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Morphometric Study of *Musanga cecropioides* R. Brown and *Myrianthus arboreus* Palisot de Beauvois (Family Cecropiaceae)

***[1]ARUSURAIRE, JO; [2]NYANANYO, BL**

[1]*Department of Plant Science and Biotechnology, University of Port Harcourt, Port Harcourt, Nigeria*
[2*]*Department of Biological Sciences, Federal University Otuoke, Otuoke, Nigeria*
bionyananyo@yahoo.com
*Corresponding author: [2]Nyananyo, B. L.

ABSTRACT: Morphometric or Numerical taxonomic analysis of 56 quantitative and qualitative characters, obtained from *Musanga cecropioides* R. Brown and five species of *Myrianthus*, *M. arboreus* Palisot de Beauvois, *M. holstii* Engler, *M. libericus* Rendle, *M. preusii* Engler and *M. serratus* (Trecul) Bentham was carried out by calculating similarity and distance indices followed by cluster analysis and construction of a dendrogram for visual appreciation of the taxonomic relationship among these species. The dendrogram showed close similarity among the *Myrianthus* species, with *Musanga cecropioides* clearly distinct from the *Myrianthus* species. This confirms the monotypic status of *Musanga*, with only one species, *Musanga cecropioides*.© JASEM

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The taxonomic status of the species, *Musanga cecropioides* R.Br. and *Myrianthus arboreus* P.Beauv. has been problematic (Nyananyo and Offiong, 2012). Both genera have been placed in various families: Urticaceae (Corner, 1962; Ojinnaka *et al*., 1984, 1986; Airy-Shaw, 1985; Nyananyo, 2006), Moraceae (Keay, 1989; Oke and Odebiyi, 2007; Kadiri and Ajayi, 2009) and Cecropiaceae (Berg, 1978; Burkill, 1985; Setoguchi *et al*., 1993; Okafor, 2004; Takhtajan, 2009; Nyananyo and Offiong, 2012).

In Engler's (1889) classification of the Moraceae, the two African genera, *Musanga* and *Myrianthus*, together with the neotropical genera, *Cecropia* Loefl., *Coussapoa* Poepp. & Endl. and the Asiatic genus, *Poikilospermum* Zippelius ex Miguel., constituted the subfamily Conocephaloideae (Ruiter, 1976). Corner (1962), transferred the whole subfamily to the Urticaceae. However, Wee-Lek (1963), suggested an even more unnatural system of classification based on fruit size. He placed *Musanga* and other microspermous genera of the Conocephaloideae in the Urticaceae leaving the megaspermous genera including *Myrianthus* in the Moraceae. The classification of Corner (1962) had support from various workers using evidence from such systematic lines of evidence as gross morphology and phytochemistry (Ruiter, 1976; Ojinnaka *et al*., 1986).

Berg (1978), proposed the new family, Cecropiaceae, to incorporate the genera, *Musanga* and *Myrianthus* based on morphological characters, pointing out that they apparently form a natural coherent group distinct from members of the Moraceae and Urticaceae.

The confused taxonomic history of Cecropiaceae (Setoguchi *et al*., 1993) reflects the fact that Cecropiaceae is intermediate between the Moraceae, with which they share possession of lactifers, and the Urticaceae with which they share orthotropous sub-basal or basal ovule (Berg, 1978; Takhtajan, 2009).

The isolation of tormentic and euscaphic acids from *Musanga* and *Myrianthus* and their absence in other genera of the families, Moraceae and Urticaceae (Ojinnaka *et al*., 1984, 1986), provided a chemical systematic line of evidence in support of Berg's (1978) proposal for a separate family Cecropiaceae for the genera, *Musanga* and *Myrianthus*.

Morphometrics also known as Numerical taxonomy can be defined as the quantitative analyses of biological form. It has been widely used in a lot of disciplines including Systematics (Henderson, 2006). Morphometrics or Numerical taxonomy is the application of various mathematical procedures to numerically encode characters. This practice integrates data from a wide variety of sources such as anatomy *sensu lato*, chemistry, cytology, ecology, genetics, geography, palynology, physiology etc. (Soladoye *et al*., 2010). Actual morphometric or numerical taxonomic studies of plant taxa were very scarce before the 1960s (Dogan *et al*., 2009). The product of this exercise is usually accepted as unbiased and therefore objective and used to classify or place

**Corresponding author Email: bionyananyo@yahoo.com*

taxa in an appropriate and acceptable hierarchy (Quike, 1993). Morphometrics or Numerical taxonomy has previously been applied in the classification of a number of plant taxa (El-Gazzar, 2008; Dogan *et al*., 2009; Soladoye *et al*., 2010).

In this investigation, morphometrics or numerical taxonomy (which is not a systematic line of evidence) has been applied to clarify the doubtful taxonomic status of *Musanga cecropioides* and five species of *Myrianthus*, based on quantitative and qualitative characters.

MATERIALS AND METHODS

Musanga cecropioides R. Brown and five (5) species of *Myrianthus* (*M. arboreus* Palisot de Beauvois., *M. holstii* Engler, *M. libericus* Rendle, *M. preusii* Engler) and *M. serratus* (Trecul) Bentham) were grouped by cluster analysis using the un-weighted pair group method analysis (UPGMA) based on the similarity matrix of Euclidean distances of 56 quantitative and qualitative characters. The characters were selected without prejudice. These characters obtained from the leaf, habit, stem, flower and fruit structure, seed, chemical components (leaf and stem), anatomy (leaf and stem), pollen morphology, and ecology were placed under ten headings (Table 1).To trace the relationship among the taxa studied, the data were standardized before clustering and a dendrogram was constructed. The statistical analyses were performed using the PAST software.

Table 1: List of Characters and Character States used in the Numerical Analysis

A	**LEAVES**			**7 elliptic/oblong/oblanceolate**
1	Leaf margin	1 – serrate	10 Lateral nerves	1 – 0-10 pairs
		2 – entire		2 – 11-20 pairs
		3 – undulate		3 – 21-30 pairs
		4 – dentate		4 – 0-20 pairs
		5 – serrate,		5 – 0-30 pairs
		undulate & dentate		6 – 11-30 pairs
2	Leaf lobe	1 – not lobed	11 Length	1 – 0-10cm
		2 – often lobed		2 – 11-20cm
		3 – lobed & not		3 – 21-30cm
		lobed		4 – 31-40cm
				5 – 41-50cm
3	Leaf nature	1 – simple		6 – 0-40cm
		2 – compound		7 – 11-30cm
		1 – alternate		8 – 11-40cm
4	Venation	2 – reticulate		1 – 0-10cm
		3 – parallel	12 Width	2 – 11-20cm
		1 - ≥7		- 21-30cm
		2- ≤7		- 31-40cm
5	Leaflets	3 - ≤7≥		- 0-20cm
		0 – absent		6 – 0-40cm
		1 – present		- absent
		1 – acuminate		- present
6	Pubescence	2 – acute		1 – opposite
		3 – obtuse	13 Stipules	2 – alternate
		4 – acuminate & acute		3 – whorled
7	Apex	5 – acute & obtuse		- alternate & whorled
		1 – cuneate	14 Phyllotaxy	0 – absent
		2 – acute		1 – present
		3 – obtuse		2 – regular
		4 – cuneate & obtuse	15 Petiole	2 – regular
				1 – inferior
				2 – superior
8	Base:		30 Ovary	
9	Shape	1 – ovate	31Ovary cells	1 – unilocula
		2 – elliptic		2–bilocular
		3 – oblong		
		4 – lanceolate	32 Calyx:	1 – free
		5 – oblanceolate		2- fused
		6 ovate/elliptic/oblanceolate		
16	Petiole length	1 – 0-10cm	33 Nature of stamen	1 – branched
		2 – 11-20cm		2 – erect
		3 – 21-30cm		
		4 – 31-40cm	34 No. of	
		5 – 41-50cm	Stamens	1 – 1
		6 – 51-60cm		2- >1
		7 - 0-20cm	35 Nature of style	
		8 – 0-50cm		1 – straight
		1 – epiphytic		2– curled
B	**HABIT**	2 – epiphytic	36 No. of style	
17	Habi	3 – climbing		1 1 -

		1 – herb			2- > 1
18	Habit type	2 – tree	E **FRUIT**		
		3 – shrub	**37 I** nfructescence		1 – simple
					2- aggregate
		0 – absent			
		1 – present			
19	Trunk		38 Fruit type		1 – capsule
					- berry
		1 – plant bisexual			- drupe
		2 – plant unisexual			1 – rough
20	Plant type		39 Surface Ornamentation		2 – smooth
		0 – absent			1 – ellipsoid
		1 – present	40 Fruit shape		2– obovoid
21	Aerial stilt Root				3– globose
					4 – lobulate
		1 – sympodial			5 – ellipsoid&obovoid
		2– monopodial			
22	Branching pattern				- acute
		1 – stem herbaceous	41 Fruit apex		obtuse
		2– stem woody			- acute&obtuse
	STEM				0 – absent
C	Nature of				1 – present
23	Stem	1 – stem glabrous	42 Pulp in fruit		
		2 - stem pubescent			1 – axile
					2 – basal
	Pubescence	1 – white	43 Placentation		3– others
24		2– grey			
		3 – brown			
	Stem colour	4 – brownish green			1 – 1-2
25		5 – greenish white			2– 3-4
		6 – grey/brown	**F. SEED**		3 – 5-6
		7 – white/grey	**44** No. of seeds		4– 7-8
		8– grey/brownish green			5– 9-10
		9– grey/brown/greenish white			6– 11 & above
		0 – absent			
		1– present			1 – lanceolate
		2 – absent/present			2 – ovate
		1 – terminal	45 Seed shape		3 – oblong
		2 – axillary			
	Thorns and Spines:				
26		1 – not in dense heads	I **POLLEN**		- colpate
		2 – in dense heads	**MORPHOLOGY**		colporate
	FLOWERS	1 – irregular	**52** Pollen type		- with 2 apertures
	Inflorescence	2- others			with >2 apertures
D			53 Pollen aperture		
27	Flower head	0 – absent			- aquatic
		1 – present			- terrestrial
28		0 – absent			- plant totally submerged
	Flower type	1 – present	J **ECOLOGY**		- partially submerged
			54 Habitat		- plant not submerged
29		0 – absent			
	CHEMISTRY	1 – present	**55** Submergence		1 - sympatric
					2 – allopatric
G			56 Speciation		
46	Flavonols:	0 – absent			
		0 – absent			
47					
	Saponi	0 – absent			
		1 – present			
48					
		0 – absent			
	Cyanidin	1– present			
49					
	ANATOMY				
	Trichomes				
H					
50	Free hypanthium				
51					

RESULTS AND DISCUSSION

In the present study, six taxa were evaluated on the basis of data matrix generated from 56 quantitative and qualitative characters (Table 1). A similarity matrix based on Euclidean distances for the six taxa is presented in Table 2. The constructed dendrogram

based on the Euclidean distances from the data matrix (Appendix 1) divides the taxa into three clusters, viz. cluster G_1 and subclusters SG_1 and SG_2 (Figure 1).

Cluster 1 (G_1) consists of only one species, *Musanga cecropioides*. While cluster 2 (G_2) has two subclusters, SG_1 and SG_2. Subcluster SG_1 comprises of *Myrianthus arboreus, M. holstii* and *M. preussii*, in which their leaves are palmately compound, with 5-7 serrated leaflets. Subcluster SG_2 comprises of *Myrianthus serratus* and *M. libericus*, in which both have simple leaves with fine toothed margins. This result confirms the report of Hutchinson & Dalziel, 1954.

The dendrogram showed that *Myrianthus arboreus*, *M. holstii* and *M. preussii* are closely related with *M. arboreus* and *M. holstii* being more closely related. While *M. serratus* and *M. libericus* are closely related. *Musanga cecropioides* appeared to be distinct from all the *Myrianthus* species.

Table 2: Similarity matrix of *Musanga cecropioides* and 5 species of *Myrianthus.*

Musanga cecropioides R.Br.	0	7.6811	8.4261	8.6603	8.7178	7.4162
Myrianthus arboreus P.Beauv.	7.6811	0	6.4807	6.3246	5.5678	6.1644
M. serratus (Trecul) Benth.	8.4261	6.4807	0	5.6569	7	8.4853
M. libericus Rendle	8.6603	6.3246	5.6569	0	7.4162	9.5917
M. holstii Engl.	8.7178	5.5678	7	7.4162	0	6.4031
M. preussii Engl.	7.4162	6.1644	8.4853	9.5917	6.4031	0

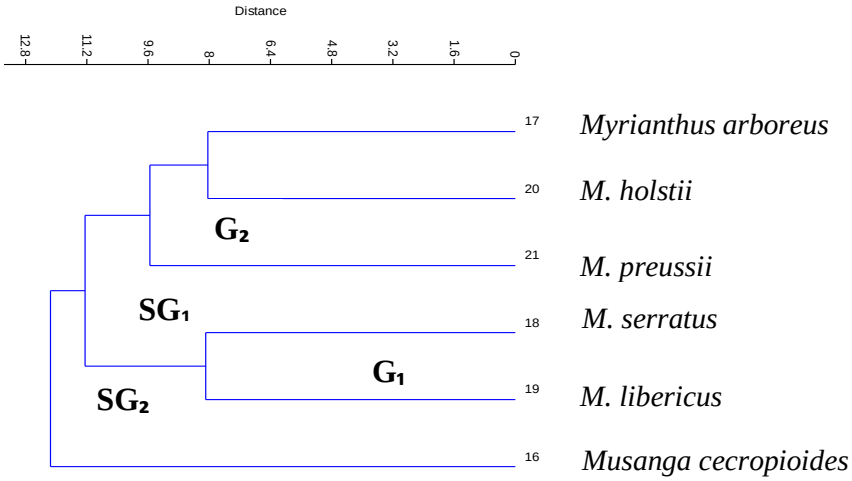

Fig 1: Dendrogram showing the relationship between *Musanga cecropioides* and *Myrianthus* species (where G and SG represent Group and Subgroup respectively)

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APPENDIX 1Data Matrix of Characters used in Numerical Analysis

OTUs	CHARACTER NUMBER																											
	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
Musanga cecropioides R.Br.	1	1	2	2	1	1	1	1	5	3	5	1	1	4	1	6	2	2	1	1	2	1	2	3	6	2	2	1
Myrianthus arboreus P. Beauv.	2	1	2	2	3	1	2	1	5	6	3	5	1	4	1	8	2	2	1	1	2	1	2	1	6	0	2	1
M. serratus (trecul) Benth	2	1	1	2	2	1	5	4	6	4	6	5	1	2	1	7	3	2	1	1	2	1	2	1	7	0	2	1
M. libericus Rendle	2	3	1	2	2	1	4	1	2	4	6	6	1	2	1	7	3	2	1	1	2	1	2	1	6	0	2	1
M. holstii Engl.	5	3	2	2	3	1	2	1	7	6	6	5	1	4	1	8	3	2	1	1	2	1	2	3	6	0	2	1
M. preussii Engl.	5	1	2	2	3	1	1	1	7	5	3	1	1	4	1	7	3	2	1	1	2	1	2	1	6	0	2	1

OTUs	CHARACTER NUMBER																											
	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Musanga cecropioides R.Br.	2	2	2	1	2	1	1	5	2	1	3	0	2	6	2	2	1	1	3	0	0	0	1	1	0	2	1	3
Myrianthus arboreus P. Beauv.	2	2	2	2	2	1	2	3	1	3	3	1	2	6	2	2	1	1	3	0	0	0	1	1	0	2	1	3
M. serratus (trecul) Benth	2	2	2	2	2	1	2	4	1	3	3	1	2	6	2	2	1	1	3	0	0	0	1	1	0	2	1	3
M. libericus Rendle	2	2	2	2	2	1	2	4	1	3	3	1	2	6	2	2	1	1	3	0	0	0	1	1	0	2	1	3
M. holstii Engl.	2	2	2	2	2	1	2	3	1	3	3	1	2	6	2	2	1	1	3	0	0	0	1	1	0	2	1	3
M. preussii Engl.	2	2	2	2	2	1	2	4	1	3	1	1	2	6	2	2	1	1	3	0	0	0	1	1	0	2	1	3