

SUMMARY

Chapter 1: INTRODUCTION

Asteraceae is the largest family in Dicots represented by more than 1300 genera and 33,000 species. Family is highly evolved and is economically important as crop, ornamental and medicinal plants.

The important morphological characters which can be used for characterization and classification of Asteraceae are habit, branching, leaves, capitulescence, capitulum, receptacle, phyllaries, florets, anthers, style, cypsela and pappus.

The study area for current research comprises of five district of south Gujarat which are Surat, Tapi, Navsari, Dang and Valsad. Surat District's total area is 4,418 km². Total area of Tapi district is 3139 km². Navsari is an administrative district with its headquarters at Navsari city with area 2,211 km². Dang is a district with the administrative headquarters of the district are located in Ahwa. Dang has an area of 1,764 km². Valsad district covers 3008 km².

Study area comprises of various landscapes like forest, lakes, rivers, grasslands agricultural field, coastal regions etc. There are two protected areas i.e. Vasda National Park and Purna Wildlife Sanctuary.

South Gujarat is an important zone from the perspective of the Western Ghats and it comprises many different types of landscapes and habitat which give possibility to find new plants which may have not been reported or properly identified in earlier works. hence it has been worked out in current study.

Chapter 2: STUDY AREA AND SURVEY

Asteraceae was first described by Giseke (1792) as Compositae owing to the presence of composite heads. However, the first proper classification of the family at tribe level was given by Cassini (1814-1819). Later on, the other detailed works were given by Bentham (1876), Cronquist (1985), Bremer (1987), Funk *et al.* (2009) etc. The current classification comprises of 12 sub-families and 43 tribes (Funk *et al.*, 2009).

At national level, Asteraceae is represented by 167 genera and nearly 900 species under 12 tribes of Asteraceae family (Hajra *et al.*, 1995). The first monographic work was published by Clarke (1876) in *Compositae Indicae*. Later on, Hooker (1883) gave detail accounts on Asteraceae in Flora of British India in which he has included 127 genera and 607 species in 13 tribes. Some of the major work on Asteraceae by Botanical Survey of India at national level are Hajra *et al.* (1995) and Mao & Dash (2020). The revisionary works at tribes and genus level has been carried out by Bhattacharjee *et al.* (2019), Kasana *et al.* (2021), Shinde & Singh (2014), Kumar & Singh (2001), Bhellum & Magotra (2013), Mamgain (1998), Shekhar *et al.* (2013), Mukherjee (2002), Dakshini (1978) etc.

At regional level Asteraceae has not been studied in details. It was restricted to only to floras like Shah (1978), GEC (1996) and Raghvan *et al.* (1981) with many unresolved species and name. Thus, monographic work will give insight into the present status of Asteraceae in Gujarat.

In South Gujarat, the major works are included in floristic works like Suryanarayan (1968), Yadav (1979), Tadvi (2013). Patel (1971), More (1972), Desai (1976), Contractor (1986), Mac (1982), Reddy (1987).

Chapter 3: METHODOLOGY

Field survey was carried out and the habitat of Asteraceae members were studied. Comparative analysis of diversity in different districts and habitats has been done. Specimens were collected, dried, poisoned and mounted on herbarium sheets. The voucher specimens were deposited to BARO Herbarium.

The specimen was brought to the laboratory and the morphology was studied in detailed. The morphological characters like habit, stem, leaf, capitulescence, capitulum, involucre, florets, anthers, styles and pappus were studied in detail.

Pollens of Asteraceae were collected from specimen and stored in Glacial Acetic Acid which was followed by Erdatmann's Acetolysis method. Acetolysed pollen were mounted on slide in Glycerine Jelly and pollens were studied in light microscope and confocal microscope. 27 types of pollen were segregated on the basis of qualitative data. Quantitative data collected was put to statistical analysis like Kruskal Wallis test for variable analysis.

Morphological and Palynological data were collected and analysed by Maximum Parsimony method in PAUP* software. The outgroup is *Scavola taccada* because it belongs to Goodeniaceae which is the sister family of Asteraceae. Cladogram was compared with supertree of Asteraceae family prepared by Funk et al (2005).

Chapter 4: OBSERVATION AND DISCUSSION

Total of 70 species belonging to 51 genera and 11 tribes were collected from South Gujarat. Additionally, the study shows the doubtful existence of *Blumea lacera*, *Centratherum phyllonaeum*, *Erigeron asteroides*, *Flaveria trinervia*, *Gnaphalium luteo-album*, *Acmella calva* and *Tricholepis amplexicaulis* probably owing the deficient data or wrong identification.

The proper identification Key for the genus and species was provided as this family is very complicated. It is followed by the detail description of the plant which includes accepted names, synonyms, morphological characters, flowering and fruiting and distribution. Along with above, taxonomic notes are also provided to avoid the confusion between related species. Photo plates are also provided. The largest tribe in genera is Heliantheae (12 genera, 16 species) while the largest tribe in the species is Inuleae (9 genera, 19 species) followed by Vernonieae (6 genera, 6 species), Cardueae (4 genera, 4 species), Astereae (4 genera, 4 species), Coreopsidae (3 genera, 5 species), Millereae (3 genera, 3 species), Eupatorieae (3 genera, 3 species), Senecioneae (3 genera, 3 species), Cichoreae (2 genera, 4 species) and Gnaphalieae (2 genera, 3 species).

For pollen studies, the detail description of pollen morphology was provided which includes: symmetry, shape, number of apertures, types of aperture, exine ornamentation and the presence of cavea with the measurements. Four types of pollens were observed. Type 1 found in the members of Cichoreae and Vernonieae. Type 2 found in *Xanthium strumarium*. Type 3 found in the *Echinops echinatus* and *Oligochaeta divaricata*. Type 4 found in the rest of the members of Asteraceae. After running the Kruskal Wallis test, it was found that in all the 6 variables i.e. size of pollen, length of ornamentation, polar axis, equatorial diameter, PA/ED ratio, width of aperture the p-value is <0.001 and hence the variation is significant.

A cladogram prepared from the morphological and palynological data has been given along with explanation. It shows generic compatibility with recent classification among

different species. The tribes like Carduaceae, Gnaphalieae, Inuleae and Cichoreae show the monophyly. Heliantheae and Astereae tribes shows polyphyly.

CONCLUSION

After detailed study involving review of literature, field survey and observing the morphological and palynological characters, the following conclusions were drawn.

The survey resulted in one species which is new to the world i.e. *Thespis thakeri* JJ Sharma and Nagar. Additionally, *Lipochaeta lobata* was a new generic record to Asia and *Crassocephalum crepidioides* is a new generic record to Gujarat. New records for south Gujarat are *Acmella uliginosa*, *Pullicaria aungustifolia*, *Blumea virens*, *Blumea obliqua*, *Blumea sinuate*, *Pluchea ovalis*, *Pluchea wallichiana*, *Gamochoeta pensylvanica*, *Pseudoconyza viscosa*, *Sonchus apser* and *Tithonia diversifolia*.

In depth studies shows that, *Blumea malcolmii* has been confused as *Blumea lacera* and *Centratherum punctatum* as *Centratherum phylloneum*.

Tribes such as Vernoniaeae and Inuleae are particularly challenging, making it difficult to identify plants at both the generic and species levels. Members of the Heliantheae alliance are also intriguing taxa to study. Among them, the Eupatorieae tribe is relatively easy to distinguish compared to the other tribes within the Heliantheae alliance, which are delimited based on molecular phylogeny and not on the morphological characters. *Xanthium*, a controversial genus, warrants reconsideration of its taxonomic position within the Asteraceae family, as it exhibits significant differences from the typical characteristics of the Heliantheae tribe.

The analysis identifies 27 distinct pollen types from various species within the Asteraceae family, classified based on a combination of qualitative traits such as symmetry, shape, aperture type, ornamentation and size. Each pollen type is linked to specific species, highlighting the morphological diversity within the family. To assess whether these traits show significant variation across species, a Kruskal-Wallis test was performed due to the non-normal distribution of the quantitative data. The test results indicated that for all measured parameters, including pollen size, ornamentation length, polar axis, equator diameter, PA/ED ratio, and aperture width, the null hypothesis (which posits no significant differences between species) was rejected. This shows that these parameters vary significantly between species. The findings

suggest that both qualitative and quantitative data are valuable for systematic classification and cladistic analysis of Asteraceae pollen types. The study concludes that these traits can be effectively used to enhance our understanding of species relationships within the family, making them essential for taxonomic and evolutionary research.

The phylogenetic analysis of the Asteraceae family using Maximum Parsimony and morphological/palynological data provides important insights into the evolutionary relationships within this complex group. Several well-supported monophyletic clades are identified, particularly within the Cardueae, Gnaphalieae, and parts of the Cichorioideae subfamily, reflecting robust evolutionary signals. However, polyphyly observed in the Heliantheae alliance, Eupatoreae, and Millerieae tribes suggests the need for reclassification and further studies other than molecular studies to resolve these relationships. Moreover, the close affinity between *Caesulia axillaris* and the Cardueae tribe, as well as the placement of Gnaphalieae within Inuleae, highlights areas where the integration of other evidences along with molecular studies may resolve the discrepancies among this family.