. *Celosia* type

6. Seed Morphology:

The seed morphology has been studied with the help of LM. The exomorphic characteristics like seed shape, colour, surface texture and position of hilum have been presented along with quantitative data. The seed shape ranges from oblong, reniform to orbicular. The surface texture is mostly smooth and the hilum median or submedian.

7. Phytochemical studies:

The distribution pattern of the 25 secondary metabolites classified under 6 categories viz., alkaloids, flavonoids, quinones, tannins, terpenoids and miscellaneous compounds have been tested by standard procedures in all 43 taxa.

The free amino acids of the leaf and the phenolic compounds of the aerial vegetative parts have been analysed and presented.
The amino acids have been studied in all the 43 taxa using unidirectional ascending paper chromatography. A total of 28 free amino acids have been observed and identified with the help of standards. The specific presence of certain phenolic compounds has been made use of in the identification of some taxa.

The phenolic compounds have been studied in all the 43 taxa using bidirectional ascending paper chromatography. A total of 25 compounds have been observed and identified with the help of standards. The specific presence of certain phenolic compounds has been made use of in the identification of some taxa.

The chemical data delineate 3 distinct groups in this family. They are tribe I Celosieae without flavonols/-ones and glycoflavones, tribe II Amarantheae with flavonols and tribe III Gomphreneae with flavonols, flavones and glycoflavones. This is in accordance with the existing classification proposed by Bentham and Hooker 1862.

8. Taximetrics:

The relationships among 43 taxa studied have been evaluated by numerical analysis. For this purpose, a total of 185 attributes (25 from external morphology, 14 from leaf architecture, 48 from foliar anatomy, one from karyomorphology, 7 from palynology, 6 from seed morphology and 83 from phytochemical studies) have been selected. The percentage of similarity of all the taxa in relation to every other have been calculated and represented diagrammatically in a similarity matrix for ready reference. The polygonal representations were constructed based on similarity matrix for each tribe and for all 43 taxa. The maximum similarity (97%) have been observed between Allmania longipedunculata and A. nodiflora var. nodiflora, Iresine herbstii and I. lendeni. The minimum similarity (55%) is between Amaranthus hybridus ssp. cruentus and Trichurus monsoniae.

The above observations derive the following conclusions.

1. It demonstrates that the three existing tribes are well defined and markedly differ from each other.
2. The tribe Celosieae shows distinct characters of its own and its elevation to a new sub family-Celosoideae is supported.
3. Recognition of two subtribes i.e., Achyrantheneae and Amarantheneae in the Amarantheae is justified.
4. Allmania differs from other members of Amarantheae
5. Iresine appears a typical from the other members of Gomphreneae.