



A review on taxonomy of the family asteraceae in Uttar Pradesh

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Abstract

Asteraceae is the largest angiospermic plant family that contains 24,000–30,000 species under 1600–1700 genera worldwide. Asteraceous members are found in nearly all the parts of world except Antarctica. In India the family is represented by 999 species under 193 genera which are generally herbaceous except some shrubs, climbers and rarely trees. Uttar Pradesh is India's 4th largest area covering state of which about 16.8 million ha. (69.5%) is occupied by agriculture lands that provide a better environment for the growth of herbaceous and weedy plants. In Uttar Pradesh family Asteraceae dealt only in few regional flora and also in recently published state flora. During present study previously published literature were surveyed and information available on family Asteraceae has been derived.

Keywords: asteraceae, Uttar Pradesh, flora, literature, revision

Introduction

Flowering plants species represent upto 95% of all vascular plants on the earth, of which family Asteraceae comprises about 10% of the total diversity (Mandel *et al.*, 2019) [19]. Compositae (*nom. alt.* Asteraceae) also known as daisy family or sunflower family, is considered as the most dominant family in the world. It comprises 24000–30000 species under 1600–1700 genera (Funk *et al.*, 2009) [3]. Earlier the entire family was divided into 20 tribes (Cassini, 1826 & 1834). Recently Funk *et al.* (2009) [14] produced a phylogenetic classification of Asteraceae based on molecular markers wherein they classified entire family into 12 subfamilies and 43 tribes. Mainly family Asteraceae divided into 2 broad groups *viz.*, Non Asteroideae (a grade) and Asteroideae (a subfamily). The Non Asteroideae grade contains 23 tribes under 11 subfamilies and Asteroideae subfamily contains 20 tribes.

Asteraceae are clearly monophyletic and molecular study has suggested that it originated in the late Cretaceous in South America and explosively radiated during the Eocene to North America, Asia, Africa followed by multiple worldwide dispersal in many directions (Mandel *et al.*, 2019) [19].

The members of family Asteraceae are found everywhere i.e. from arid regions to rain forests and from arctic region to alpine except Antarctica. The members of the family are generally annual or perennial herbs followed by under shrubs such as *Duhaldia cappa* Buch.–Ham., *Parthenium hysterophorus* L., *Xanthium strumarium* L., shrubs such as *Solidago canadensis* L., few climbers Such as *Cissampelopsis corymbosa* (Wall. ex DC.) C. Jeffrey & Y.L. Chen, *Tarlmounia elliptica* (DC.) H. Rob., and rarely trees Such as *Vernonia arborea* Buch.–Ham. etc.

Asteraceae are natural assemblage of well-knit species which are characterized by capitulum inflorescence that can be homogamous (presence of alike florets) or heterogamous

(presence of different types of florets) with three distinct types of florets, *viz.* ray florets, disc florets and neutral florets. Ray florets are ligulate female and disc florets are tubular bisexual in nature. Capitula having only ray florets are known as Ligulate, that having only disc florets are known as Discoid and the capitula having both ray and disc florets are known as Radiate type. Except these other distinguishing features of the family are presence of pappus/scales/awns in place of calyx, 5-lobed gamopetalous corolla, syngeneisous condition of stamens (sagittate anthers), unilocular ovary with a single basal ovule and achene or cypsela (inferior achene) type of fruits and ex-albuminous seeds.

In India the family comprises 1149 taxa (including 999 species, 21 sub-species, 122 varieties and 7 formae) under 193 genera (Karthikeyan *et al.*, 2009) [26]. Majority of the Indian Asteraceae (ca 72.67%) grown in temperate regions of Himalaya and the north–east part of the country and considered as the largest family in India followed by Poaceae, Orchidaceae and Fabaceae (Mitra & Mukherjee, 2017) [23]. The species majorly grow in open areas along road sides, agricultural fields, waste lands and forest fringes as annual or perennial weed.

Uttar Pradesh is the India's 4th largest state as far as its area is concerned. The forested area in the state is quite low due to availability of huge agriculture lands which provided great opportunity to grow and survive sun loving herbaceous plants. The *Flora of Upper Gangetic Plain* (Duthie, 1903) [11] is the first comprehensive work from the state in which 114 taxa (including 15 cultivated ones) under 53 genera have been included in the family Asteraceae. After this monumental work no any comprehensive work has so far been published separately on Asteraceae except some scattered information in district floras (Kanjilal, 1933 [24]; Shrivastav, 1938 [59]; Bhattacharya, 1964 [5]; P. C. Kanjilal, 1966 [25]; T. N. Shrivastav, 1976 [60]; Siddiqui,

1990; Verma & Misra, 1992^[22]; Singh, 1994; Sharma & Dhakre, 1995^[50]; Singh, 1997^[56]; Singh, 1998^[55]; Singh and Khanuja, 2006^[57]; Kumar *et al.*, 2015^[30]; Singh, 2015^[58]; Lata, 2017^[32]; Khanna, 1999, 2009, 2017^[27, 28, 29]; Kumar and Narain, 2018; Singh, 2018; Kushwaha *et al.*, 2018^[31]; Kumar *et al.* 2018, Sinha & Shukla, 2020^[52]).

The members of family Asteraceae are economically very important and contain several food, oil, dye yielding and medicinal plants. Some economically important plants such as *Lactuca sativa* and *Helianthus tuberosus* are widely grown as vegetable, *Helianthus annuus* and *Carthamus tinctorius* are important oil yielding plants in India, *Chrysanthemum cinerariifolium* used to obtain an insecticide pyrethrin, *Taraxacum officinale* provides a drug Taraxacum, *Parthenium argentatum* commercially used to

produce guayule rubber, several medicinal plants are also reported from the family such as *Acmella paniculata*, *Ageratum conyzoides*, *Blumea lacera*, *Artemisia nilagirica*, *Eclipta prostrata*, *Mikania micrantha*, *Tridax procumbens* etc. There are also many ornamental plants in this family such as *Aster* spp., *Calendula* spp., *Cosmos* spp., *Chrysanthemum* spp., *Dahlia* spp., *Helianthus* spp., *Tagetes* spp., *Zinnia* spp. etc.

Systematic position of the family Asteraceae in Bentham-Hooker classification

George Bentham and Joseph D. Hooker were English botanists who gave their natural system of classification (*Genera Plantarum*, 1862-1883) in which they placed Asteraceae in a separate order Asterales as follows:

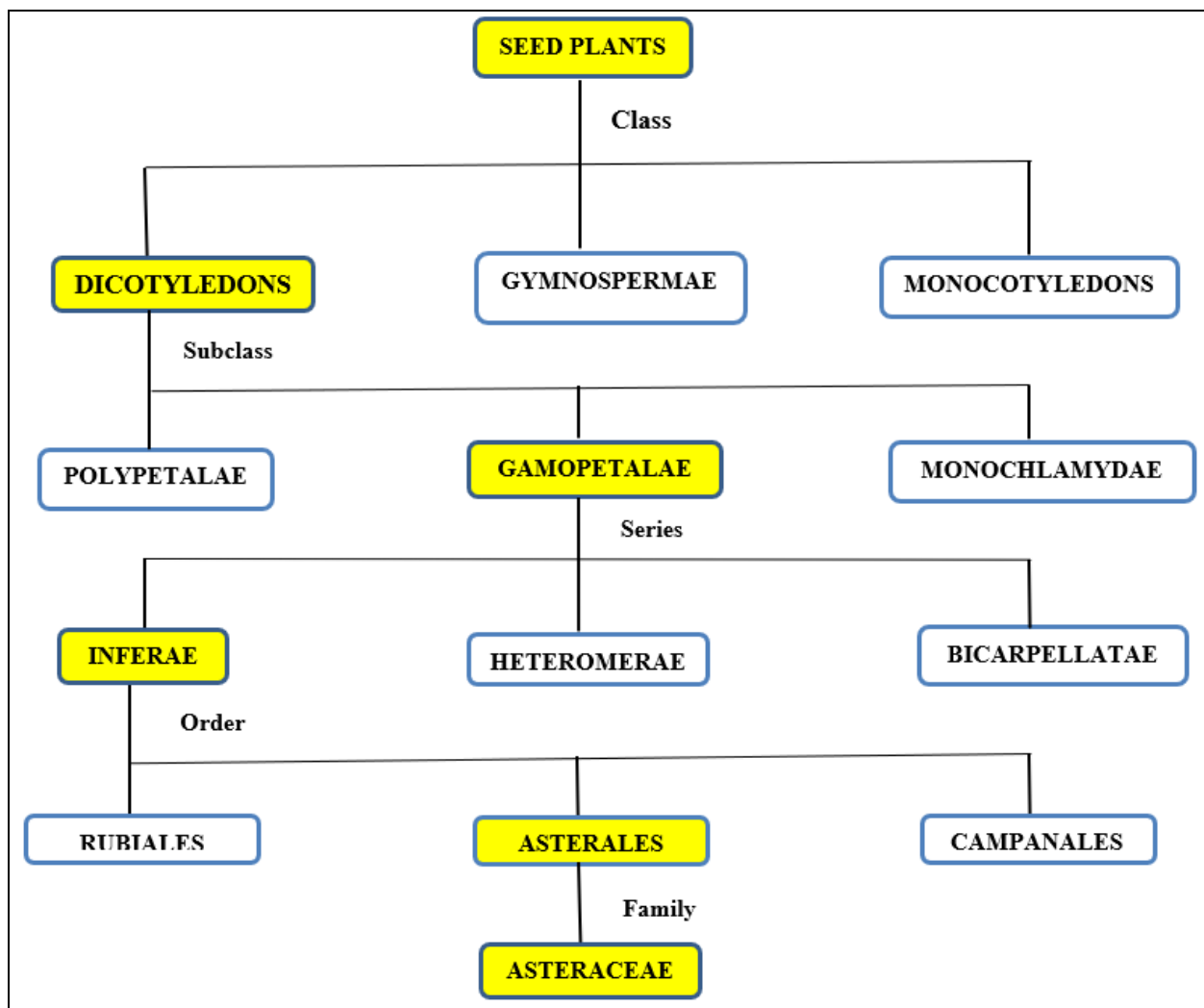


Fig 1

Review of literature

At global level the family is represented by 24000-30000 species under 1600-1700 genera. The word Compositae for a flowering plant family is first of all used by Michel Adanson in 1763 in his book *Families des plantes* but in Vienna Congress (2005) the starting date of the name of families was set to 4 August 1789, so the priority of name of the family fell to Paul Dietrich Giseke who had published the name Compositae independently in his publication *Praelectiones* in 1792 (Bonifacino *et al.*, 2009)^[3]. Ivan Ivanovich Martynov (1820), in his publication *Tekno-Botanicshkii slovan* validated the name of 99 plant families

and in the same publication he mentioned the name of Compositae as Asteraceae on the basis of type genus *Aster*. Van Barkhey was the first person to write a book fully dedicated to general features of Asteraceae entitled as *Expositio Characteristica Structurae Florum qui Dicuntur Compositi* (1760). Cassini was the first person to classified Asteraceae and published it in *Opuscules Phytologiques vols. 1 and 2* (1826). He believed that detailed description of corolla, anthers, style and achene led him to classify a complex group. During 1862-1883, Bentham and hooker published most accepted natural system of classification of phanerogams in which they placed family Asteraceae under

class Gamopetalae series Inferae and order Asterales. Bentham (1873) also published a paper that provides information on history, distribution and classification of the family. Small (1917) published a monograph entitled as *The origin and development of the Compositae*. In recent time several phylogenetic studies (Bonifacino *et al.*, 2009; Funk *et al.*, 2009; Mandel *et al.*, 2019 etc.)^[3, 21] have been published that provide us the global data on family Asteraceae.

The 1st record of Indian Asteraceae comes through Van Rheede's (1690) *Hortus Malabaricus* (Vol.10) wherein 14 species of this family were documented. Linnaeus (1753) in his two volumes of *Species Plantarum* described 72 species from the country, while Burman (1786) recorded 56 species of Asteraceae from India. However in India the first important contribution on this family is available in D. Don's *Prodromus Florae Nepalensis* (1825), wherein he described about 60 species. The prime contribution on this

family in Indian region is mainly by two British botanists, i.e. C.B. Clarke (1876) and J.D. Hooker (1881)^[18]. After the work of Hooker, several taxonomic works have been produced on Indian Asteraceae such as Rao *et al.*, 1988^[47]; Hajra *et al.*, 1995^[16, 17]; Chaudhary *et al.*, 2001^[9]; Karthikeyan *et al.*, 2009^[26], Arisdason and Lakshminarasimhan 2017^[2], etc. An analysis of the distribution of Asteraceous taxa from India revealed that the richest zone of diversity of family Asteraceae in India is the Western Himalaya which support ca 540 species followed by Eastern Himalaya (300 species), Western Ghats (225 species), Northeastern India (193 species), Deccan (126 species), Desert biogeographic zone (110 species), Gangetic plains (109 species), and the Andaman & Nicobar Islands (25 species) (Rao and Datta, 1996)^[46].

The major works on Indian Asteraceae have been summarized in following table:

Table 1

Literature/Book name and published year	Author name	Information taken
<i>Hortus Malabaricus</i> (1690)	Van Rheede	14 species of Asteraceae documented.
<i>Species Plantarum</i> (1753)	Linnaeus	Described 72 species of Asteraceae from Indian region.
<i>Prodromus Florae Nepalensis</i> (1825)	D. Don	First important contribution on family Composite in India, described about 60 species.
<i>Wallichian Catalogue</i> (1831)	Wallich	Catalogued 400 species of Asteraceae from Indian region, many of them are named for 1 st time and Majority of them treated as synonyms by subsequent workers.
<i>Flora Indica</i> (1832)	Roxburgh	Recorded 89 species of Asteraceae from east India.
<i>Flora of British India</i> (1881)	J.D. Hooker	Detail taxonomic account of 608 species belonging to 128 genera.
<i>Flora of Upper Gangetic Plain and adjacent Shivalik series</i> (1903)	J.F. Duthie	Taxonomic account of 114 species (including 15 cultivated ones) belonging to 53 genera.
<i>Florae Indicae Enumeratio-Asteraceae</i> (1988)	Rao <i>et al.</i>	Enumerated 1052 taxa of family Asteraceae under 177 genera from within the territorial limits of the Indian Republic.
<i>Flora of India</i> (1995)	Hajra <i>et al.</i>	BSI published flora of India in several volumes. Volume 12 & 13 on family Asteraceae wherein taxonomic description of 892 species under 167 genera have been provided. Also included 41 species under 20 genera that are cultivated and used ornamentally in different places of India.
<i>Flowering plants of India vol.1</i> (2009)	Karthikeyan <i>et al.</i> , 2009 ^[26]	In the first volume of this book they provided current taxonomic status of 18 dicotyledons families in which Asteraceae represented by 999 species, 21 sub-species, 122 varieties and 7 formae under 193 genera in India.

Uttar Pradesh is India's most populous state and also 4th largest state in terms of total geographic area. It covers an area of 2,40,928 sq. km. (approx. 7.3% of total area of the country) and lies between 23° 52' – 31° 28' N latitudes and 77° 30' E – 84° 39' E longitudes. It is bordered by Bihar in the East, Delhi, Haryana & Rajasthan in the west, Uttarakhand in the north, Chhattisgarh in the south and Madhya Pradesh in the south-west. Uttar Pradesh also shares an international border with Nepal in the north (Anonymous, 2019). It is divided into four distinct eco-regions, namely Terai region in north, Gangetic plain in the center, Vindhyan and Bundelkhand region in south and Semi-arid region in the south-west. The main rivers of state are Ganga, Yamuna, Gomti, Ghagra, Betwa, Chambal and Gandak. It has a humid & subtropical climate and experiences 4 seasons with the annual rainfall ranges between 1,000 mm to 1,200 mm and the mean temperature vary from 22.5°C to 25°C (Anonymous, 2016). The actual forest cover of the state is 14,349 sq. km which constitute ca 5.96% of the geographical area of the state (Anonymous, 2013). The entire province contains about 2817 species distributed under 1200 genera and 176 families, of these 518

species belong to cultivated category (Singh *et al.*, 2016). In order to biodiversity conservation, one National Park, one Ramsar site, two zoological gardens and twenty four Wildlife Sanctuaries have been recognized in Uttar Pradesh (Anonymous, 2013). Latest Remote Sensing Applications Centre (RSAC) records show that Uttar Pradesh also has 11, 45,178 ha. area (4.8% of its geographical area) as wetlands. The main source of income in Uttar Pradesh is agriculture that shares about 33% of total income of the state. About 16.8 million ha. (69.5%) of total land is allocated to agriculture (Anonymous, 2004) that provide a better environment for herbaceous plant to flourish well. Most of the members of family Asteraceae are herbaceous in nature and have good opportunity to grow abundantly in this area. The *Flora of Upper Gangetic Plain* (Duthie, 1903–1929)^[11] is the first comprehensive work from the state in which 114 taxa (including 15 cultivated ones) under 53 genera have been included in the family Asteraceae. Apart from the monumental work *Flora of British India* (J. D. Hooker, 1881)^[18] and *Flora of Upper Gangetic Plain* (J. F. Duthie, 1903–1929)^[11], several other publications in form of district or regional floras, systematic enumeration of particular

areas, checklists, new distributional records, new species, exotic species and weeds, additions to several previously published floras etc. have been made from various parts of the state. Some of the Pioneer floristic works on the region include *The plants of Agra district* (Munro, 1884) [39] probably considered as the first flora from the state, *The plants from the Banda district of Bundelkhand region* (Edgeworth, 1852) [12], *The Flora of Lucknow including cultivated and indigenous plants* (Anderson, 1859) [1], *The forest flora for the Pilibhit, Oudh, Gorakhpur and Bundelkhand* (P. C. Kanjilal, 1933) [24], *The forest flora for the plains of Uttar Pradesh* (P. C. Kanjilal, 1966) [25]. Several regional floras and checklists have been published that provide us little information on family Asteraceae.

Sharma & Dhakre (1995) [50] described 609 species under 384 genera and 103 families of angiosperms found in Agra district wherein Asteraceae is the 3rd largest family and represented by 41 species under 31 genera. Several workers such as Srivastava, 1938 [59]; Panigrahi, 1966 [42]; Mishra & Verma 1992 [22] etc. conducted the floristic exploration of Allahabad district. Shrivastav (1938) [59], provided a brief description of ca. 26 Asteraceous species under 19 genera. Rajagopal and Panigrahi (1966) [42] reported naturalized alien species of Flora of Allahabad. Mishra & Verma (1992) [22] described 713 species under 419 genera and 113 families from Allahabad wherein Asteraceae is the 4th largest family and represented by 44 species under 27 genera. Sharma & Pandey (1982) [51] enumerated 458 exotic plant species of Allahabad district wherein the time of introduction, phenology, nativity and common name of each species have been provided. Singh (1994;1995) listed 54 species under 38 genera from Deoria district. Shrivastav (1976) [60] in *Flora Gorakhpurensis* described 642 species belonging to 410 genera and 114 Angiosperm families in which family Asteraceae is 4th largest family and represented by 40 species under 30 genera. Saini (1993) [49] reported 33 species as addition to the Flora of Gorakhpur district. Siddiqui (1990) described 47 Asteraceous species under 34 genera from Hardoi district. Verma & Shukla (1997) [38] described 563 species under 371 genera and 107 families from Jalaun district wherein Asteraceae is 2nd largest family and represented by 41 species under 26 genera. Singh (1997) [56] in *Flora of Dudhwa National Park* described 56 Asteraceous species under 36 genera. Lucknow district has been explored botanically by Anderson (1951) [1], Kapoor (1962), Balapure & Srivastava (1964), Sharma (1964), Husain & Kapoor (1970), Saini (1990) [48] etc. Singh (1998) [55] enumerated 64 Asteraceous species under 42 genera in *Asteraceae of Lucknow*. Recently Singh & Khanuja (2006) [57] has compiled flora of Lucknow wherein brief description of 59 Asteraceous species under 39 genera have been provided. Bhattacharya (1964) [5] enumerated 31 Asteraceous species under 27 genera from Mirzapur. Lata (2017) [32] described 78 species under 51 genera from Terai region of state. In the same manner several other regional floras (Muzaffarnagar (Gupta, 1961) [15]; Mahoba and Hamirpur district (Bhattacharya & Malhotra, 1964) [6]; Bahraich district (Panigrahi *et al.*, 1969) [44]; Bulandsaher district (Singh, 1969) [53]; Kheri district (Singh, 1982) [54]; Moradabad (Paliwal & Singh, 1982) [41]; Sitapur (Maheshwari & Tomar, 1983) [34]; Fatehpur (Dixit *et al.*, 1984); have been also published that provide scattered information on family Asteraceae. Several checklists of different regions such as Kumar *et al.* (2015) [30] enumerated

51 Asteraceous species under 40 genera from Katarniyaghat. Khanna (2017) [29] listed 152 Asteraceous species belonging to 89 genera from Uttar Pradesh. Kumar and Narain (2018) [40] listed 33 wild species under 25 genera from Ghazipur. Kushwaha *et al.* (2018) [31] listed 38 species under 32 genera from Sonbhadra district. Kumar *et al.* (2018) listed 50 species under 32 genera from *Shahjahanpur*. Some new records of Asteraceae for state have also been published by workers (Singh and Shah, 1990; Vaishya, 2013) [62]. Recently Sinha & Shukla (2020) [52] described 142 asteraceous species from the state under 81 genera. In majority of the above given publications the Asteraceous plants have simply been enumerated by the workers and either the plants have been described very briefly or not supported by illustrations and live images.

Relative abundance of Asteraceae

Table 2

Region	Genera	Species	Reference
World	1600-1700	24000-30000	<i>Funk et al., 2009</i> [36]
India	193	999	<i>Karthikeyan et al., 2009</i> [26]
Uttar Pradesh	81	142	<i>Sinha & Shukla, 2020</i> [52]

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