# Chapter 1: Introduction

Systematics is the study of the diversification of the living organisms at different taxonomic hierarchical levels which are also known as taxon (Pl. Taxa). This area of biology also includes the use of cladistic analysis to examine the relationships between living organisms. Simpson (2019) describes that the primary goal of the discipline of systematics, which includes taxonomy—the description, identification, nomenclature, and classification of organisms—is to reconstruct phylogeny, or the evolutionary history of life. Carl Linnaeus is credited with coining the term "Systematics" (1735). He coined the term to describe his artificial sexual organ classification.

Asteraceae Bercht. & J. Presl is referred to as the "Sunflower Family" or the "Daisy Family." Due of the existence of composite heads, this family was earlier known as Compositae Giseke. This family, which include crop, ornamental, and medicinal plants, is highly evolved and significant to the economy. Because of their wide distribution and significant economic significance, knowledge of the characteristics and diversity of Asteraceae plants is essential in disciplines including botany, horticulture, ecology, and agriculture.

Asteraceae is a cosmopolitan family that inhabits many types of habitats. Except for Antarctica, it is present on every continent. Temperate zones have the largest diversity, followed by tropical and subtropical regions. With over 1300 genera and over 33,000 species, this is the biggest family in the Dicotyledonae (Funk *et al.*, 2009; CWG, 2024).

The Asteraceae is a broad family with a wide range of characteristics, hence its categorisation has been revised periodically. According to Funk *et al.* (2009), there are 43 tribes and 12 sub-families in the most recent classification. Asteraceae family could be recognised based on following characteristics.

1. The inflorescence is head or capitulum.
2. Involucre bract is present.
3. Flower is epigynous, bisexual (disc florets), female or neuter (ray florets).
4. Calyx is modified to pappus.
5. Anthers are Syngenesious.
6. Gynoecium is bicarpellary syncarpous with one ovule in one locule.
7. Placentation is basal.
8. Fruit is Cypsela.

### 1.1. Morphological Parameters Used for Examining Asteraceae Family

Cassini (1813a) was the first one to describe Asteraceae family in detail. Over the years, various factors have been used for studying Asteraceae. Taking into consideration of available references, the parameters which have been used for describing Asteraceae are as follows.

#### 1.1.1. Habit

The members of Asteraceae have wide range of variation in their habit. Plants with **acaulescent** habits, in which the stem is greatly reduced and the leaves are arranged in rosettes, include *Elephantopus scaber* L. and numerous species of *Launaea*. In herbaceous habit, **procumbent** plants have their stems that grow horizontally along the ground without rooting at intervals, eg. *Sphagneticola trilobata* (L.) Pruski. **Decumbent** plants also grow horizontally but have tips turning upward, eg. *Tridax procumbens*. **Diffuse** plants spread widely having frequent branches extending out in all directions, eg. *Blumea oxyodonta*. **Suffruticose** plants are semi-woody type, having a woody base with herbaceous growth above, eg. *Lipoblepharis urticifolia*. **Shrubs** are woody plants with several stems (bushy), eg. *Tithonia diversifolia*. **Trees** have a single wooden trunk and a clearly defined crown, eg. *Vernonia arborea*.

#### 1.1.2. Leaves

Asteraceae family has a variety of leaf types. The following are typical examples of phyllotaxy in Asteraceae: A **rosette** is a dense cluster of leaves that forms near the ground at the base of a plant, where the leaves radiate outward from a short stem in a circular pattern, eg. *Elephantopus scaber*. The term "**alternate phyllotaxy**" refers to a staggered pattern of leaf arrangement in which each leaf grows at a distinct level along the stem and there is only one leaf per node, eg. *Emilia sonchifolia*. In contrast, two leaves developing at the same node on the stem in direct opposition to one another is known as **opposite phyllotaxy**, eg. *Synedrella nodiflora*.

In types, a **simple** leaf has one single, undivided blade that is attached to the stem by a petiole, eg. *Acilepis divergens*. On the contrary, a **pinnate** leaf is a kind of compound leaf that has leaflets arranged in a feather-like pattern on either side of a central axis, or rachis, eg. *Bidens bipinnata*. Another type of compound leaf that resembles a clover like appearance is called a **ternate** leaf, which has three leaflets attached at a single point, eg. *Bidens biternata*. A **decompound** leaf, on the other hand, is a highly divided compound leaf with multiple levels of division, in which the primary leaflets are further subdivided into secondary or even tertiary leaflets, eg. *Parthenium hysterophorus*.

Asteraceae leaves typically have the following shapes: **linear** leaves, which are long and narrow with parallel margins, eg. *Caesulia axillaris*. **Oblong** leaves are elongated, with nearly parallel sides that resemble rectangle like shape, eg. *Pluchea wallichiana*. **Lanceolate** leaves have a lance-like shape; they taper to a point and are longer than wide. **Ovate** leaves appear like an egg, with the broadest area located below the middle, eg. *Synedrella nodiflora*. **Spathulate** leaves are spoon-shaped, having a narrower base and a broad, rounded top, eg. *Gamochaeta pensylvanica*. Oval in shape, **elliptical** leaves have their widest point in the middle, eg. *Pluchea ovalis*. Commonly found in Asteraceae, **deltoid** leaves are triangular in shape, resembling the Greek letter delta, eg. *Chromolaena odarata*.

Members of the Asteraceae family exhibit varied leaf margins. **Entire** leaves have smooth, continuous edges devoid of lobes or teeth eg. *Gamochaeta purpurea*. Similar to a serrated knife, **serrate** leaves have sawtoothed edges that are sharp and point forward, eg. *Blumea axillaris*. The tiny, rounded teeth that border the margin of **crenulate** leaves give them a scalloped look, eg. *Elephantopus scaber*. **Dentate** leaves have teeth orientated more pronounced and evenly spaced and outward along their border than forward, eg. *Launaea procumbens*. Some species of oak have **sinuate** leaves, which have a wavy edge that gives them an undulating shape, eg. *Lagascea mollis*. A leaf is **laciniate** if it is deeply sliced, lobed, or divided into sharp, narrow segments, eg. Blumea sinuata. **Runcinate** leaves have an edge that is finely serrated or lobed and points in the direction of the leaf base, eg. *Sonchus oleracea*.

In the Asteraceae family, the various types of leaf apex are: the **acute** apex which tapers to a sharp point with sides that are either straight or slightly curled, eg. *Ageratum conyzoides*. An **obtuse** apex is an angle made that is greater than 90 degrees, and it has a rounded or blunt end, eg. *Elephantopus scaber*. The **acuminate** apex progressively narrows to a long, pointed tip having a tapering effect, eg. *Chromolaena odorata*.

Leaf base in Asteraceae are: a **truncate** base is distinguished by a straight, flat edge that gives the impression of being severed, eg. *Xanthium strumarium*. When the leaf base encircles and clasps the stem, creating the illusion that the stem is piercing the leaf, this is known as an **amplexicaule** base, eg. *Emilia sonchifolia*. A **decurrent** base extends downward along the stem, where the leaf tissue runs along the stem, creating a winged effect, as seen in thistle leaves, eg. *Pluchea ovalis*. The **cuneate** base is wedge-shaped and gradually gets narrower until it joins the petiole, eg. *Blumea malcolmii*. On either side of the petiole, an **auriculate** base has lobes or appendages that resemble ears, eg. *Vicoa indica*. An **attenuate** base taper gradually to a slender point, merging smoothly with the petiole, eg. *Cyanthillium cinereum*.

### 1.1.3. Capitulescence

Capitulescence is the arrangement of capitula or heads in a plant. It is the secondary inflorescence (primary being capitulum or head). In **Solitary**, there in only one capitulum in whole capitulescence, eg. *Tricholepis glaberrima*. In **Raceme**, the capitula possess stalk (peduncle) and they are arranged in acropetal succession on rachis where young capitulum is above and mature ones are below, eg. *Launaea procumbens*. **Panicle** is compound (branched) raceme, *Blumea virens*. **Spike** is the modification of raceme where the capitula are sessile, eg. *Gamochaeta purpurea*. **Glomerulus** is the capitulescence where the capitula are arranged in clusters, eg. *Gamochaeta pensylvanica*. In **umbel**, all capitula are stalked, arise from tip of the floral branch and are arranged at same level, eg. Eg. *Blumea eriantha*. **Corymb** is the modification of the umbel where the capitula arises from different nodes but are arranged at same level, eg. *Eschenbachia stricta*. In **biparous cyme**, the floral branch ends into mature capitulum below which two capitula are arrangedeg. *Acmella radicans*. In **dichotomous**, the capitula are arranged on the tip of each dichotomy of the floral branches, eg. *Oligochaeta divaricata*.

### 1.1.4. Capitulum or Head

Capitulum (pl. capitula) or head is the primary inflorescence of Asteraceae family where the florets are arranged on the receptacle (the rachis of the peduncle is condensed into the special platform) along with involucre of phyllaries. The term ‘capitulum’ and ‘head’ are used synonymously in Asteraceae family but ‘capitulum’ is only used for the inflorescence of Asteraceae while ‘head’ can be used for other families like Fabaceae, Rubiaceae etc.

Capitulum or head is classified into homogamous (all florets same) or heterogamous (Different florets arranged as inner disc and outer ray florets). Homogamous heads may be **Ligulate** where all florets are ligulate (eg. *Launaea procumbens*) or **Discoid** where all florets are tubular (eg. *Centratherum punctatum*). Heterogamous heads may be **Radiate** where ray florets are ligulate and disc florets are tubular (eg. *Cosmos caudatus*) or **Disciform** where ray florets are filiform (slender or thin) and disc florets are tubular (eg. *Blumea oxyodonta*).

Complexity of head or capitulum is classified into **simple** where the head is single unit (made of florets and involucre) (eg. *Laggera aurita*) and **compound** where the head or capitulum possess more than one headlets or units (eg. *Elephatopus scaber*).

On the basis of florets, the capitulum can be classified as: **Bisexual** where all florets are hermaphrodite (eg. *Ageratum conyzoides*). **Neuter and bisexual** where ray florets are neuter and disc florets are hermaphrodite (eg. *Cosmos caudatus*). **Gynomonoecious** where ray floret

is female and disc floret is hermaphrodite (eg. *Vicoa indica*). **Unisexual** where either the ray floret is female and disc floret is functional male or the all florets of the heads are male or female (eg. *Xanthium strumarium*).

### 1.1.5. Involucral bract or Phyllary

Involucral bracts or Phyllaries (Singular: Phyllary) are the bracts which surrounds the florets in capitulum. These are the primary bracts which are found in whorls. It may be arranged in **uniseriate** (one whorl, eg. *Emilia sonchifolia*), **biseriate** (two whorls, eg. *Bidens biternata*) or **multiseriate** (many whorls, eg. *Acilepis divergens*).

### 1.1.6. Receptacular Bract or Palea or Chaff

**Palea** is the secondary bract which are attached to each floret. Unlike Involucral bracts which surrounds the capitulum, palea is the bract of single floret. It is common in members of Heliantheae tribe, eg. *Lipobelpharis uriticifolia*.

### 1.1.7. Receptacle

**Receptacle** is the tip of the peduncle where rachis is modified to plateform on which florets are arranged. Receptacle can be **convex** or **dome** shaped where the curvature is outwards (eg. *Acmella uliginosa*) or it may be **flat** (eg. *Blumea malcolmii*) or it may be **concave** or **cup shaped** where the curvature is inward, eg. *Cyathocline purpurea*.

### 1.1.8. Florets

**Florets** is very specific type of flower in Asteraceae as it is the unit of composite flower (head or capitulum) and hence instead of flower, term ‘floret’ is used. Florets are epigynous, they may be complete or incomplete; calyx is either modified to pappus or absent; corolla are modified into different forms; may be fertile or infertile.

Majorly, there are four types of florets: **Bilabiate** where there are two lips in corolla, eg. *Vicoa indica*. **Ligulate** where corolla is not forming a tube but it is the strap-shaped where corolla lobes are 3-5; it can be neuter, female or hermaphrodite, eg. *Sonchus asper*. In **tubular** floret, the corolla is forming a tube and five corolla lobes; it can be hermaphrodite or male, eg. *Echinops echinatus*. **Filiform** florets are the slender florets which are always arranged as ray floret in disciform head and it is female; it may have corolla lobes 0-3, Eg. *Blumea axillaris*. (Note: In tubular florets, if the length of corolla lobe is greater than its width then lobes are deep and if width of corolla is greater than its length then it is shallow).

### 1.1.9. Anthers

Stamens are **syngenecious** (fused from anther lobes and free from filament) which is one of the typical characters of Asteraceae. The variations in the apex and base of the anthers plays significant role in delimiting taxa in Asteraceae.

The type of anther apices are: **Acute** where the apex is triangular end which is less than 90 degrees, eg. *Ageratum conyzoides*. **Obtuse** or **rounded** where apex is round or the angle is more than 90 degrees, eg. *Acmella oleracea*. **Apiculate** where there is a thin and small tail on the apex, eg. *Grangea maderaspatana*. Truncate where the apex is a straight, flat edge that appears as if cut off, eg. *Xanthium strumarium*.

The type of anther bases are: **Entire** or **sub-entire** or **obtuse** where the base is rounded, eg. *Cyathocline purpurea*. **Sagittate** where the appendage is broad and tapering downwards (anther looks like arrow head), eg. *Pseudoconyza viscosa*. **Tailed** where the base possess filament like appendage, eg. *Blumea belangeriana*.

### 1.1.10. Style Branches

In Asteraceae, gynoecium is bicarpellary, unilocular ovary with one basal ovule. The style is bifurcate into two branches. The arrangement of stigmatic tissues (hairs) can be **adaxial** (inner surface facing each other) or can be **marginal** (on the margins of the branches).

The apex of style branches also plays important role in the delimitation of Asteraceae members. **Obtuse** apex is where the apex is rounded, eg. *Acanthospermum hispidum*. **Subulate** is the triangular apex (like pointed part of the nail), eg. *Emilia sonchifolia*. **Appendiculate** is where the apex is tapering into filament, eg. *Guizotia abyssinica*. In **Truncate**, the apex is a straight, flat edge that appears as if cut off, eg. *Senecio bombayensis*.

### 1.1.11. Cypsela

Cypsela is the fruit of the Asteraceae members. It is dry, one-seeded, and indehiscent fruit which is developed from inferior ovary. In many old literatures, achene is used as fruit of Asteraceae but since achene is developed from superior ovary, it is not used in Asteraceae anymore. Many members may possess disc at the base of cypsela.

Cypsela is found in different shapes: **Obovate**: The cypsela is broader at the top and tapers toward the base, resembling an upside-down egg shape, eg. *Sonchus asper*. **Gibbous**: The cypsela have a pouch-like enlargement from one side, eg. *Sclerocarpus africanus*. **Oblong**: The cypsela is elongated, with nearly parallel sides and rounded ends, eg, *Launaea*

*procumbens*. **Ovate**: The cypsela is egg-shaped, with the broader end at the base, eg. *Xanthium strumarium*. **Fusiform**: spindle shaped, eg. *Emilia sonchifolia*.

The apex types are: **Truncate**: The apex is flat or nearly straight, appearing as if the end has been cut off, eg *Launaea procumbens*. **Beaked**: The apex tapers gradually to a long point, eg. *Cosmos sulphureous*. **Rounded**: The apex is smooth and curved, giving a rounded appearance, eg. *Sonchus oleraceous*.

The bases are: **Cuneate**: The base tapers in a wedge-like manner, eg, *Sonchus asper*. **Truncate**: The base is flat or straight, eg. *Launaea procumbens*. **Rounded**: The base is smooth and curved, giving it a rounded appearance, eg. *Xanthium strumarium*.

### 1.1.12. Pappus

Pappus is the modified calyx in Asteraceae. It may be present or absent. It may be persistent after formation of cypsela or it may be caducous.

**Plumose** pappus consists of feathery bristles that resemble tiny feathers with small branches which help catch the wind for dispersal, eg. *Pluchea wallichiana*. **Setose** pappus is same as that of plumose but the branches are long and further divided, eg. *Tridax procumbens*. **Barbed** pappus features bristles with tiny hooks or barbs, enabling the seeds to latch onto animal fur or clothing, eg. *Bidens biternata*. **Scaly** pappus consists of small, flat scales that can act like sails, eg. *Ageratum conyzoides*. **Awned** pappus has bristles that end in sharp, pointed tips, which can aid in anchoring the seed to the ground, eg. *Synedrella nodiflora*. **Bristles** pappus is made up of fine, hair-like bristles that are often simple and smooth, eg *Launaea procumbens*. **Cup** or **Collar** or **Annular** pappus is made of ring, eg. *Sphagneticola trilobata*.

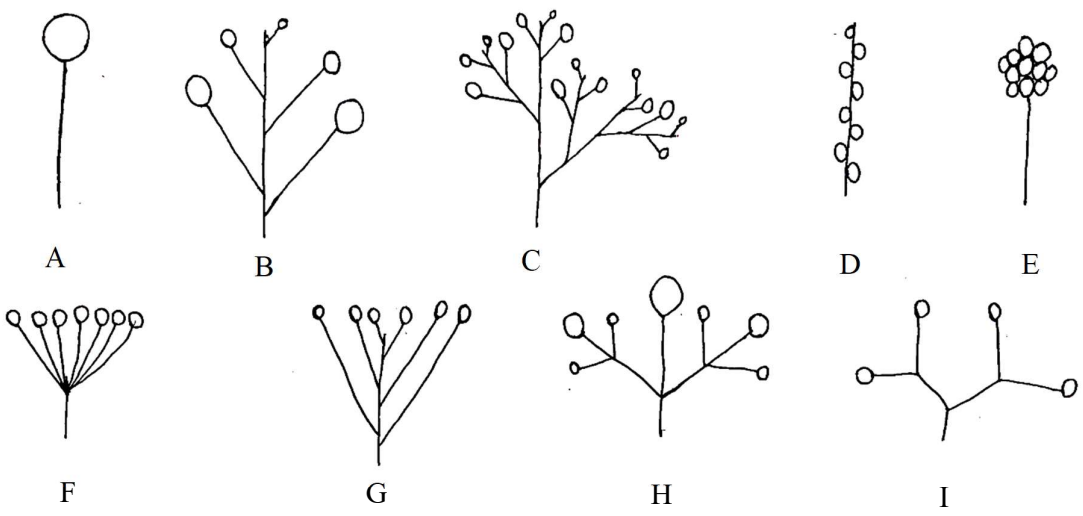


**Plate 1.1** Types of Capitulescence; A. Solitary; B. Raceme; C. Panicle; D. Spike; E. Clustered; F. Umbel; G. Corymb; H. Biparous; I. Dichotomous.

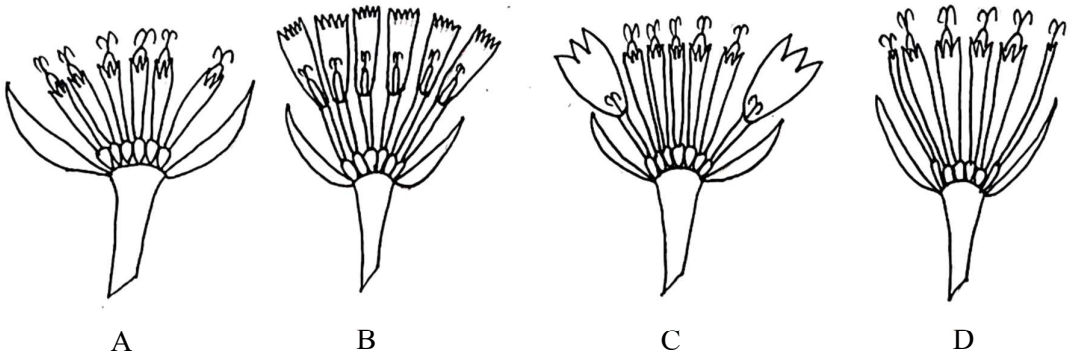


**Plate 1.2** Types of Capitulum; A. Discoid; B. Ligulate; C. Radiate; D. Disciform.

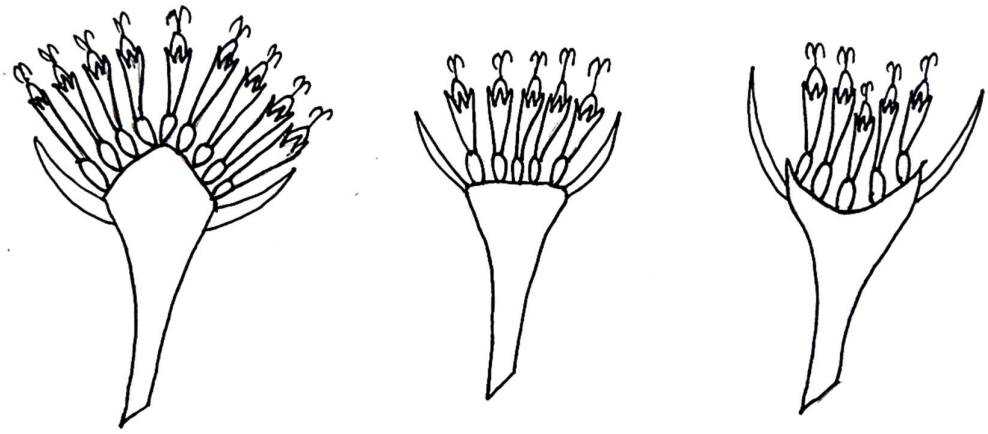


**Plate 1.3** Types of Receptacle; A. Convex; B. Flat; C. Concave.

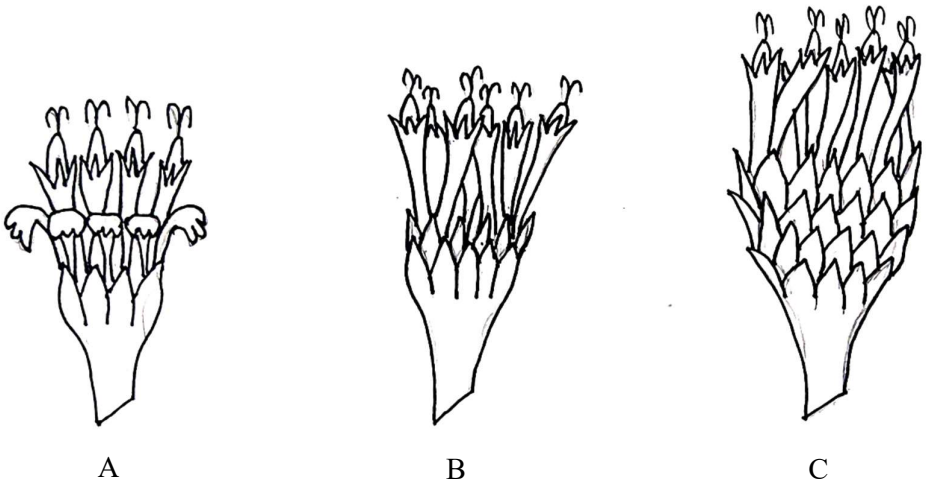


**Plate 1.4** Types of Involucre; A. Uniseriate; B. Biseriate; C. Mutliseriate.

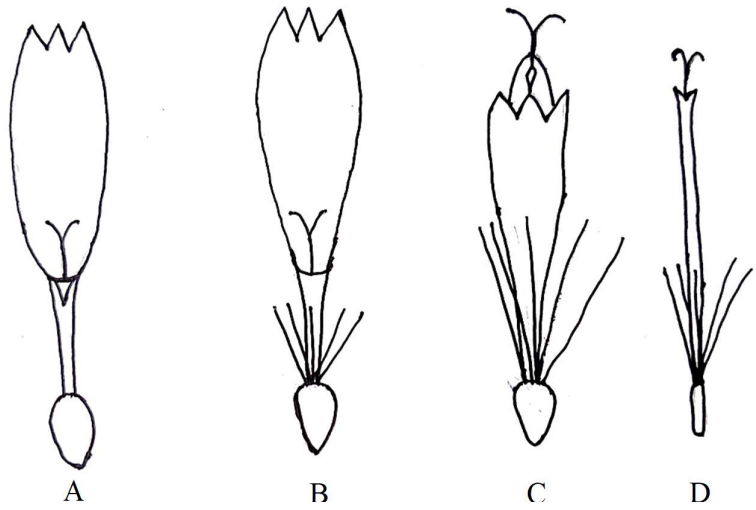


**Plate 1.5** Types of Florets; A. Bilabiate; B. Ligulate; C. Tubular; D. Filiform.

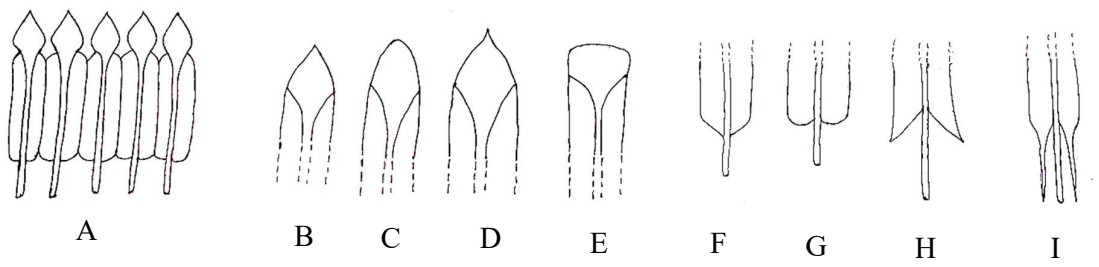


**Plate 1.6** Anthers; A. Syngenecious anthers; B-E. Anther Apex (B. Acute; C. Obtuse; D. Apiculate; E. Truncate); F-I. Anther base (F. Entire; G. Subentire; H. Sagittate; I. Tailed).

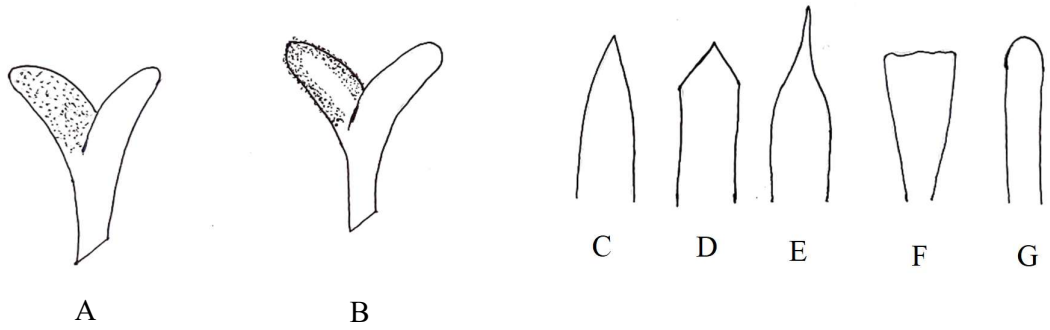


**Plate 1.7** Style; A. Adaxial stigma; B. Marginal stigma; C-G. Style Apex (C. Acute; D. Subulate; E. Acuminate; E. Truncate; F. Obtuse).

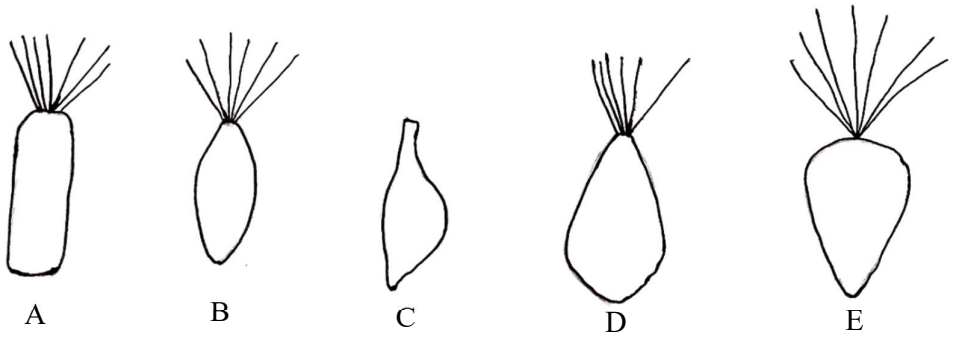


**Plate 1.8** Types of Cypsela; A. Oblong; B. Fusiform, C. Gibbous; D. Ovoid; E. Obovoid.

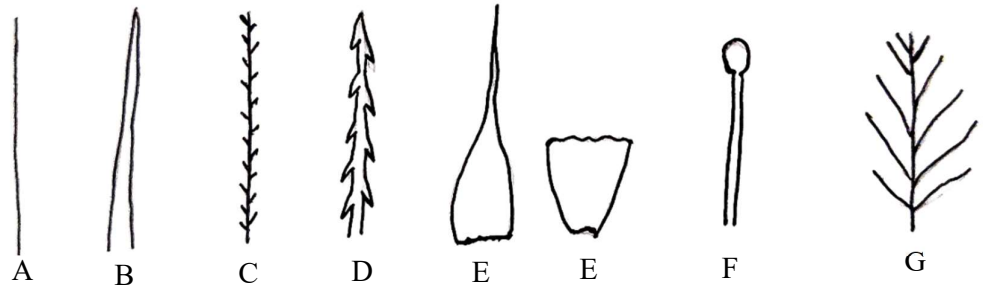


**Plate 1.9** Pappus; A. Bristle; B. Awn; C. Plumose; D. Barbed; E. Scale; F. Club; G. Setose.

### 1.2 Importance of Asteraceae in Society

Asteraceae family is an economically important plant family and also it has been used by humans for very long time for the different purpose.

As ornamental plants, many members of Asteraceae family are used for its aesthetic capitulum. The species of *Zinnia* L., *Chrysanthemum* L., *Solidago* L., *Gerbera* L., *Helianthus* L., *Cosmos* Cav., *Aster* L. etc. are common garden plants which are used in various landscape for enhancing aesthetic value.

Asteraceae members are also used in foods. Leaves of members of Cichoreae tribe like *Launeae* Cass. and *Lactuca* L. are used in food. *Blumea malcolmii* Hook.f. and *Blumea lacera* (Burm.f.) DC. is used for lining the pot while making Ubadiyu which is the cuisine in Dangs and Valsad during winter. Since many members of Asteraceae family like *Guizotia abyssinica* (L.f.) Cass. are oil yielding plants, their oil is also used for cooking.

Medicinal important plants are also present in Asteraceae family. *Eclipta prostrata* (L.) L. is used as hepato-protective plant. This plant is also used for good hair growth, liver disorders, skin diseases, and respiratory infections. *Tridax procumbens* L. is traditionally used for wound healing and as an anti-inflammatory, in dysentery, diarrhea, achne and to stop bleeding. *Sphaeranthus indicus* L. is used in epilepsy, skin diseases, jaundice, and piles. It also has anti-inflammatory and antioxidant properties. *Pluchea lanceolata* (DC.) C.B.Clarke is used in treating rheumatism and joint pain. *Artemisia annua* L. is used for malaria. There are many other plants which are used as medicine.

### 1.3 Ecological Importance

The Asteraceae family is essential to many ecosystems worldwide, due to their adaptability to a broad variety of ecological niches including those in Gujarat. The Asteraceae family plays an important ecological role in maintaining biodiversity. For a wide range of creatures, such as insects, birds, and mammals, these plants offer both food and vital habitats. Their flowers' vivid colors and copious amounts of nectar make them especially good at drawing pollinators like bees, butterflies, and birds. This attraction supports the reproductive success and genetic diversity of plant communities by making it easier for nearby plants, including Asteraceae species, to be pollinated.

Many species in the Asteraceae family are crucial for maintaining soil health and preventing erosion in addition to their role in promoting biodiversity. These plants' root systems, which are especially helpful in arid and semi-arid areas like some parts of Gujarat, stabilize the soil, preventing erosion and preserving soil integrity. Additionally, by breaking

down organic matter and adding necessary nutrients to the soil, they aid in the cycle of nutrients that benefits other plants and creatures within the ecosystem. To keep soil fertility high and encourage strong plant growth, nutrient cycling is essential.

Additionally, species of the Asteraceae family are important for ecological succession. Numerous species are pioneers, able to settle in untamed or disturbed areas (such as those left behind by fires or human activity), helping to gradually restore habitat and give rise to increasingly complex plant communities. Their presence can contribute to the improvement of soil conditions, which will facilitate the establishment and growth of other plants. The Asteraceae family also contains a number of species that have evolved to withstand harsh conditions. For example, drought-resistant species help preserve vegetation cover in areas where water is scarce. By enabling ecosystems to tolerate and recover from environmental stresses, this resilience adds to the stability and resilience of ecosystems.

Even though some Asteraceae species have the potential to spread, knowing their ecological functions can help manage ecosystems and keep native and non-native species in balance. All things considered, the Asteraceae family is essential to the health of ecosystems because it offers a wide range of ecological services that promote biodiversity, healthy soil, and ecosystem resilience.

### 1.4 Study Area

The study area for current research comprises of five district of south Gujarat which are Surat, Tapi, Navsari, Dang and Valsad. This area is selected because western ghats starts from the basin of the Tapi river. The details of study area is as follows.

#### 1.4.1 Topological Data

**Location**

The Dang district is situated in the southeast part of Gujarat state and lies between 20° 33' 50" to 21° 04' 52" North latitudes and 73° 27' 58" to 73° 56' 38" East longitudes.

Tapi district is located in the southeastern part of Gujarat, India, between latitudes 21.0°N to 21.4°N and longitudes 73.3°E to 73.6°E.

Navsari district is situated in the southern part of Gujarat, India, between latitudes 20.96°N to 21.28°N and longitudes 72.95°E to 73.30°E. It is bounded in the north by Surat district, in east by The Dangs district, in the south by Valsad and in west by Arabian sea. The area covered by the district is 2,209 Sq.Km. The rank of the district in area is 23rd in the State.

Surat district is located in the southern part of Gujarat, India, approximately between latitudes 21.11°N to 21.61°N and longitudes 72.54°E to 73.25°E. The length from north to south of this territory is about 84.9 km and from east to west is about 177.7 km. It is bounded on the west by gulf of Khambhat, on the south by Navsari and on the south east by the Dangs district, on the east and north east by Maharashtra state and in the north by Bharuch and Narmada districts. The area covered by Surat district is 7,657 sq.km having 9th ranks in comparison to other districts of the state.

Valsad district is situated in the southern part of Gujarat, India, between latitudes 20.07°N to 20.70°N and longitudes 72.60°E to 73.10°E.

**General Topography**

The regions collectively span from the hilly terrain of the Western Ghats (Sahyadri Range) in the Dang district to the flat coastal plains along the Arabian Sea, covering Navsari, Surat, and Valsad. The terrain in Tapi and parts of Valsad is largely flat, while the Dang district features rugged, forested hills. The region is intersected by rivers that support fertile agricultural lands.

**Elevation**

The Dang district, being part of the Western Ghats, has elevations ranging from 400 to 1,400 meters. Tapi, Navsari, Surat, and Valsad have much lower elevations, ranging from sea level to about 80 meters, with Valsad having some hilly areas rising to about 400 meters.

**Rivers**

Tapi River: The most significant, flowing through Surat and Tapi districts.

Purna River: Flows through Navsari and the Dang district.

Auranga, Par, and Damanganga Rivers: These flow through Valsad.

Smaller rivers such as the Gira are also present in the Dang district.

**Soil**

Dang has predominantly lateritic soil, suitable for forest vegetation. Tapi, Navsari, Surat, and parts of Valsad has rich alluvial soil, highly fertile, supporting crops like sugarcane, rice, and cotton. Valsad also has areas with lateritic soil.

### 1.4.2 Geological Data

**Geological Formation**

There is a diverse geological formation, ranging from the volcanic Deccan Traps in Dang and parts of Valsad to the Quaternary alluvial deposits in Tapi, Navsari, Surat, and coastal Valsad. The region transitions from the rugged, ancient volcanic rocks of the Western Ghats to younger alluvial plains formed by river systems.

#### 1.4.2.1 Deccan Traps (Dang & parts of Valsad)

**Geological Age**

The Deccan Traps are one of the largest volcanic provinces in the world, formed during the late Cretaceous period (~66 million years ago). They are primarily composed of basaltic lava flows.

**Rock Types**

The dominant rock type in these areas is basalt, an igneous rock. This volcanic formation is responsible for the hilly terrain, particularly in the Dang district and the higher elevations in Valsad.

**Soil Composition**

The weathering of basalt has produced lateritic soil, which is rich in iron and aluminium but generally poor in nutrients for agriculture.

**Topography**

This region has a rugged, elevated topography with steep slopes and dense forests, especially in the Dang district.

**1.4.2.2 Alluvial Plains (Tapi, Navsari, Surat, and Coastal Valsad)**

**Geological Age**

The alluvial plains were formed during the Quaternary period (less than 2.6 million years ago), consisting of unconsolidated sediments deposited by rivers, especially the Tapi River.

**Rock Types**

These districts are dominated by sedimentary deposits such as sand, silt, clay, and gravel. These alluvial deposits have formed over time through the action of rivers and floods.

**Soil Composition**

The plains are characterized by fertile alluvial soils, particularly black soil (regur), which is highly productive for agriculture. These soils are rich in organic matter and support the cultivation of crops like rice, sugarcane, and cotton.

**Topography**

The alluvial plains are flat to gently sloping, with low elevations near the coast, especially in Surat, Navsari, and Tapi districts.

**Mineral Resources**

Dang and hilly parts of Valsad: Limited to basalt, which is used locally for construction. Some lateritic deposits may also be present.

Tapi, Navsari, and Surat: The main geological resources here are sand, gravel, and clay, which are used in construction.

Valsad: In addition to basalt in the hilly areas, the plains have alluvial deposits of sand and clay.

### 1.4.3 Biogeography

Dang: Characterized by Tropical Evergreen and Deciduous Forests, rich in biodiversity including large mammals like leopards (*Panthera pardus*).

Tapi: Features Riverine and Alluvial Plains, with less dense forest cover and a focus on agriculture. Flora includes sugarcane (*Saccharum officinarum*) and rice (*Oryza sativa*).

Navsari: Exhibits Coastal and Mangrove Ecosystems, supporting salt-tolerant plants like *Rhizophora* spp. and various coastal species. The fauna includes crabs and mangrove-dwelling birds.

Surat: Dominated by Coastal Alluvial Plains with significant agricultural areas. Key species include rice and sugarcane, and the fauna consists of small mammals and bird species adapted to these environments.

Valsad: Features a mix of Coastal and Hilly Ecosystems, supporting a range of plant species like mango (*Mangifera indica*) and cashew (*Anacardium occidentale*), and wildlife adapted to both coastal and hilly terrains.

**Key Flora**

Dang and Valsad share species such as Teak (*Tectona grandis*) and Sal (*Shorea robusta*), indicative of their forested landscapes. Tapi and Surat are dominated by sugarcane (*Saccharum officinarum*) and rice (*Oryza sativa*) in agricultural zones.

Navsari stands out with its Mangroves (*Rhizophora* spp.) and Coconut (*Cocos nucifera*), unique to coastal areas.

**Key Fauna**

Dang: Rich in large mammals like leopards, and diverse bird species.

Tapi: Fauna includes smaller mammals and riverine species.

Navsari: Coastal and mangrove species, including various crabs and fish.

Surat: Small mammals and common bird species adapted to agricultural and coastal areas.

Valsad: A mix of coastal and hilly fauna, including deer and wild boars.

**Climate Variations**

Dang experiences a tropical rainforest climate with heavy rainfall and high humidity year-round. Tapi and Surat have a tropical wet and dry climate with distinct wet and dry seasons. Navsari and Valsad have tropical coastal climates with high humidity and substantial rainfall during the monsoon season.

### 1.4.4 Forest Types According to Champion and Seth (1968)

**Forest Types**

Dang is characterized by Southern Moist Mixed Deciduous Forests (3B/C2), Tropical Dry Deciduous Forests (5A/C3) and Tropical Thorn Forests (6B/C1).

Tapi and Surat is characterized by Tropical Moist Deciduous Forests (3B/C2), Tropical Dry Deciduous Forests (5A/C3) and in addition along the coast of Surat district, particularly in estuarine regions near the Arabian Sea, mangrove forests are present. These forests are crucial for coastal protection and serve as important habitats for various species. Common mangrove species include: *Avicennia marina* and *Rhizophora mucronata*.

Navsari is characterized by Tropical Dry Deciduous Forests (5A/C3) and Mangrove Forests (4B/TS2).

Valsad is characterized by Tropical Semi-Evergreen Forests (2A/C2) and Tropical Moist Deciduous Forests (3B/C2).

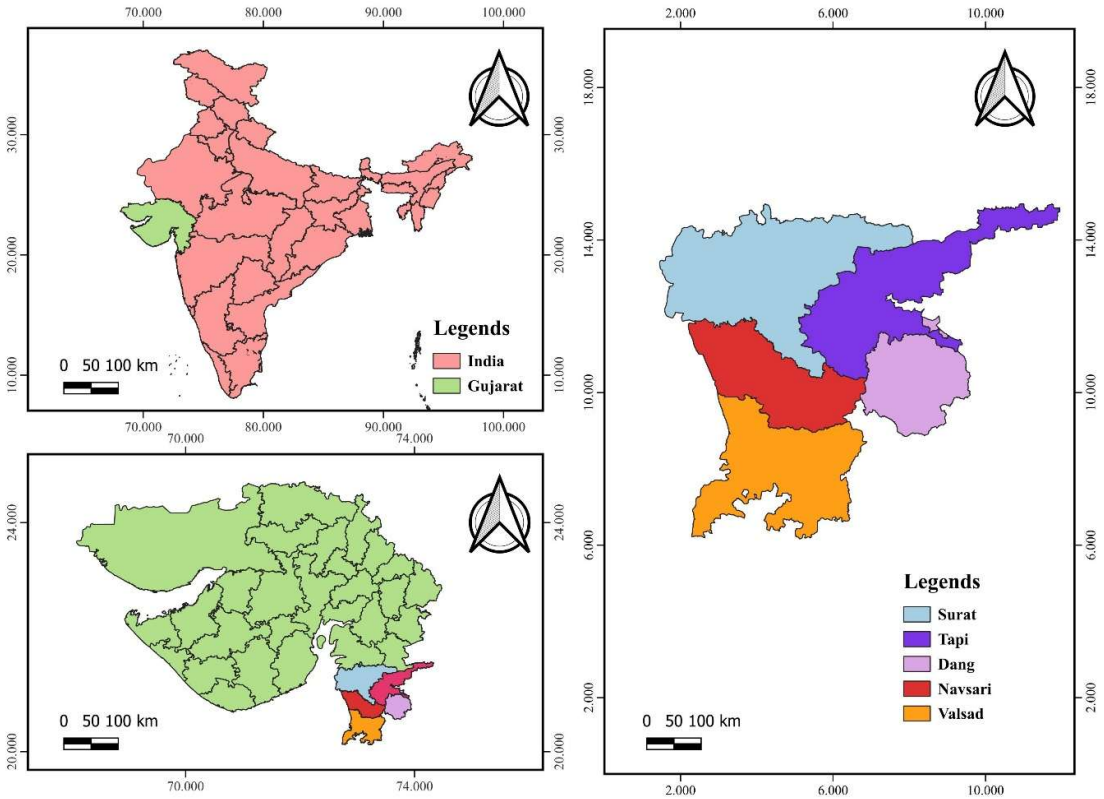


**Figure 1.1 Map of South Gujarat Districts.**

## 1.5 Objectives

Although morphological palynological phylogeny, pollen analysis, tribal level classification, and other factors were considered for key formation, these factors are lacking in information and research at the national and state levels. With this in mind, the following objectives were set for the current study.

**The main objectives of the study are:**

1. Survey of the members of family Asteraceae in South Gujarat.
2. To describe morphological characters of Asteraceae species.
3. Pollen types and their evolutionary and taxonomic significance.
4. Cladistic analysis for understanding phylogenetic relationship.