



NUMERICAL TAXONOMIC STUDY OF SELECTED PLANTS OF ASTERACEAE FAMILY FROM AHMEDABAD DISTRICT, GUJARAT

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ABSTRACT

The article is about the systematic study of 30 species that belongs to 26 genera of Asteraceae family in Ahmedabad District. A total of 52 characters were measured, comprising qualitative and quantitative characters. Characters and character states were determined through examination of both living and herbarium specimens. Numerical taxonomy, also termed as morphometric deals with grouping by numerical methods of taxonomic units into taxa on the basis of their character state. On the basis of UPGMA (Unpaired Group Method off Averaging) clustering, Neighbour joining cluster analysis and a dendrogram was constructed as two clades and other sub clade are recognized. Results obtained from the present study are found congruent with morphological studies showing the significance of numerical analysis for taxonomic relationship in the Asteraceae family

Keywords: Systematic study, Asteraceae, numerical analysis, Numerical taxonomy morphological characters, Dendrogram, clade, taxonomic relationship

INTRODUCTION

Numerical taxonomy, also termed as morphometric deals with grouping by numerical methods of taxonomic units into taxa on the basis of their character state (Sneath and Sokal, 1973). Numerical taxonomic studies are important for discovering and documenting new morphological character and character states, and many attempts have been made in this regard for understanding phenetic relationships in different groups of plants (Mulumba and Kakudidi, 2010; Stevens and P. F., 1991; Ward, J. M., 1993.)

The two main numerical approaches used are phenetics and cladistics (Sneath and P. H., 1995). Phenetics makes use of as many characters as possible, usually morphological, anatomical or biochemical and equally weighted, to investigate overall similarity of organisms and thereby infer relatedness (Sneath, 1988). There are therefore no implications of relationship by ancestry. It is perceived that a large number of characters is required to produce a stable classification, originally advised as sixty or more (Sokal and Sneath, 1963), but later as many as is feasible, to avoid anomalous characters greatly affecting the outcome (Sneath and Sokal, 1973).

Asteraceae family is the largest family of the flowering plants with more than 24000 - 30000 species and 1600 - 1700 genera (Funk et al, 2005) worldwide and inhabit almost every environment and continent except Antarctica (Bisht, 2010). The largest genera are *Senecio* (1,500 species), *Vernonia* (1,000 species), *Cousinia* (600 species) and *Centaurea* (600 species) (Bisht, 2010). Asteraceae is widely distributed with in diverse regions ranging from Southwest of US, Mexico, Southern Brazil, South Africa, Middle and Southwest Asia as well as Australia. South America is accepted to be phylo-genetically the geographic origin of the family (Bremer 1994, 1996).

Materials and Methods STUDY AREA

The city of Ahmedabad district, a leading industrial and commercial city of Gujarat, situated on 23.01° N Latitude and 72.61° East Longitude in 8,086.81 sq. km area, on the bank of river Sabarmati. Ahmedabad is spread across ten talukas - Barwala, Daskroi, Dholka, Dhandhuka, Detroj, Sanand, Bavla, Ranpur, Mandal and Viramgam. It is the fifth largest city and seventh largest metropolitan area of India (World Gazetteer, 2010).

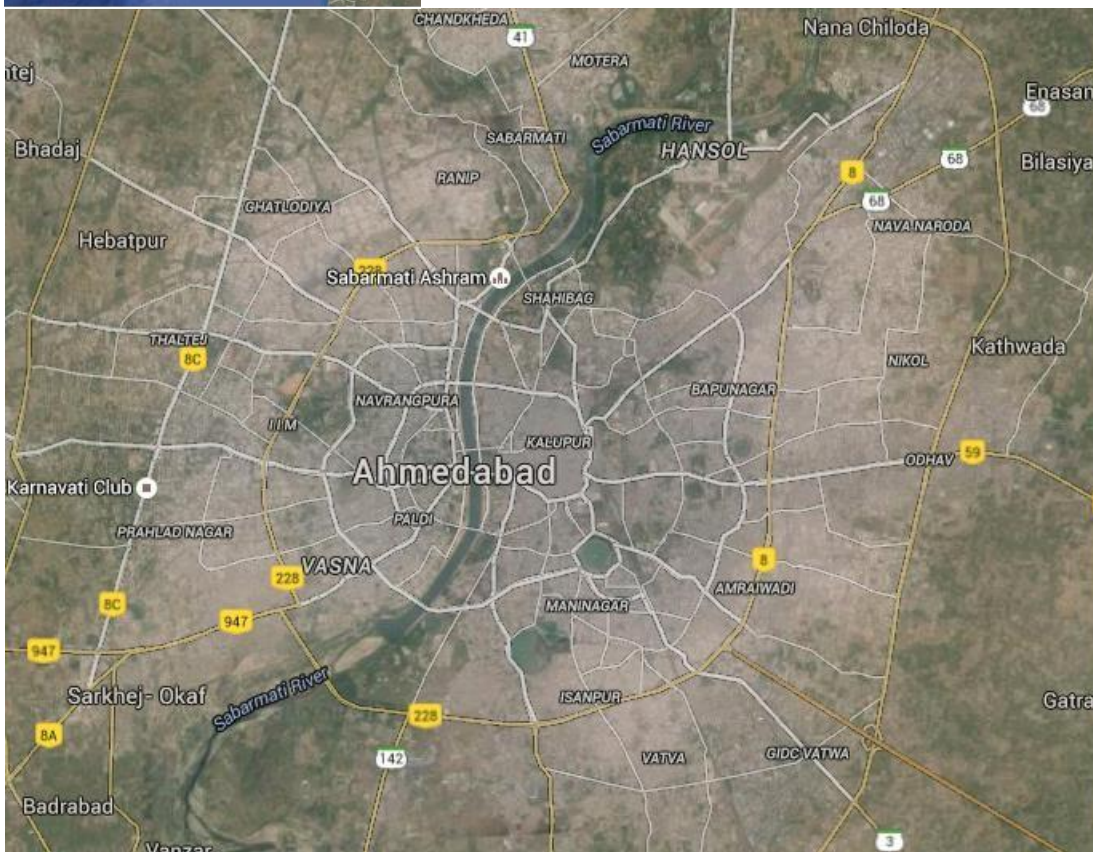


Figure 1 Satellite image of Ahmedabad (Source: Google map)

PLANT MATERIAL

The study deals with 30 species belonging to 26 genera of Asteraceae family in Ahmedabad District. Established taxonomic procedures for specimen collection, herbarium preparation (Jain and Rao, 1977) and identification of taxa are followed with the help of such as Flora of British India (Clarke and Hooker, 1881), Flora of Gujarat state (Shah, 1978), Flora of Bombay presidency (Cooke 1906) is available in the library of Department of Botany, Gujarat University and the Serenity Library, Gandhinagar.

CHARACTERS USED FOR NUMERICAL ANALYSIS

A total of 52 characters were measured, comprising qualitative and quantitative characters. Characters and character states were determined through examination of both living and herbarium specimens housed at Department of Botany, Gujarat University. Both qualitative and quantitative characters were coded as binary-state. The characters and their binary states used for numerical taxonomic studies are listed in Table 1.

Table 1. List of Morphological characters and Character states used in the numerical analysis.

Sr. No.	Characters	Characters states
1	Habit	Herb (0), Shrub (1), Climber (2)
2	Stem thickness	0.1-0.9 (0), 1-1.9 (1), 2-2.9 (2)
3	Stem hairiness	Glabrous (0), Hairy (1)
4	Stem branched	Branched (0), Branched from Base (1), Branched Upper Part (2), Dichotomously Branched (3), Unbranched (4)
5	Stem (Erect/Prostrate)	Prostrate (0), Erect (1)
6	Stem (woody/herbecious)	Herbecious (0), Woody (1)
7	Ventral surface of leaves	Glabrous (0), Hairy (1)
8	Dorsal surface of leaves	Glabrous (0), Hairy (1)
9	Upper leaf length	1-10 cm (0), 11-20 cm (1), 21-30 cm (2)
10	Upper leaf width	0.1-6 cm (0), 7-13 cm (1), 14-20 cm (2)
11	Upper leaf shape	Ovate-Lanceolate (0), Oblong-Lanceolate (1), Elliptic-Lanceolate (2), Oblanceolate (3), Obovate-Oblong (4), Linear-Lanceolate (5), Obovate (6), Ovate-Oblong (7), Ovate (8), Oblong-Elliptic (9), Ovate-Obovate (10), Linear-Oblong (11)
12	Basal leaf length	1-13 cm (0), 14-27 cm (1), 28-41 cm (2)
13	Basal leaf width	0.1-6.6 cm (0), 6.7-13.3 cm (1), 13.4-20 cm (2)
14	Basal leaf shape	Ovate-Lanceolate (0), Oblong-Lanceolate (1), Elliptic-Lanceolate (2), Oblanceolate (3), Obovate-Oblong (4), Linear-Oblong (5), Obovate (6), Ovate-Oblong (7), Ovate (8), Oblong-Elliptic (9), Obovate-Elliptic (10), Linear-Lanceolate (11), Ovate-Lanceolate (12)
15	Basal leaf hairiness	Glabrous (0), Hairy (1)
16	Basal leaf narrow	Broad (0), Narrow (1)
17	Basal leaf rosulate	Rosulate (0)
18	Leaf edge	Serrate (0), Dentate (1), Crenate-Serrate (2), Sinuate-Dentate (3), Entire (4), Entire-Crenulate (5), Sinuate (6), Serrate-Dentate (7), Entire-Serrulate (8)
		Acute (0), Mucronate (1), Obtuse (2), Obtuse-



19	Leaf apex	Mucronate (3), Acute-Obtuse (4), Acute-Acuminate (5), SubAcute (6), Acute-Mucronate (7)
20	Leaf phyllotaxy	Alternet(0), Opposite (1), Upper Alternet-Lower Opposite(2), Upper Opposite-Lower Alternet (3)
21	Leaf attachment	Amplexicaule(0), Semiamplexicaule(1)
22	Petiole length	Absent (0), 0.1-3.2 cm(1), 3.3-6.5 cm(2), 6.6-9.8 cm(3)
23	Bract length	0.1-1 cm(0), 1.1-2 cm(1), 2.1-3 cm(2)
24	Bract Shape	Ovate(0), Obovate (1), Linear-Lanceolate(2), Elliptic(3), Linear-Cylindrical(4), Lanceolate(5), Ovate-Obovate(6), Oblong-Lanceolate(7), Linear(8), Oblong (9), Ovate-Lanceolate(10), Cylindrical(11)
25	Bract margin	Entire(0), Serrate(1), Creante-Entire(2), Entire-Dentate(3)
26	Bract tip	Acute (0), Acuminate (1),Mucronate (2), Obtuse (3), Rounded (4), Acute-Acuminate (5), Acute-Mucronate (6), Acute-Obtuse (7)
27	Bract colour	Green (0), Green-Brown (1), Greenish Yellow (3)
28	Inflorescence type	Capitulum (0)
29	Flower colour	Yellow(0), Pinkish-Violet (1), Violet (2), Purple (3), Greenish-Yellow (4), White (5), Yellow-Orange (6), Orange-Reddish (7)
30	Ray floret length	0.1-2.0 cm(0), 2.1-4.0 cm(1), 4.1-6.0 cm(2)
31	Disc floret length	0.1-1.0 cm(0), 1.1-2.0 (1), 2.1-3.0 cm(2)
32	Corolla tube length(cm)	0.1-0.7 cm(0), 0.8-1.4 cm(1), 1.5-2.1 cm(2)
33	Anther length(cm)	0.1-0.3 cm(0), 0.4-0.6 cm(1), 0.7-0.9 cm(2)
34	Stigma Size	0.01-0.07 cm(0), 0.08-0.14 cm(1), 0.15-0.21 cm(2)
35	Style length(cm)	0.1-0.7 cm(0), 0.8-1.4 cm(1), 1.5-2.1 cm(2)
36	Inferior/ Superior ovary	Inferior(0), Superior (1)
37	Filament length	0.1-0.7 cm(0), 0.8-1.4 cm(1), 1.5-2.1 cm(2)
38	Pedicle Length	Absent (0), 0.1-13 cm (1), 14-26 cm(0), 27-39 cm(0)
39	Capitula length (cm)	0.1-3.3 cm(0), 3.4-6.6 cm(1), 6.7-9.9 cm(2)
40	Capitula width (cm)	0.1-13.3cm(0), 13.4-26.6 cm(1), 26.7-39.9(2)
41	Capitula solitary	Solitary(0)
42	capitula corymbose	Corymbose (0)
43	Outer phyllaries length (cm)	0.1-0.9 cm(0), 1.0-1.7 cm(1), 1.8-2.6 cm(2)
44	Outer phyllaries width (cm)	0.1-0.6 cm(0), 0.7-1.2 cm(1), 1.3-1.8 cm(2)
45	Inner phyllaries length (cm)	0.1-0.9 cm(0), 1.0-1.7 cm(1), 1.8-2.6 cm(2)
46	Inner phyllaries width (cm)	0.1-0.3 cm(0), 0.4-0.6 cm(1), 0.7-0.9 cm(2)
47	Achene length (cm)	0.1-0.4 cm(0), 0.5-0.8 cm(1), 0.9-1.2 cm (2)
48	Pappus length (cm)	Absent (0), 0.1-0.3cm(1), 0.4-0.6 cm (2), 0.7-0.9 cm (3)
49	Fruit dehiscent/indehiscent	Dehiscent (0), Indehiscent (1)
50	Achene colour	Black(0), Brown-Black(1), Brown(2), Green- Brown(3), Grayish-Brown (4)
51	Achene shape	Linear-Oblong (0), Lanceolate (1), Linear (2), Oblong (3), Cylindric (4), Obovate (5), Subtruncate (6), Cuneate (7), Tuberculate(8) , Obcordate (9), Terete (10), Linear-Lanceolate (11), Obovoid (12), Wedge (13)
52	Achene texture	Glabrous (0), Hairy (1)

Table.2 List of Morphological characters and Character states used in the numerical analysis.

S r - N o -	C h a r a c t e r s	Characters states	Botanical name																																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30						
1	Habit	Herb (0), Shrub (1), Climber (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
2	Stem thickness	0.1-0.9 (0), 1-1.9 (1), 2-2.9 (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
3	Stem hairiness	Glabrous (0), Hairy (1)	1	0	0	1	0	0	1	1	1	1	0	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	1	1	1	1	1				
4	Stem branching	Branched (0), Branched from Base (1), Branched Upper Part (2), Dichotomously Branched (3), Unbranched (4)	1	0	0	0	1	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	2	1	1	0	0	0	0
5	Stem	Prostrate (0), Erect (1)	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
6	(Erect / Deciduous)																																					
	Stem (woody/deciduous)	Herbaceous (0), Woody (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	Venetral surface of leaves	Glabrous (0), Hairy (1)	1	0	0	1	0	0	1	1	1	1	0	1	0	1	1	0	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	
8	Dorsal surface of leaves	Glabrous (0), Hairy (1)	1	0	0	1	0	0	1	1	1	1	1	0	1	1	0	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	
9	Upper length	1-10 cm (0), 11-20 cm (1), 21-30 cm (2)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	Upper	0.1-6 cm (0), 7-13 cm (1), 14-20 cm (2)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	



11	U p p e r l e a f a p e	Ovate-Lanceolate (0), Oblong-Lanceolate (1), Elliptic-Lanceolate (2), Oblanceolate(3), Obovate-Oblong (4), Linear-Lanceolate (5), Obovate (6), Ovate-Oblong (7), Ovate (8), Oblong-Elliptic (9), Ovate-Obovate (10), Linear-Oblong (11)	0	1	2	3	4	5	6	7	8	4	9	1	8	9	1	1	8	4	5	0	0	4	1	0	4	1	1	1	1	8	9	9		
12	B a s a l l e a f l e n g t h	1-13 cm(0), 14-27 cm(1), 28-41 cm(2)	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0	0			
13	B a s a l l e a f w i d t h	0.1-6.6 cm(0), 6.7-13.3 cm(1), 13.4-20 cm(2)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0			
14	B a s a l l e a f a p e	Ovate-Lanceolate(0), Oblong-Lanceolate (1), Elliptic-Lanceolate (2), Oblanceolate (3), Obovate-Oblong (4), Linear-Oblong (5), Obovate(6), Ovate-Oblong (7), Ovate (8), Oblong-Elliptic (9), Obovate-Elliptic (10), Linear-Lanceolate (11), Ovate-Lanceolate (12)	0	1	2	3	4	5	6	7	8	4	1	0	1	8	1	0	1	1	8	4	1	1	2	1	2	4	1	4	5	5	1	8	9	6
15	B a s a l l e a f h a i r n e s s	Glabrous (0), Hairy (1)	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1		
16	B a s a l l e a f e d g e	Broad(0), Narrow (1)	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	1	0	0	1	1	0	0	1	1	0	0	1	0	0	1	1	1		

17	B a s a l l e a f s p i n e	Rosulate (0), Absent(1)	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1
18	L e a f e d g e	Serrate(0), Dentate(1), Crenate-Serrate(2), Sinuate-Dentate(3), Entire(4), Entire-Crenulate(5), Sinuate(6), Serrate-Dentate(7), Entire-Serrulate(8)	0	1	2	3	3	4	5	4	0	6	4	0	0	0	0	0	0	1	4	7	0	8	1	7	8	8	8	2	7	1	
19	L e a f a p e x	Acute (0), Mucronate (1), Obtuse (2), Obtuse-Mucronate (3), Acute-Obtuse (4), Acute-Acuminatate (5), Serrate (6), Acute-Mucronate (7)	0	1	1	2	2	0	0	0	0	3	4	5	5	0	0	5	0	6	7	5	0	0	5	5	2	2	5	6	2	4	
20	L e a f p h y l l o t a x y	Alternate(0), Opposite (1), Upper Alternate-Lower Opposite(2), Upper Opposite-Lower Alternate(3)	1	0	1	0	2	0	1	0	0	0	0	2	1	1	2	0	1	0	0	0	2	0	0	0	0	0	1	2	0	2	
21	L e a f a t t a c h m e n t	Amplexicaule(0), Sepuamplexicaule(1), Simple(2)	2	2	2	2	1	2	2	2	2	1	2	2	2	2	2	0	2	2	1	2	2	2	2	2	0	1	1	2	2	2	2
22	P e t i o l e n g t h	Absent (0), 0.1-3.2 cm(1), 3.3-6.5 cm(2), 6.6-9.8 cm(3)	1	1	1	0	0	0	0	0	3	0	1	0	1	1	0	0	1	0	0	1	2	1	0	0	0	0	0	2	0	1	
23	B e t w e e n l e n g t h	0.1-1 cm(0), 1.1-2 cm(1), 2.1-3 cm(2)	0	0	0	0	0	0	0	0	2	0	0	2	1	1	2	1	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0

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24	B g. S ha pe	<u>Ovate</u> (0), Obovate (1), Linear-Lanceolate(2), Elliptic(3), Linear-Cylindrical(4), Lanceolate(5), Ovate-Obovate(6), Oblong-Lanceolate(7), Linear(8), Oblong (9), Ovate-Lanceolate(10), <u>Cylindrical</u> (11)	6	0	2	3	4	5	6	0	7	2	8	5	0	5	5	2	9	2	2	2	1	0	7	1	1	5	8	2	0	8	2	8
25	B g. m. f. n	<u>Entire</u> (0), Serrate(1), <u>Cogate</u> -Entire(2), Entire-Dentate(3)	1	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	1	0	3	3	0	1	0	0	0	0	0	1	0	0	
26	B g. P	Acute (0), Acuminate (1), <u>Mucronate</u> (2), Obtuse (3), Rounded (4), Acute-Acuminate (5), Acute-Mucronate (6), Acute-Obtuse (7)	5	2	2	4	1	1	1	1	1	1	1	2	6	0	2	0	7	6	0	1	1	1	5	0	3	3	0	0	0	0	0	
27	B g. co lo ur	Green (0), Green-Brown (1), Greenish Yellow (3)	0	0	0	0	0	1	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
28	In co lo ur of the cap itulum	Capitulum (0), Other (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
29	Fl o w er co lo ur	<u>Yellow</u> (0), Pinkish-Violet (1), Violet (2), Purple (3), Greenish-Yellow (4), White (5), <u>Yellow-Orange</u> (6), Orange-Reddish (7)	0	0	1	2	3	3	4	5	4	0	5	6	0	0	6	0	5	3	0	7	0	0	3	0	0	0	5	5	0	5		
30	R a y l e n g t h	0.1-2.0 <u>cm</u> (0), 2.1-4.0 <u>cm</u> (1), 4.1-6.0 cm(2)	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0		
31	D i s c o r d e r l e n g t h	0.1-1.0 <u>cm</u> (0), 1.1-2.0 (1), 2.1-3.0 <u>cm</u> (2)	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0		

32	C o r o l l a r l e n g t h (<u>cm</u>)	0.1-0.7 <u>cm</u> (0), 0.8-1.4 <u>cm</u> (1), 1.5-2.1 cm(2)	1	1	0	0	0	1	0	0	0	0	0	2	0	0	2	0	0	0	0	0	1	2	2	0	1	0	0	0	0	0
33	A x i l l e n g t h (<u>cm</u>)	0.1-0.3 <u>cm</u> (0), 0.4-0.6 <u>cm</u> (1), 0.7-0.9 cm(2)	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0
34	St a m e n a l s i z e	0.01-0.07 <u>cm</u> (0), 0.08-0.14 <u>cm</u> (1), 0.15-0.21 <u>cm</u> (2)	1	1	1	0	1	1	1	1	1	1	2	1	1	2	1	1	1	1	1	2	2	2	2	1	2	2	1	1	1	1
35	St a m e n a l l e n g t h (<u>cm</u>)	0.1-0.7 <u>cm</u> (0), 0.8-1.4 <u>cm</u> (1), 1.5-2.1 cm(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
36	In f l o r e t e r i a l l e n g t h (<u>cm</u>)	<u>Infracture</u> (0), <u>Supracoma</u> (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Fl o w e r l e n g t h	0.1-0.7 <u>cm</u> (0), 0.8-1.4 <u>cm</u> (1), 1.5-2.1 cm(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

303 404 414 424 434	n h p e d i c e l e g e n d a r y (c m))	Absent (0), 0.1-13 cm (1), 14-26 cm(0), 27-39 cm(0)	1	1	1	1	1	1	1	0	1	1	1	1	2	0	1	2	1	1	1	1	1	2	3	1	1	1	1	1	1	1	1	1	1
	a u t o u m (c m))	0.1-3.3 cm(0), 3.4-6.6 cm(1), 6.7-9.9 cm(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
	a u t o u m (c m))	0.1-13.3cm(0), 13.4-26.6 cm(1), 26.7-39.9(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0
	s o l i t a r y (c m))	Solitary(0), Absent (1)	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	c o r y m b o s e (c m))	Corymbose (0), Absent (1)	1	1	0	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	1

444 455 466 477	a u t o u m (c m))	0.1-0.6 cm(0), 0.7-1.2 cm(1), 1.3-1.8 cm(2)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	i n t e r p h a l a n c i e s (c m))	0.1-0.9 cm(0), 1.0-1.7 cm(1), 1.8-2.6 cm(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0
	i n t e r p h a l a n c i e s (c m))	0.1-0.3 cm(0), 0.4-0.6 cm(1), 0.7-0.9 cm(2)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	a c c e s s o r y (c m))	0.1-0.4 cm(0), 0.5-0.8 cm(1), 0.9-1.2 cm (2)	0	0	0	0	0	0	1	0	0	1	0	1	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0

48	Pappule length (cm)	Absent (0), 0.1-0.3cm(1), 0.4-0.6 cm (2), 0.7-0.9 cm (3)	2	2	2	1	3	1	0	1	0	3	2	2	1	2	1	2	1	0	1	3	2	2	0	2	2	2	1	0	2	2			
49	Fruit dehiscence	Dehiscent (0), Indehiscent (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
50	ACHAECOLOR	Black(0), Brown-Black(1), Brown(2), Green-Brown(3), Grayish-Brown (4)	0	1	2	0	2	2	3	0	2	4	2	0	1	2	1	2	1	2	2	2	2	0	0	0	1	2	2	2	0	2	2		
51	ACHAEAPAE	Linear-Oblong (0), Lanceolate (1), Linear (2), Oblong (3), Cylindric (4), Obovate (5), Subtruncate (6), Cuneate (7), Tuberculate(8), Obcordate (9), Terete (10), Linear-Lanceolate (11), Obovoid (12), Wedge (13)	3	0	4	2	4	3	1	3	5	3	6	5	0	7	7	0	8	9	3	1	0	5	5	1	3	1	2	3	3	7	7	3	1
52	ACHAEAE	Glabrous (0), Hairy (1)	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	1	0	0	1	0	1	

Note : 1. *Tridax procumbens* (L.) L , 2. *Chrysanthellum americanum* (L.) Vatke,

3.

Cyanthillium cinereum (L.) H.Rob.

1. *Grangea maderaspatana* (L.) Poir, 5. *Emilia sonchifolia* (L.) DC. ex DC., 6. *Tricholepis glaberrima* DC., 7. *Acanthospermum hispidum* DC., 8. *Parthenium hysterophorus* L., 9. *Xanthium strumarium* L., 10. *Launaea procumbens* (Roxb.) Ramayya & Rajagopal, 11. *Vernonia elaeagnifolia* DC., 12. *Tagetes patula* L., 13. *Wedelia urticifolia* (Bl.) Dc., 14. *Wedelia triloba* (L.) Hitchc., 15. *Tagetes erecta* L., 16. *Sonchus Oleraceus* (L.) L., 17. *Acmella radicans* (Jacq.) R.K. Jansen, 18. *Sphaeranthus indicus* L., 19. *Pentanema indicum* (L.) Ling, 20. *Senecio confusus* Burt, 21. *Helianthus annuus* L., 22. *Gerbera jamesonii* Bolus ex Hook.f., 23. *Cyathocline purpurea* (Buch.-Ham. ex D.Don) Kuntze, 24. *Lactuca sativa* L., 25. *Pulicaria angustifolia* DC., 26. *Pulicaria wightiana* (DC.) C.B. Clarke, 27. *Eclipta prostrata* (L.) L., 28. *Ageratum conyzoides* (L.) L., 29. *Blumea lacera* (Burm.f.) DC. , 30. *Blumea eriantha* DC.

STATISTICAL ANALYSIS

The data matrix was scored using binary matrix. Dissimilarity matrix was prepared based on the data matrix. Cluster analysis was performed using UPGMA (un-weighted pair group method with arithmetic mean) and a dendrogram was constructed to show the relationship among the species (Sneath and Sokal, 1973).

RESULT AND DISCUSSION CHARACTERS

In the present study 52 characters were investigated and used for phylogenetic relationships between the species occur in Asteraceae family. Characters and character states were determined through examination of both living and herbarium specimens. Both qualitative



and quantitative characters were coded as binary-state. The characters and their binary states used for numerical taxonomic studies are listed.

UPGMA CLUSTERING ANALYSIS

Cluster analysis of the 30 species belonging to 27 genera depending on 52 Morphological characters. The first clade species was *Helianthus annuus* L. at 17 dissimilarity distance and other second clade separation of these species into two sub-clades 2(A) and 2(B) at 15 dissimilarity distances. The 2(A) clad comprised 1 species *Senecio confusus* Burt. at 15 dissimilarity distances, while the 2(B) clad separation of these species into two other sub-clades 3rd and 4th at 14.1 dissimilarity distance (Figure 1).

The 3rd clad comprised 12 species *Tagetes patula* L., *Tagetes erecta* L., *Eclipta prostrata* (L.) L., *Chrysanthellum americanum* (L.) Vatke, *Cyanthillium cinereum* (L.) H. Rob., *Grangea maderaspatana* (L.) Poir., *Launaea procumbens* (Roxb.) Ramayya & Rajagopal, *Sphaeranthus indicus* L., *Sonchus Oleraceus* (L.) L., *Tridax procumbens* (L.) L., *Tricholepis glaberrima* DC., while the 4th clad comprised 16 species *Acanthospermum hispidum* DC., *Gerbera jamesonii* Bolus ex Hook. f., *Lactuca sativa* L., *Parthenium hysterophorus* L., *Pulicaria angustifolia* DC., *Pulicaria wightiana* (DC.) Clarke, *Blumea lacera* (Burm. f.) DC., *Xanthium strumarium* L., *Blumea eriantha* DC., *Vernonia elaeagnifolia* DC., *Ageratum conyzoides* (L.) L., *Cyathocline purpurea* (Buch.-Ham. ex D. Don) Kuntze, *Wedelia triloba* (L.) Hitchc., *Acmella radicans* (Jacq.) R. K. Jansen, *Wedelia urticifolia* (Bl.) DC., *Pentanema indicum* (L.) Ling. In the 3rd clad, we distinguished three sub-clads: (1) a sub-clad with *Tricholepis glaberrima* DC. at 13.8 dissimilarity distance. (2) A sub-clad with 2 species *Tagetes patula* L. and *Tagetes erecta* L. at 12 dissimilarity distance. (3) the third sub-clad comprised the rest of the 9 studied species *Eclipta prostrata* (L.) L., *Chrysanthellum americanum* (L.) Vatke, *Cyanthillium cinereum* (L.) H. Rob., *Emilia sonchifolia* (L.) DC. ex DC., *Grangea maderaspatana* (L.) Poir., *Launaea procumbens* (Roxb.) Ramayya & Rajagopal, *Sphaeranthus indicus* L., *Sonchus Oleraceus* (L.) L. and *Tridax procumbens* (L.) L., at 11 dissimilarity distance.

In the 4th clad, we distinguished four sub-clads: (1) a sub-clad with 3 species *Acanthospermum hispidum* DC., *Gerbera jamesonii* Bolus ex Hook. f. and *Lactuca sativa* L. at 14 dissimilarity distance. (2) A sub-clad with 2 species *Wedelia urticifolia* (Bl.) DC. and *Pentanema indicum* (L.) Ling. at 12.4 dissimilarity distance. (3) A sub-clad with 7 species *Xanthium strumarium* L., *Blumea eriantha* DC., *Vernonia elaeagnifolia* DC., *Ageratum conyzoides* (L.) L., *Cyathocline purpurea* (Buch. Ham. ex Don) Kuntze, *Wedelia triloba* (L.) Hitchc. and *Acmella radicans* (Jacq.) Jansen at 10.8 dissimilarity distance. (4) A sub-clad with 4 species *Parthenium hysterophorus* L., *Pulicaria angustifolia* DC., *Pulicaria wightiana* (DC.) Clarke and *Blumea lacera* (Burm. f.) DC. at 9.9 dissimilarity distance.

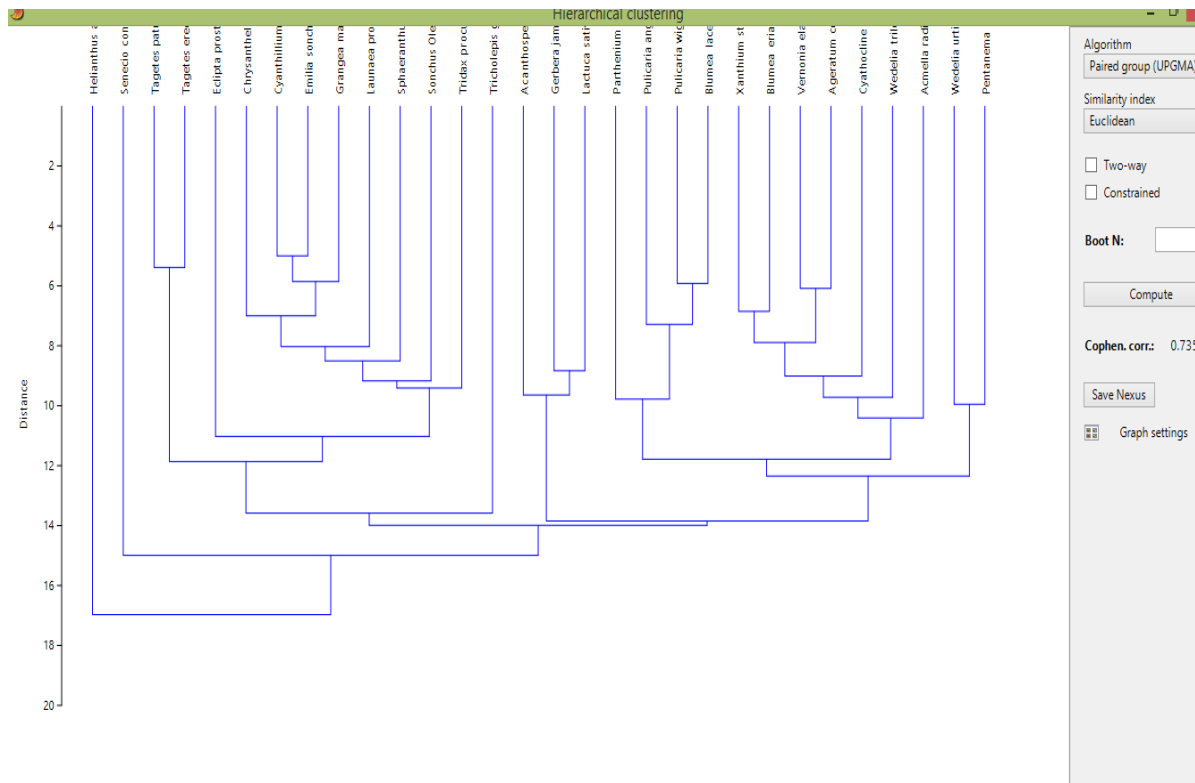


Figure 2 Phenogram of the 30 studied species, Hierarchical clustering with the UPGMA method and Euclidean distance.

NEIGHBOUR JOINING CLUSTERING ANALYSIS

Neighbour joining cluster analysis of the 30 species belonging to 27 genera depending on 52 Morphological characters. Mainly 6 neighbour joining clustering clade studied base on similarity and dissimilarity distance of morphological characters.

In the 1st neighbour joining clustering clade comprised 3 species *Wedelia urticifolia* (Bl.) Dc., *Pentanema indicum* (L.) Ling and *Senecio confuses* Burtt. In this species *Wedelia urticifolia* (Bl.)Dc. and *Pentanema indicum* (L.) Ling are closely related and neighbour joining clustering with *Senecio confuses* Burtt.

In the 2nd neighbour joining clustering clade comprised 3 species *Acanthospermum hispidum* DC., *Gerbera jamesonii* Bolus ex Hook.f. and *Lactuca sativa* L. In these species *Lactuca sativa* L. and *Acanthospermum hispidum* DC. closely related and neighbour joining clustering group with *Gerbera jamesonii* Bolus ex Hook.f.

In the 3rd neighbour joining clustering clade comprised 8 species *Vernonia elaeagnifolia* DC., *Cyathocline purpurea* (Buch.-Ham. ex D.Don) Kuntze , *Ageratum conyzoides* (L.) L. , *Xanthium strumarium* L., *Blumea eriantha* DC., *Acemella radicans* (Jacq.) R.K. Jansen, *Wedelia triloba* (L.) Hitchc and *Helianthus annuus* L. In these species, *Xanthium strumarium* L. and *Blumea eriantha* DC. are closely related while *Vernonia elaeagnifolia* DC. and *Cyathocline purpurea* (Buch.-Ham. ex D.Don) Kuntze are closely related and neighbour joining clustering group with other species .

In the 4th neighbouring clustering clad comprised 5 species *Pulicaria angustifolia* DC., *Pulicaria wightiana* (DC.) Clarke, *Blumea lacera* (Burm.f.) DC., *Parthenium hysterophorus* L., *Tricholepis glaberrima* DC. In these species *Pulicaria angustifolia* DC. and *Pulicaria wightiana*

(DC.) Clarke closely related and neighbouring joining clustering group with other 3 species *Blumea lacera* (Burm.f.) DC., *Parthenium hysterophorus* L. and *Tricholepis glaberrima* DC.

In the 5th neighbouring clustering clad group comprised 3 species *Sonchus oleraceus* (L.) L., *Eclipta prostrata* (L.) L. and *Launaea procumbens* (Roxb.) Ramayya & Rajagopal. In these species *Sonchus oleraceus* (L.) L. and *Eclipta prostrata* (L.) L. closely related and neighbouring joining clustering group with *Launaea procumbens* (Roxb.) Ramayya & Rajagopal.

In the 6th neighbouring clustering clad group comprised 8 species *Chrysanthellum americanum* (L.) Vatke, *Cyanthillium cinereum* (L.) H.Rob. *Tridax procumbens* (L.) L., *Tagetes patula* L., *Tagetes erecta* L.,

Grangea maderaspatana (L.) Poir., *Sphaeranthus indicus* L. and *Emilia sonchifolia* (L.) DC. ex DC. In these species *Chrysanthellum americanum* (L.) Vatke and *Cyanthillium cinereum* (L.) H.Rob. while *Grangea maderaspatana* (L.) Poir. and *Sphaeranthus indicus* L. closely related and neighbouring joining clustering group with other rest of the studied species

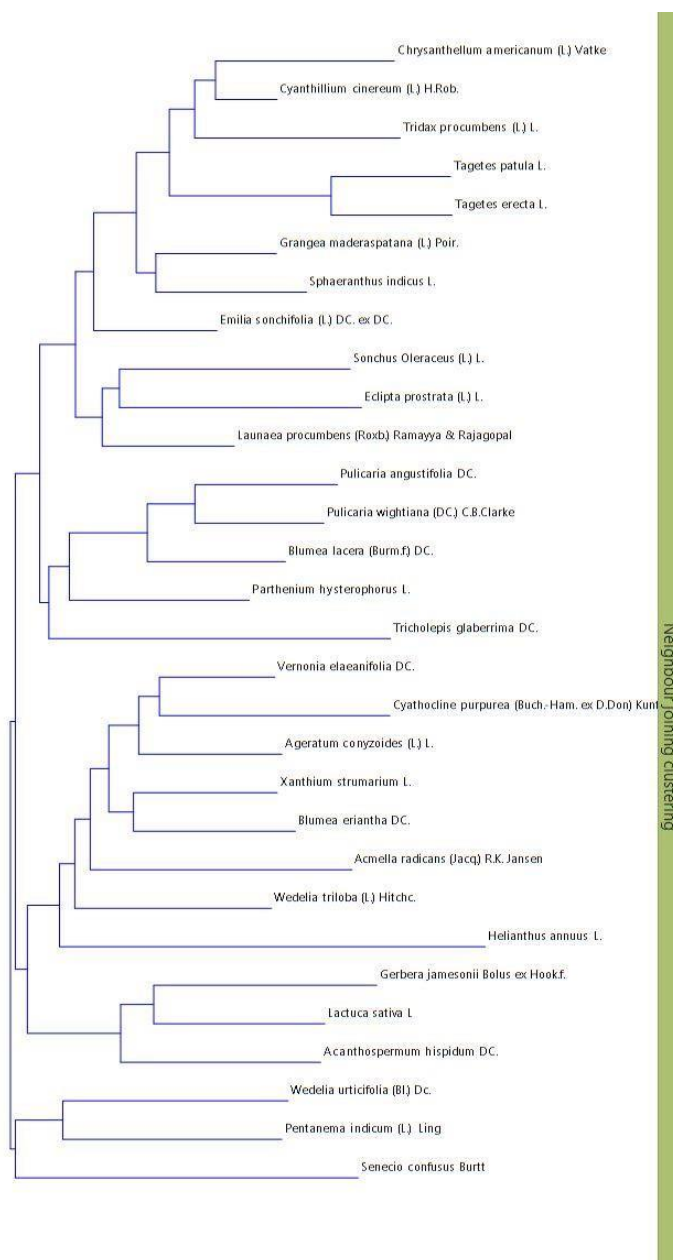


Figure 3 Phenogram of the 30 studied species, Neighbour joining Clustering with the UPGMA method and Euclidean Similarity index.

CONCLUSION

The present studies were based on a morphological character to understand systematics in Asteraceae and their evolutionary relationship. UPGMA gives insight into degree of similarity among the studied species and whether they form groups /clusters and gives an indication of the level of variation within and between species. Obtained data shows that mixing occurred at an infrageneric level during the revolutionary process. Sometimes geological and ecological factors also affect the genetic characterization and organization of diversity. To resolve the problem of Asteraceae at an infrageneric level there is need to study other genomic regions to produce groups depicting natural classification. Phynological data are considered important character in taxonomy& phylogeny of Asteraceae in general.

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