

Morphometric studies in the genus *Clerodendrum* L.

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Abstract

Six *Clerodendrum* L. species from Kolhapur district were morphometrically analyzed with the help of PCA, cluster analysis and CD. It was observed that the quantitative characters viz. petiole length, leaf length and leaf width have great significance in delimitation of all the species and corolla tube length, leaf width, gynoecium length and leaf length have great contribution in separation of the taxa. *Clerodendrum multiflorum* (Burm.f.) O. Ktze.- *Clerodendrum inerme* (L.) Gaertn., *Clerodendrum paniculatum* L. - *Clerodendrum viscosum* Vent. and *Clerodendrum inerme* (L.) Gaertn. - *Clerodendrum serratum* (L.) Moon. are very closely related with each other and *Clerodendrum multiflorum* (Burm.f.) O.Ktze.- *Clerodendrum paniculatum* L. and *Clerodendrum multiflorum* (Burm.f.) O. Ktze. - *Clerodendrum viscosum* Vent. are significantly different from each other.

Keywords: CD, cluster analysis, PCA.

INTRODUCTION

The genus *Clerodendrum* was first described by Linnaeus in 1753 with the identification of *Clerodendrum infortunatum*. The genus comprises about more than five hundred species most of which are ethno medically important and are widely distributed in tropical and subtropical regions of the world. (Shrivastava and Patel, 2007). Some authors have classified the genus into two sub- genera as *Clerodendrum* and *Cyclonema* on the basis of morphological variations like length of the corolla tube, size of the leaves and types of the inflorescence. (Steane *et al.* 1999) while others have classified into five subgenera and each subgenus is again subdivided into many sections (Moldenke, 1985). As most of the *Clerodendrum* L. species are ethnomedically important their proper identification is very important. Morphometrics adds a quantitative element to descriptions, allowing more rigorous comparisons between different forms and it has great significance in distinct grouping or separation of closely related species. In numerical classification studies, cluster analysis and principal component analysis (PCA) are widely used, which produces hierarchical classification of entities (taxa) based on similarity matrix and reduces the dimensions of the original data respectively. Such type of studies have been carried in the genus *Ficus* L. (Sonibare, *et al.* 2004), *Acalypha* L. and *Senna* Mill. (Soladoye, *et al.*, 2008, 2010) and *Cassia* L., *Exacum* L. (Deshmukh, 2011, 2012).

MATERIALS AND METHODS

Clerodendrum L. species were collected from various regions

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of Kolhapur District in the year 2010 and 2011. Collected species were identified as per Yadav and Sardesai, (2002). Various quantitative characters (viz. petiole length, leaf length, leaf width, pedicel length, calyx length, corolla tube length, stamen length and gynoecium length) were measured with the help of thread and line ruler. Corresponding mean values of each quantitative characters alongwith their standard deviation were obtained and processed for principal component analysis and cluster analysis (Kovach, 1999). Coefficient of difference values for all the quantitative characters were also calculated according to Mayr, (1969).

RESULTS AND DISCUSSIONS

Present study deals with six *Clerodendrum* L. species from Kolhapur District. Both cluster analysis and PCA were analyzed by data transformed at $\log_{(10)}$ and tolerance of eigenanalysis set at 1E-010. The values of mean and standard deviation for nine characters viz. petiole length, leaf length, leaf width, leaf length/leaf width, pedicel length, calyx length, corolla tube length, stamen length and gynoecium length are given in Table I.

PCA results of nine quantitative characters based on similarity matrix reveals significantly the correlation between petiole length and pedicel length, petiole length and leaf width, leaf length and leaf width, leaf length and pedicel length, leaf width and pedicel length and stamen length and gynoecium length.

Cluster analysis and dendrogram based on farthest neighbor, mean character difference and constrained clustering strategy show that the *Clerodendrum* L. species are distinctly divided into two groups; one group comprises *Clerodendrum multiflorum* (Burm.f.) O. Ktze., *Clerodendrum inerme* (L.) Gaertn. and *Clerodendrum serratum* (L.) Moon and other is of *Clerodendrum paniculatum* L., *Clerodendrum viscosum* Vent. and *Clerodendrum philippinum* Schuer. It also pointed out that *Clerodendrum multiflorum* (Burm.f.) O. Ktze. - *Clerodendrum inerme* (L.) Gaertn. and *Clerodendrum paniculatum* L. - *Clerodendrum viscosum* Vent. are very closely related with each other.

Coefficient of difference values were also calculated for all the quantitative parameters. The CD values revealed that the

quantitative characters i.e. corolla tube length, leaf width, gynoecium length, leaf length and calyx length have great contribution in separation of the taxa. CD values mentioned that *Clerodendrum*

multiflorum (Burm.f.) O. Ktze. - *Clerodendrum viscosum* Vent. are significantly different from each other and *Clerodendrum paniculatum* L. - *Clerodendrum viscosum* Vent. are morphologically very similar.

Table 1. Quantitative characters of *Clerodendrum* L. species (in cm.) with mean and standard deviation.

	C1	C2	C3	C4	C5	C6
PetL	0.82 ± 0.28	0.92 ± 0.26	5.72 ± 4.53	21.21 ± 9.35	11.12 ± 4.51	0.63 ± 0.022
LL	3.2 ± 0.90	5.14 ± 1.56	12.37 ± 3.79	20.06 ± 3	22.89 ± 2.15	17.17 ± 7.05
LW	1.98 ± 0.69	2.7 ± 0.82	10.02 ± 3.52	21.81 ± 4.21	21.36 ± 2.15	6.03 ± 0.44
LL/LW	1.61 ± 0.57	1.9 ± 0.9	1.23 ± 0.88	0.91 ± 0.71	1.02 ± 0.86	2.84 ± 0.92
PedL	1.25 ± 0.40	0.5 ± 0.11	0.65 ± 0.12	1.15 ± 0.07	1.15 ± 0.63	0.53 ± 0.11
CaL	0.3 ± 0.07	0.5 ± 0.081	1.94 ± 0.2	0.4 ± 0.1	1.82 ± 0.07	0.5 ± 0.11
CoL	2.73 ± 0.11	3.6 ± 0.16	2.82 ± 0.095	2.23 ± 0.15	3.52 ± 0.35	0.95 ± 0.33
SL	2.4 ± 0.16	3.17 ± 0.42	1.5 ± 0.65	3.33 ± 0.15	3.6 ± 0.2	3.3 ± 0.14
GL	3.8 ± 0.20	5.3 ± 0.36	2.56 ± 0.56	4.2 ± 0.057	4.66 ± 0.32	3.7 ± 0.07

PetL: petiole length, LL: leaf length, LW: leaf width, LL/LW: leaf length/ leaf width, PedL: pedicel length, CaL: calyx length, CoL: corolla tube length, SL: stamen length, GL: gynoecium length.

C1: *Clerodendrum multiflorum* (Burm.f.) O. Ktze., C2: *Clerodendrum inerme* (L.) Gaertn., C3: *Clerodendrum philippinum* Schuer, C4: *Clerodendrum paniculatum* L., C5: *Clerodendrum viscosum* Vent, 6: *Clerodendrum serratum* (L.) Moon.

Table 2. Principal Component Analysis of *Clerodendrum* L. species (Tolerance of eigenanalysis set at 1E-010)

Similarity Matrix	PetL	LL	LW	LL/LW	PedL	CaL	CoL	SL	GL
PetL	1.000								
LL	0.685	1.000							
LW	0.919	0.913	1.000						
LL/LW	-0.884	-0.299	-0.662	1.000					
PedL	0.922	0.844	0.963	-0.695	1.000				
CaL	0.303	0.226	0.339	-0.434	0.228	1.000			
CoL	0.261	-0.313	0.005	-0.608	0.152	0.439	1.000		
SL	0.098	0.324	0.220	0.115	0.392	-0.501	-0.143	1.000	
GL	-0.047	-0.095	-0.080	0.039	0.175	-0.469	0.297	0.849	1.000

PetL: petiole length, LL: leaf length, LW: leaf width, LL/LW: leaf length/ leaf width, PedL: pedicel length, CaL: calyx length, CoL: corolla tube length, SL: stamen length, GL: gynoecium length

Table 3. Coefficient of Difference in between all the species groups of *Clerodendrum* L.

SG	PetL	LL	LW	L/LW	PedL	CaL	CoL	SL	GL	Total
C1& C2					*	*	*	*	*	05
C1 & C3		*	*			*			*	04
C1& C4	*	*	*				*	*	*	06
C1& C5	*	*	*			*	*	*	*	07
C1&C6		*	*		*		*	*	*	05
C2 & C3		*	*			*	*	*	*	06
C2& C4	*	*	*		*		*		*	06
C2& C5	*	*	*			*				04
C2&C6		*	*				*		*	04
C3& C4			*		*	*	*	*	*	06
C3& C5		*	*				*	*	*	05
C3&C6						*	*	*	*	04
C4 & C5						*	*			02
C4&C6	*		*		*		*		*	05
C5&C6	*		*			*	*		*	05
Total	06	09	12	00	05	09	13	08	12	

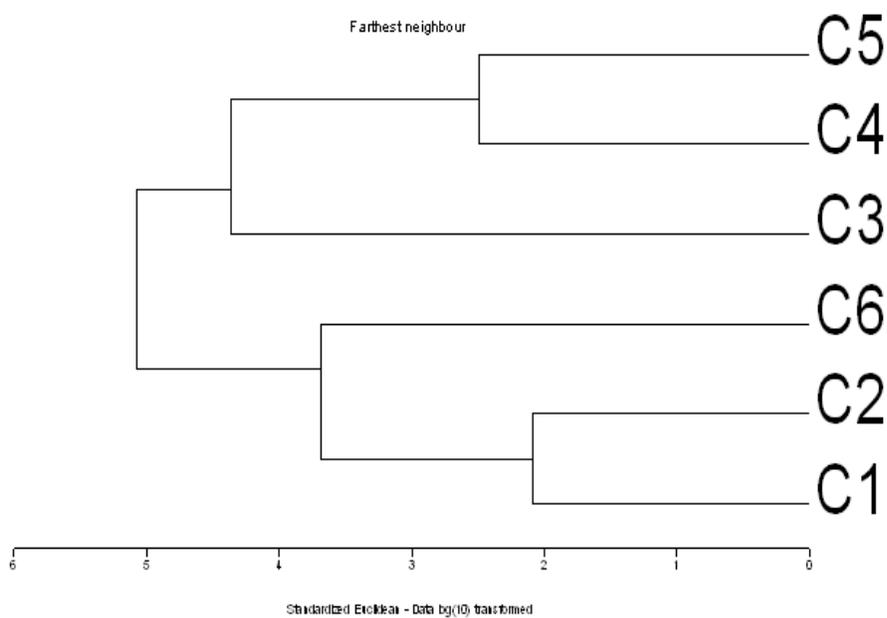
*: CD greater than 1.28 (Mayr, 1969).

SG: Species Group, PetL: petiole length, LL: leaf length, LW: leaf width, LL/LW: leaf length/ leaf width, PedL: pedicel length, CaL: calyx length, CoL: corolla tube length, SL: stamen length, GL: gynoecium length C1: *Clerodendrum multiflorum* (Burm.f.) O. Ktze, C2: *Clerodendrum inerme* (L.) Gaertn., C3: *Clerodendrum philippinum* Schuer, C4: *Clerodendrum paniculatum* L., C5: *Clerodendrum viscosum* Vent, 6: *Clerodendrum serratum* (L.) Moon.

Table 4. Cluster analysis revealing relationship between six *Clerodendrum* L. species.

Distance matrix	C1	C2	C3	C4	C5	C6
C1	0					
C2	0.094	0				
C3	0.333	0.308	0			
C4	0.532	0.486	0.263	0		
C5	0.488	0.438	0.199	0.145	0	
C6	0.274	0.230	0.285	0.436	0.385	0

C1: *Clerodendrum multiflorum* (Burm.f.) O. Ktze., C2: *Clerodendrum inerme* (L.) Gaertn., C3: *Clerodendrum philippinum* Schuer, C4: *Clerodendrum paniculatum* L., C5: *Clerodendrum viscosum* Vent, 6: *Clerodendrum serratum* (L.) Moon.



C1: *Clerodendrum multiflorum* (Burm.f.) O. Ktze, C2: *Clerodendrum inerme* (L.) Gaertn., C3: *Clerodendrum philippinum* Schuer, C4: *Clerodendrum paniculatum* L., C5: *Clerodendrum viscosum* Vent, 6: *Clerodendrum serratum* (L.) Moon.

Fig 1. Dendrogram on the basis of farthest neighbor, mean character difference and constrained clustering strategy observed in quantitative characters of *Clerodendrum* species.



Clerodendrum paniculatum L



Clerodendrum philippinum Schuer



Clerodendrum serratum (L.) Moon



Clerodendrum viscosum Vent.



Clerodendrum multiflorum (Burm.f.) O. Ktze.



Clerodendrum inerme (L.) Gaertn.

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