
Morpho-Taxonomic studies of some herbaceous species of *Euphorbia* L. (Euphorbiaceae L.) in Nigeria

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Abstract

Systematic studies in Euphorbia have not been comprehensively investigated in Nigeria. The study provides detailed morphological observations on selected species of weedy species of Euphorbia showing relationships among species. Hitherto unattended gross qualitative characters were assessed for stable, distinctive and diagnostic features. Quantitative features were measured with the aid of a line ruler and calibrated ocular. Results from the morphological examinations showed that the variation in stem, leaf, petiole and internode lengths, cyathium, involucre and cyathia gland characters, male flower, anther, ovary and seed attributes are diagnostic among species characteristics. In this work, vegetative and floral morphological data obtained are enough for the clarification of taxonomic relationships in the genus Euphorbia. Some characters have been redefined, better identification has been achieved and a new identification key has been constructed other than the ones used in the flora of West Tropical Africa.

Keywords: Cyathia, diagnostic, *Euphorbia*, herbaceous, morphological,

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Introduction

Euphorbia, a temperate, tropical and non-tropical genus of the family Euphorbiaceae, tribe Euphorbieae and subtribe Euphorbiinae is rated as third largest genus of angiosperms after *Astragalus* (Fabaceae) and *Psychotria* (Rubiaceae) (Govaerts *et al.*, 2000). Accounts across the globe reveal that the genus is among the five most species-rich genera in the flowering plants (Frodin, 2004) and it is considered as a large genus of about 2000 species.

Hutchinson and Dalziel (1958) described 30 species of the genus in Nigeria. However, apart from these there exists one additional exotic species (*Euphorbia graminea* Jacq.) not originally listed in the flora of West Tropical Africa. Aigbokhan and Ekutu (2012) reported the occurrence and proliferation of *Euphorbia graminea* in Nigeria and suggested that it is a recently introduced species. Radcliffe-Smith (1980) reported 44 species of *Euphorbia* for the Iraqi flora. Post (1933) gave the description of 44 species of *Euphorbia* for flora of Syria, Palestine and Sinai. Also, Migahid (1978) reported 14 species in flora of Saudi Arabia. Fayed and Hassan (2007) considered *Euphorbia* as the largest genus in the Egyptian flora. El-Hadidi (1974) and Fayed and Hassan (2007) recorded 39 species for Egypt. Chemaly and Chemaly (2007) gave the illustrations of 38 species of *Euphorbia* in the flora of Lebanon. The life form of *Euphorbia* is annual or perennial herbs, shrubs and trees. They occur as prostrate, decumbent or erect, monoecious or dioecious, succulent and non-succulent (Dutta, 1974; Olorode, 2012).

In spite of the importance of *Euphorbia* regarding its potential and functions, understanding of weedy habit and the numerous economic uses and its importance as a significant element of the flora of both tropical and subtropical regions, systematic studies in *Euphorbia* have not been comprehensively investigated in Nigeria. The present work investigates the macro-morphological characters of the selected species of *Euphorbia* studied in order to establish the taxonomic relationship among the six species for easy identification and delimitation.

Materials and Methods

Plant Collection

Freshly collected specimens (of *E. graminea*, *E. heterophylla*, *E. hirta*, *E. prostrata*, *E. hyssopifolia* and *E. thymifolia*) from the field and specimen from different herbaria (Forest Herbarium Ibadan (FHI), Elikaf Herbarium of Olabisi Onabanjo University, Ago-Iwoye, Ogun State and Obafemi Awolowo University, Ile-Ife herbarium) were employed for the study. The fresh specimens were pressed with the aid of plant press. Identification and authentication was done appropriately at Forest Herbarium Ibadan (FHI) and the specimens were deposited both at FHI, Elikaf Herbarium of Olabisi Onabanjo University, Ago-Iwoye, Ogun State and Obafemi Awolowo University, Ile-Ife herbarium (IFE). All the names of plants used are according to the flora of West Africa (Hutchinson and Dalziel, 1958).

Field collection was conducted between flowering and fructifying period throughout the years (2015-2018). Features of botanical interest observed in the field collections were photographed with a Canon EOS 550D DSLR Camera fitted to binocular dissecting microscope (XT-3C 20x & 40x dual light illumination turret step stereoscopic microscope/student microscope & Biological compound microscope). These photographs were useful for identification and differentiation of morphological features.

Macro-morphological study

Qualitative characters

Both the vegetative and the reproductive characters of all the species of *Euphorbia* examined were employed in the morphological studies. Qualitative characters were based on physical examination with naked eyes and dissecting microscope. Descriptive terminologies used were according to Hutchinson and Dalziel (1958), Steinmann and Porter (2002), Bruyns *et al.* (2006) and Zokia (2011).

Quantitative characters/Statistical analysis

The statistical analyses of the morphological quantitative data were

based on to the method employed by Sonibare *et al.* (2004) and Soladoye *et al.* (2010) with some modifications. The quantitative characters were measured and thirty (30) measurements were taken for each of the characters. The measurement was taken to the nearest millimeters. Counts were taken of the number of aborted cyathia, number of lateral nerves, number of male flowers, number of styles, number of stigma, number of cyathia and number of glands. Vegetative characters were measured with thread and meter rule while floral features were measured using ocular micrometer inserted into eye piece of the dissecting microscope. Mean values along with standard error were calculated for each character. The values generated were then recorded into Microsoft Excel spreadsheet and raw data were coded to allow analysis using SPSS 19.0 analysis sheet.

Results

The morphological features of the six species of *Euphorbia* are given in Table 1, 2, 3 and 4 and showed in Figure 1. Qualitative characters were described in Table 1 and 2 while quantitative macro-morphological characters were shown in Table 3 and 4. The morphological characters of stem, mature leaves, trichomes, cyathium and nature of seeds at comparative positions were described for each species. These characters include stem length, stem color, numbers of lateral branches on the stem, stem types (mode of branching), leaf apex, leaf margin, leaf shape, leaf surface, leaf base, leaf length, leaf width, leaf blade or lamina length, petiole length, petiole width, internode, number of aborted cyathia, involucre shapes, length, width, shapes, number, colour of glands, length of male flower, diameter of anther, diameter of filament, colour of filament, length of pedicel, ovary shape, diameter of ovary, length of ovary pedicel, type of cyathium, apex of gland and seed color. Most of the characters examined are variable in size and number while some characters such as number of styles and stigma branches, show consistency.

Artificial key for the identification of *Euphorbia* species based on macro-morphological characters

- 1a. Plants herbaceous annual weed; stem prostrate or decumbent; stipulate; leaf arrangement opposite (2)
- 1b. Plants herbaceous perennial weed, stem erect, non-stipulate, leaf arrangement opposite above and alternate below..... *E. graminea*
- 2a. Ovary surface pubescent or pubescent only on the edge, seed shape oblong-conical or tetragonal; colour of gland red.....(3)
- 2b. Ovary surface glabrous; seed shape truncate ellipsoid or ovoid to quadrangular; colour of gland, green peltate.....(4)
- 3a. Leaf blade pubescent on both surfaces, stipule linear, ovary pubescent, involucre campanulate (5)
- 3b. Leaf blade pubescent only on the one surface, stipule triangular, ovary pubescent only on the angles; involucre turbinate..... *E. prostrata*
- 4a. Involucre urn shaped, glands 1, green, pellate funnel-shape, style up to

Table 1: Qualitative vegetative morphological characters of the species of *Euphorbia* studied

Species Characters	<i>Euphorbia graminea</i>	<i>Euphorbia heterophylla</i>	<i>Euphorbia hirta</i>	<i>Euphorbia hyssopifolia</i>	<i>Euphorbia prostrata</i>	<i>Euphorbia thymifolia</i>
Habit	Perennial	Annual	Perennial	Perennial	Annual	Perennial
Stem shape	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical	Cylindrical
Stem colour	Green	Green often tinged red towards the apex	Green to red	Green to red	Red or brown	Pink when fresh but pale green or dark purplish when drying
Type of branching	Branching from the base and dichotomously branched distally	Sparsely branched	Branched from the middle or above	Branched from the base	Branched from the base	Branched from the base
Leaf blade	Ovate to rounded-oblong	Ovate to lanceolate	Oblique obovate-oblong or oblong	Oblique obovate-oblong or oblong	Oblique obovate-oblong or oblong	Oblique obovate-oblong or oblong
Types of leaf	Simple	Simple	Simple	Simple	Simple	Simple
Leaf apex	Acuminate to acute	Obtuse to slightly acuminate	Almost acute	Rounded to subacute	Obtuse or round	Obtuse or round
Leaf base	Acute to obtuse	Cuneate	Obliquely rounded	Obliquely rounded	Obliquely rounded	Obliquely rounded
Leaf margin	Entire	Minute gland-tipped teeth	Often toothed	Serrulate (serrate along the upper leaf margin)	Shallowly toothed	Shallowly toothed
Presence of trichomes on leaf	Pubescent on both surfaces	Lower leaves pubescent and upper leaves almost glabrous	Pubescent on both surfaces	Glabrous on both surfaces	Glabrous above and sparsely hairy beneath	Glabrous above and pilose beneath
Leaf colour	Green	Green, upper leaves with whitish or reddish base	Green to red	Green to purple	Green to purple	Green
Leaf arrangement	Alternate below and opposite above around cyathium	Spirally crowded at stem apex	Opposite	Opposite	Opposite	Opposite
Stipules	No stipule	Stipules modified into purplish gland	Linear	Connate	Triangular	Linear

Table 2: Qualitative floral characters of the species of *Euphorbia* studied

Species Character	<i>Euphorbia graminea</i>	<i>Euphorbia heterophylla</i>	<i>Euphorbia hirta</i>	<i>Euphorbia hyssopifolia</i>	<i>Euphorbia prostrata</i>	<i>Euphorbia Thymifolia</i>
Arrangement of cyathia	Long peduncle cymes	Compact axillary or terminal cyme	Dense head-like peduncle cymes	Leafy axillary cymes	Single, axillary peduncle	Axillary or terminal cymes of two or more in an axil
Involute shape	Campanulate	Urn-shape	Campanulate	Turbinate	Turbinate	Campanulate
Shape of gland	Obovate	Peltate, funnel- shape	Tiny elliptic	Almost circular	Transversely elliptic	Almost circular
Colour of gland	Whitish or sometimes purplish	Green peltate	Red	Green	Red	Red
Colour of filament	White	White	White	White	White	White
Mode of attachment of filament to the anther	Basifixed	Basifixed	Basifixed	Basifixed	Basifixed	Basifixed
Capsule surface	Glabrous	Glabrous	Pubescent	Glabrous	Pubescent only on the angles	Pubescent
Involute surface	Glabrous	Glabrous	Pubescent	Glabrous	Glabrous	Pubescent
Seed shape	Ovoid, long and cylindrical truncated at the base	Truncate ellipsoid	Oblong – conical or tetragonal	Ovoid to quadrangular	Oblong – conical or tetragonal	Oblong – conical or tetragonal
Seed colour	White or brown – grey	Blackish – brown	Brown or grey	Black	Grey – brown	Reddish – brown
Seed configuration	Longitudinal rows of shallow depression	Pitted with transverse ridges	Slightly wrinkled	Transversely wrinkled	Transversely ridges	Shallow transverse furrows

Table 3: Quantitative vegetative morphological characters of the species of *Euphorbia* studied

Characters	Leaf length	Leaf width	Leaf blade perimeter	Internode Length	Petiole length	Stem height	No of Lateral nerves
Species							
<i>E. hirta</i>	28.3±0.81	12.88±0.35	68.67±1.80	30.13±1.36	3.63±0.15	224.17±13.84	3-4
<i>E. thymifolia</i>	7.35±0.17	4.43±0.10	14.73±0.94	9.45±0.20	1.2±0.07	142.3±10.19	1-3
<i>E. graminea</i>	50.17±1.30	33.13±0.78	112.33±3.18	48.67±3.70	29.35±1.56	394.9±27.30	6-12
<i>E. heterophylla</i>	85.9±3.09	43.43±2.07	203.3±7.51	36.77±3.92	22.47±1.59	515.8±31.02	6-13
<i>E. hyssopifolia</i>	31.33±0.66	8.67±0.47	76.4±1.71	28.37±1.19	1.54±0.09	437.57±16.88	2-3
<i>E. prostrata</i>	7.53±0.16	3.8±0.09	12.53±1.36	16.8±0.75	1.65±0.07	124.8±8.24	2-3

Units in millimeters (mm)

All measurements represent mean ±standard error

Table 4: Quantitative floral morphological characters of the species of *Euphorbia* studied

Character	MF	AD	FL	FD	MP	OL	OW	OPL	S	SL	STN	SEW	SEL	IL	IB	CY	ACY	GN
Species	N																	
	L																	
<i>E. thymifolia</i>	5-8	198.80 ± 6.87	126.4±	139±	204.80	798.20	702.80±	0	3	183±	6	235.40±	438.00±	655.00±	313.70	11.00±	0.40	4
<i>E. graminea</i>	4-19	134.6	192.3	194±	212.50	314.60	346.10	268.00	3	77.7±	6	724.50	968.90	790.00±	150.50±	1.60±	0.50±	4
<i>E. prostrata</i>	4-9	65.56± 1.73	64.88±	54.10± 2.47	54.07± 2.47	683.30	677.20±	322.00±	3	126± 5.54	6	263.60±4. 74	495.40±9. 65	990.00±4 3.30	277.10±1 0.46	3.20±0.2 0	0.60±0.1 0	4
<i>E. heterophylla</i>	7-28	320.8± 16.19	177.3±	204±5. 59	274.20 ±30.34	3849.0 0±939	2718.00 ±107.4	279.00±	3	227± 7.95	6	1355.00± 15.58	1500.00± 20.73	7.48±27.5 0	422.70±1 2.31	22.00±0. 90	0.60±0.2 0	1
<i>E. hirta</i>	8-11	165.9± 7.44	103.9±	122±4. 74	130.00 ±4.84	584.10 ±12.66	631.10± 20.25	160.00±	3	166± 11.6	6	231.90±5. 95	416.80±5. 71	496.00±1 0.00	547.50±4 0.02	57.00±4. 20	3.340±0. 50	4
<i>E. hyssopifolia</i>	6-9	156.8± 7.03	132±8. 3	146±4. 95	212.30 ±15.89	1011.0 0±9.66	1111.00 ±14.66	287.00±	3	319± 9.68	6	390.70±6. 51	615.80±1 0.19	470.00±3 0.10	290.10±1 40.00	10.00±0. 80	1.00±0.4 0	4

Units in micrometers (µm)

Measurements represent mean±standard error

MF – No of male flower; AD – Anther diameter; FL – Length of filament; FD – Filament diameter; MPL – Length of male pedicel; OL- Length of ovary; OW – Width of ovary; OPL – Length of ovary pedicel; SN – No of style; SL – Length of style; STN- No of stigma; SEW – Seed width; SEL – Length of seed; IL – Length of involucre; IB – Breadth of involucre; CY – No of cyathium; ACY – No of aborted cyathium; GN – No of gland

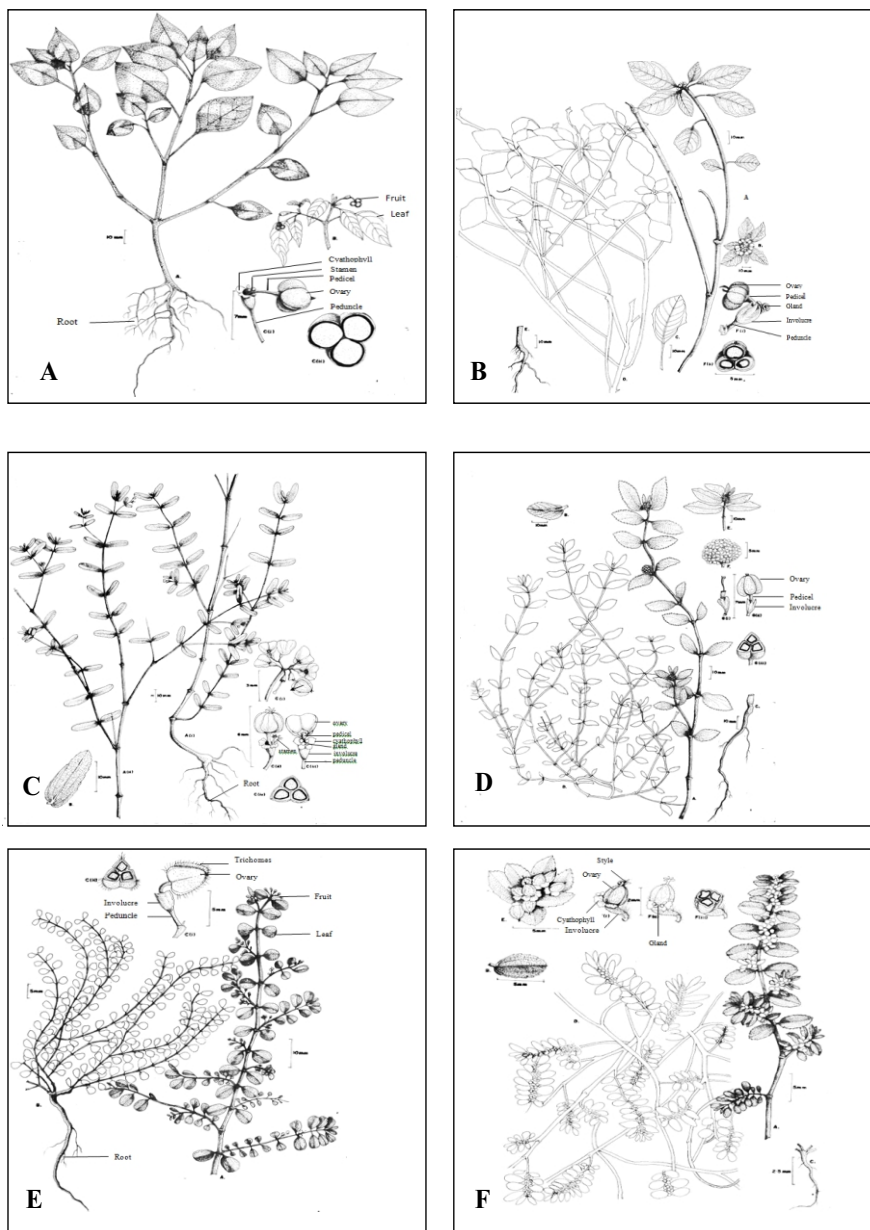


Figure 1: A: *Euphorbia* species A. *E. graminea*; B. *E. heterophylla*; C. *E. hyssopifolia*; D. *E. hirta*; E. *E. prostrata*; F. *E. thymifolia*

Discussion

Based on the result of this work, it is evident that both the vegetative and floral characters play major roles in plant systematics. Some of the vegetative features include growth habit, stem, leaves, petiole and stipules. The floral characters which were employed in this study include types of cyathium and involucre, male and female flowers and also the characters of glands and pedicels. Types of fruit and seed also provide good diagnostic attributes employed in species classification. Saheed and Illoh (2010) recognized the usefulness of the above-mentioned characters as being important in biosystematic analyses.

All the species studied are herbaceous weeds commonly found in open places, gardens, farmlands, wastelands, roadsides, rocky soils, watered fields, drylands, sandy or gravel soil, under shades, canals, between cracks, crevices, creeks etc. Herbaceous habit is an advanced character in the kingdom Plantae (Daniel, 2009). This character clearly separates *E. heterophylla* and *E. prostrata* from other species in spite of the gross morphological differences of the latter three from the former two.

The stem morphology also plays an important role in delimiting the members of *Euphorbia* species studied. The characters such as stem height, colour, mode of branching, presence of trichomes and stipules were employed as important diagnostic tools. *E. heterophylla*, *E. graminea*, *E. hyssopifolia* are erect and *E. hirta* may be erect or prostrate depending on the community where they are found while *E. prostrata* and *E. thymifolia* are prostrate herbs because they have weak stems. This agrees with the findings of Zokia (2011) who encountered two ecotypes for *E. heliscopia* and *E. hirta* (erect and prostrate ecotypes). The stems of *E. hirta*, *E. prostrata* and *E. thymifolia* may also be decumbent when the available soil water or moisture content is high and when the community is closed; i.e. when a prostrate habit is vitiated by the space needs of surrounding plants.

The leaf morphological characters have also proven to have taxonomic importance in delimiting *Euphorbia* species. Trichomes are found on the leaves in all the species of *Euphorbia* examined except in *E. hyssopifolia* where they are totally absent. This feature has been of considerable importance in delineating taxa. Zokia (2011) studied the distribution of trichomes in four species of *Euphorbia* from Iraq and found that the distribution of trichomes on the leaves is diagnostic.

The floral characters are reputed to be generally more reliable attributes on which classification systems and various other principles of systematics are based (Sharma, 2005). According to Singh (2004), floral characteristics have been found useful at all taxonomic levels, with significant contributions to the understanding of the phylogeny of angiosperms. The floral characters examined here in this study are useful in assessing the relationships among the taxa.

Endress (2001) stated that variation in the morphology of flowers play a signal role in the diversification of flowering plants. In the staminate flower, the colour of the anthers and pollen grains in the species remain constant. However, there is variation in the number of stamen among species. This observation partially contradicts those of Bolaji *et al.* (2015) that the numbers of staminate flowers are numerous in *E. hyssopifolia* and *E. heterophylla*. In *E. heterophylla*, the number ranges from 7 – 28, 6 – 9 in *E. hyssopifolia*, 4 – 9 in *E. prostrata*, 4 – 19 in *E. graminea*, 8 – 11 in *E. hirta* and 5 – 8 in *E. thymifolia* (Table 2).

According to Sharma (2005), seed characters have been variously employed in the construction of diagnostic keys and in delimiting species. Characters of seeds which include colour, shape, sculpturing, presence or absence of caruncle etc., prove helpful in separating species in Euphorbiaceae (Webster, 1994; Tokuaka and Tobie, 2002; Oladipo, 2012; Can and Kucuker, 2015; Gen and Kültür 2018). Caruncle is generally absent in all the studied species. According to Bolaji *et al.* (2015) the seed of *E. heterophylla* and *E. hyssopifolia* are carunculate, but observation in this study shows no caruncle for all the species studied including *E. heterophylla* and *E. hyssopifolia*.

The number of styles and stigma branches, show consistency in all the taxa studied, the number of styles is three and the style branches are two. The occurrence of three styles in the flowers of *Euphorbia* is well-known to be a generic character rather than diagnostic.

Conclusion

From a practical point of view, the morphological characters employed in this study provide a further means of defining the taxa of *Euphorbia*. Some characters have been redefined, better identification has been achieved and a new identification key has been constructed other than

the ones used in the flora.

According to the present work, vegetative and floral morphological data obtained are enough for the clarification of taxonomic relationship in the genus *Euphorbia*. For example, *E. thymifolia* are readily distinguishable from *E. prostrata* when floral morphological characters are used. These taxa are customarily considered as conspecific in Nigeria on account of their morphological convergences related to habit, habitat, vegetative characters and insufficient understanding of the flower of *E. thymifolia*. Furthermore, it would appear that *E. prostrata* and *E. thymifolia* differ morphologically from each other thereby raising the possibility that they are not conspecific.

The present investigation shows that the genus *Euphorbia* cannot be separated only on the vegetative characteristics, therefore in such case, a combination of vegetative and floral morphological characters is preferable. Occasionally *E. thymifolia* have been misidentified and mixed with specimens of *E. prostrata*, but according to the present study, these two species are distinguishable based on seed shape, colour, cyathium (hairiness and colour of involucreal appendage, presence intensity of trichomes on leaf and stem), shape of gland, ovary pedicel.

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