A qualitative and quantitative morphological study of eleven species representing four genera in the family Combretaceae was conducted in search of inter- and intra-generic characters which may be of taxonomic use in the identification and classification of the family, as well as enhancing the understanding of the taxonomy of the family. Collection of accessions was done from different parts of southern Nigeria. Life plants, fruits, flowers and seeds from mature plants were collected and subjected to morphological studies. Both qualitative and quantitative characters were recorded. Quantitative data were subjected to analysis of variance, single linkage cluster analysis (SLCA) and principal components analysis (PCA). Morphological characters which separate the taxa include leaf shape, leaf apex, presence of hairs, and colour of reproductive parts such as pedicel, stamen, sepal, petal, style and stigma. Quantitative vegetative and reproductive morphological characters vary significantly (\( P = .05 \)) among the taxa. The presence of undulating leaf margins and cladodromous venation in *Terminalia mantaly*, an introduced species is diagnostic for the species.

**Keywords:** Combretaceae, Diagnostic, Morphology, Reproductive, Taxonomy, Vegetative

**INTRODUCTION**

Combretaceae, one of the families of flowering plants in the order Myrtales consists of 23 genera and about 600 species (Stace, 2007). Hutchinson and Dalziel (1958) established that Combretaceae consists of nine genera while Mabberley (2008) opined that Combretaceae comprises of trees, shrubs and lianas distributed predominantly in tropical and subtropical Africa, but also in central and southern America, southern Asia and northern Australia. In West Africa, Combretaceae has nine genera with about 72 species, of which *Combretum* Loefl. is the largest genus with 49 species (Gill, 1988). However, Keay (1989) reported 25 species of straggling shrubs or lianas in the genus *Combretum* which are found in Nigeria. Hutchinson and Dalziel (1958) established that a number of species are indeterminate and occur in the south-eastern Nigeria.


**MATERIALS AND METHODS**

Collection of plants were made from different locations in southern Nigeria. The samples were identified at the Herbarium of the Department of Botany, Obafemi Awolowo University (IFE). Five accessions for each of the species were later subjected to morphological examinations. Qualitative as well as quantitative attributes of vegetative and reproductive morphological characters of the accessions collected were studied and documented as the reproductive parts were also assessed both qualitatively and quantitatively. Data collected from this documentation were subjected to cluster analysis and principal component analysis. Photographs of some of the morphological characters of the taxa were also made.

**RESULTS**

Combretum platypterum (Welw.) Hutch. &
Dals. (Plates 1a - d)
Habitat and Habit: tropical regions. A scandent shrub or forest liana, up to 10 m long
Stem: unarmed, weak, suffrutescent, bark green to grey and often flaking.
Leaf and Petiole: leathery and shiny, green to dark-green, glabrous at both surfaces, opposite, unarmed, obovate, margins entire, estipulate, apex acute or acuminate, base acute or cuneate, 13.61±0.26 cm long and 5.98±0.17 cm wide. Petiole round, glabrous, 1.45±0.23 cm long
Venation: Eucamptodromous
Inflorescence and Flower: axillary, branched, globose head surrounded by abundant whitish leaves. Flower small, whitish and fragrant, flowers are in long spike, ovary inferior.
Pedicel: pubescent, 0.20±0.00 cm long.
Sepal and Petal: short (0.15±0.00 cm) long, cream-coloured or slightly whitish, acute at the apex. Petals cream-coloured, acute, densely pubescent, 0.20±0.00 cm long
Stamen: short (0.44±0.01 cm) long and whitish.
Style and Stigma: densely pubescent, 0.59±0.02 cm long.
Fruit and Seed: one-seeded, dry indehiscent, variable in shape and size, almost round, 5-winged, whitish, cream to pale-brown, 1.65±0.01 cm in diameter; Seed tiny (0.67±0.01 cm long and 0.12±0.01 cm wide), spindle-shaped, greenish to brownish.

Combretum zenkeri Engl. & Diels. (Plates 2a - d)
Habitat and Habit: savannah and secondary forest; common in places and widely distributed. A scandent shrub or forest liana, to 27 m high
Stem: armed with spines, weak, suffrutescent, bark green to grey; sometimes dark-brown, bark on young stems is often flaky and peeling in stringy strips or threads.
Leaf and Petiole: opposite, sub-opposite, green to dark-green, pubescent at both surfaces, unarmed, obovate, margins entire, estipulate, apex acute, base cordate, veins prominent beneath, 12.03±0.54 cm long and 7.17±0.34 cm wide. Petiole round and pubescent, 1.67±0.07 cm long
Venation: Eucamptodromous
Inflorescence and Flower: axillary, branched, globose head surrounded by abundant whitish leaves. Flower small, whitish and fragrant, flowers are in long spike, ovary inferior.
Pedicel: pubescent, 0.20±0.00 cm long.
Sepal and Petal: short (0.15±0.00 cm) long, cream-coloured or slightly whitish, acute at the apex. Petals cream-coloured, acute, densely pubescent, 0.20±0.00 cm long
Stamen: short (0.44±0.01 cm) long and whitish.
Style and Stigma: densely pubescent, 0.59±0.02 cm long.
Fruit and Seed: one-seeded, dry indehiscent, variable in shape and size, almost round, 5-winged, whitish, cream to pale-brown, 1.65±0.01 cm in diameter; Seed tiny (0.67±0.01 cm long and 0.12±0.01 cm wide), spindle-shaped, greenish to brownish.

Combretum racemosum P. Beauv. (Plates 3a - d)
Habitat and Habit: forest or tropical regions. A scandent shrub or forest liana that produces from seeds and basal shoot re-growth
Stem: stem is round, covered with long weak hairs, armed with spines that are sparsely distributed, weak, suffrutescent, bark green to grey; bark on young stems is often flaky and peeling in stringy strips or threads.
Leaf and Petiole: opposite, leathery, green to dark-green, young leaves pubescent at the upper surface, matured leaves glabrous at both surfaces, leaves opposite, sub-opposite, unarmed, obovate, margins entire, estipulate, apex acute, base cordate, veins prominent beneath, 12.24±0.03 cm long
Venation: Eucamptodromous.
Inflorescence and Flower: densely flowered-spike, with flowers in large panicles, surrounded by conspicuous white or pink bract-like leaves subtending the flower clusters. Flower crimson; pink or dark-red, with hairy flower tubes, clustered in short glomeruliform or umbel-like spikes arranged in a large panicle.
Pedicel: pubescent, 0.24±0.01 cm long.
Sepal and Petal: greenish, cup-like, acute at the
apex, 0.64±0.01 cm long. Petals red or crimson, pilose outside, not incurved, elliptic to ovate, acute at the apex, 0.27±0.01 cm long
Stamen: curly and pinkish, 1.40±0.02 cm long.

Combretum dolichopetalum Engl. & Diels. (Plates 4a - d)

Habitat and Habit: forest; secondary re-growth areas, usually near rivers. A scandent shrub or forest liana

Stem: unarmed, weak, suffrutescent, bark grey to dark brown; young stems hairy.

Combretum superbum Engl. & Diels (Plates 6a - d)

Habitat and Habit: forest tree of tropical West Africa. A woody tree (up to 45.72 m high) with large thin buttresses, clean straight bole and a doomed flat crown, and a trunk typically clear of branches for much of its height, buttressed at the base.
round, glabrous, 4.18±0.16 cm long

**Venation:** Eucamptodromous

**Inflorescence and Flower:** Inflorescence an axillary spike, short-hairy. Flower small and whitish, growing in loose spikes, flowers bisexual or male, regular, usually 5-merous; receptacle spindle-shaped.

**Pedicel:** usually short (0.44±0.01 cm long) and glabrous.

**Sepal and Petal:** triangular, (0.26±0.01 cm long). Petal absent

**Stamens:** usually 10, free, densely woolly hairy; ovary inferior, 1-celled, 0.33±0.00 cm long.

**Style and Stigma:** style long (0.46±0.001 cm), sparsely hairy.

**Fruit and Seed:** a winged samara or nut, one seeded, transversely oblong-elliptical in outline, 1.79±0.01 cm long and 5.28±0.08 cm wide, including the wings. Seed golden brown, glabrous, 0.92±0.02 cm long and 0.28±0.01 cm wide

Terminalia ivorensis A. Chev. (Plates 7a - d)

**Habitat and Habit:** forest, tropical regions. It is a woody tree, to 45.72 m high, or more, with broad blunt buttresses and clean straight bole.

**Stem:** unarmed, bark dark-brown bark or blackish fissured.

**Leaf and Petiole:** unarmed, glabrous at both surfaces and often crowded at the terminal ends of branchlets, oval to obovate, margins entire, estipulate, apex acute or obtuse, base acute, leaf 10.61±0.22 cm long and 4.55±0.12 cm wide. Petiole round, long-petiolate, pubescent, petiole 1.19±0.04 cm long

**Venation:** Eucamptodromous

**Inflorescence and Flower:** an axillary spike, slender and whitish short-hairy. Flower bisexual or regular, 5-merous and pale yellow.

**Pedicel:** usually short (0.48±0.02 cm long), slightly pubescent, spindle-shaped.

**Sepal and Petal:** triangular and short, 0.33±0.01 cm. Petal absent

**Stamens:** 10, free, disc annular, densely woolly hairy. Filaments tiny (0.46±0.01 cm long), glabrous and bearing the ovoid anthers,

**Style and Stigma:** woolly glabrous, whitish to creamy, style 0.51±0.12 cm long.

**Ovary:** inferior, unilocular

**Fruit and Seed:** a winged samara or nut, one seeded, oblong in outline, variable in size, elongated and narrow, finely tomentose with very short reddish or orange-brown hairs, 6.52±0.08 cm long and 2.60±0.08 cm wide, including the wings. Seed oval and glabrous, 0.92±0.02 cm long and 0.28±0.01 cm wide

Terminalia mantaly H. Perr. (Plates 8a - d)

**Habitat and Habit:** mesophytic, a tree of west Africa dry zones, a native of Madagascar but introduced and widely cultivated in Nigeria; used as shade tree and as ornamentals. A woody tree (up to 22.86 m high), flat topped, with a wide horizontal canopy of evenly distributed foliage arising from the apex of the straight bole

**Stem:** unarmed, with smooth stem surface and an ashy-grey bark.

**Leaf and Petiole:** bright-green when young, dark-green at maturity, in terminal rosettes of 4-9 unequal leaves on short stem, leaves leathery, glabrous at both surfaces and unarmmed, obovate, margins wavy, occasionally entire, estipulate, apex obtuse, base acute, 2.69±0.14 cm long and 1.39±0.08 cm wide. Petiole sub-sessile, round and glabrous; 0.19±0.01 cm long

**Venation:** Cladodromous.

**Inflorescence and Flower:** inflorescence cluster. Flowers are small, white or cream, five lobed, arranged on long axillary spikes, with a mildly unpleasant smell, valvate and actinomorphic.

**Pedicel:** short (0.18±0.01 cm long), glabrous, flowers sub-sessile.

**Sepal and Petals:** whitish or creamson, connate and acute at the apex, 0.20±0.00 cm long. Petal absent

**Stamens:** filaments tiny (0.46±0.01 cm long), glabrous, bearing the ovoid anthers.

**Style and Stigma:** glabrous, 0.47±0.02 cm long.

**Fruit and Seed:** Fruit sessile, fleshy and one seeded drupe, laterally compressed, ovoid to ovate or elliptic, unripe fruit green to dark-purplish, ripe fruit yellow to red, typically, one to many fruits with variable sizes develop on the basal part of the flower spike. Fruit is 1.91±0.05 cm long and 0.97±0.04 cm wide. Seed is spindle-shaped, glabrous, 0.76±0.02 cm long and 0.30±0.00 cm wide.

Terminalia avicennioides Guill. & Perr. (Plates 9a - d)

**Habitat and Habit:** savannah or forest. A woody
tree (up to 19.81 m high), with short bole, sometimes bushy, branching from the base.

**Stem:** unarmed, with coarse surface, roughly fissured and black to dark-brown or rough grey.

**Leaf and Petiole:** unarmed, leathery, mature leaf greyish-green above and slightly white beneath, dark brownish, sometimes extremely abundant and often crowded at the terminal ends of branchlets, adaxial surface glabrous and densely pubescent or velvety whitish-hairy on the abaxial surface, obovate, margins entire, estipulate, apex acute or obtuse, base acute, 14.66 ± 0.41 cm long and 7.75 ± 0.19 cm wide. Petiole round and pubescent, 3.26 ± 0.09 cm long

**Venation:** Eucamptodromous

**Inflorescence and Flower:** terminal and axillary, spikes, racemes, or sometimes panicles, bracteate and velvety hairy, somewhat fairly pink. Flowers usually regular, bisexual, sometimes bisexual and male flowers present in same inflorescence. Receptacle spindle-shaped, surrounding and adnate to ovary and extended into a short or long calyx tube dilated distally; lobes 4 or 5, valvate in bud

**Pedicel:** softly pubescent, 0.44 ± 0.01 cm long.

**Sepal and Petal:** connate into a lobed campanulate cup, 0.35 ± 0.01 cm high. Petal absent

**Stamens:** 10 and free, stamens usually as many as calyx lobes in 2 series, inserted inside distal part of calyx tube, filaments incurved in bud; 0.49 ± 0.01 cm high.

**Ovary:** inferior and unilocular

**Style and Stigma:** style simple, filiform, 0.54 ± 0.01 cm long.

**Fruit and Seed:** one seeded rounded samara with 2 wings, yellowish to reddish brown; fruits almost glabrous, orbicular, laterally winged, crowded in a globose head, 0.60 ± 0.01 cm in diameter. Seed enclosed horizontally in a dense cone-like fructification, 0.43 ± 0.01 cm long and 0.14 ± 0.00 cm wide.

Anogeissus leiocarpus (DC.) Guill. & Perr. (Plates 10a - d)

**Habitat and Habit:** driest savannah to the borders of the forest zones, usually in moist situations but also in relatively dry situation. A tree, up to 21.34 m high
white to red, star shaped and fragrant; corymb; shallow corolla sinus.

**Pedicel:** greenish to brownish, softly pubescent; 0.92±0.02 cm long.

**Sepal and Petal:** regularly arranged with an acute apex acute greenish in colour, 0.37±0.02 cm long. Petals star-shaped, whitish, reddish or pinkish; 2.26±0.04 cm long

**Stamens:** filaments tiny and glabrous, 5.11±0.05 cm long.

**Style and Stigma:** style (7.02±0.07 cm long) and glabrous.

**Fruit and Seed:** one seeded; non-fleshy; indehiscent, schizocarp or drupe; oblong with sharp angles, glabrous black; usually pentameric and ellipsoidal, 3.32±0.03 cm long and 1.77±0.04 cm wide. Seed non-endospermic; ellipsoidal, embryo well differentiated; cotyledons 1-3, 1.55±0.03 cm long and 1.00±0.03 cm wide

**DISCUSSION**

In taxonomic studies morphological characters have always been useful in delimiting taxa. Hutchinson and Dalziel (1958) have used some of the morphological attributes to characterize species in the family Combretaceae except some characters like leaf margin, leaf apex, venation; colour of reproductive parts like sepal, petal as well as morphology of style and stigma, filament and pedicel which are important in the taxonomy of the genera in the family Combretaceae. Morphological characters have also been used by other researchers to enhance the taxonomy of different taxa (Smith and Ashton, 2006; Adedeji and Faluyi, 2006).

There is uniformity in obovate leaf shape in the genus Combretum (Table 1) except in Combretum dolichopetalum where it is elliptic. This character is therefore diagnostic for C. dolichopetalum. Similarly, leaf apex is of classificatory importance in this genus: acute leaf apex can be used in grouping C. zenkeri and C. racemosum while acute and occasionally cordate or acuminate leaf apex can be used to classify C. platypetalum and C. dolichopetalum (Table 1). Cordate leaf base is also classificatory of C. zenkeri and C. racemosum, however, acute or occasional cuneate leaf base delimits C. platypetalum while cordate or lobate leaf base delimits C. dolichopetalum (Table 1). The occurrence of hairs on the adaxial and abaxial surfaces of leaves and petiole surfaces in C. zenkeri and C. dolichopetalum and adaxial surface and petiole in C. racemosum is classificatory (Table 1). However, characters of unification in the genus Combretum include entire leaf margins. The variations that were discovered in the reproductive parts are also useful in the delimitation of the taxa. C. racemosum and C. dolichopetalum are characterized by green petals and acute sepal apex, while pink/cream-coloured sepal, as well as acute sepal apex can be used in grouping C. platypetalum and C. zenkeri (Table 2). Petal colour in this genus varies and has classificatory value as pink/white/cream petal colour in C. platypetalum and cream-coloured petal in C. zenkeri delimits the taxa. Red/cream-coloured petal is peculiar to C. racemosum while yellow/light-green petal separates C. dolichopetalum. However, whitish seed colour, peculiar only to C. platypetalum is diagnostic for the taxon, separating it from other members of the genus Combretum.

In the genus Terminalia, oval leaf delimits T. ivorensis as obovate leaf shape characterize other members of the genus (Table 1). Acute leaf apex is also classificatory of the taxa as it can be used in grouping T. superba and T. mantaly, while obtuse/retuse leaf apex delimits T. catapa. However, acute/obtuse leaf apex found in T. ivorensis and T. avicennioides is classificatory for the species. Leaf margin is also worthy of note in this genus. Other members of the genus Terminalia have entire leaf margins while entire/undulating leaf margin clearly delimits T. mantaly which was not described by Hutchinson and Dalziel (1958) but newly introduced. Diagnostic character which is also of great taxonomic value in the genus includes Cladodromous venation, peculiar only to T. mantaly (Table 1). Its delimitation however arises owing to the fact that it is the only mesophytic species in the genus. Leaf base is not only classificatory but also diagnostic for the genus Terminalia. Acute and occasionally cordate or lobate leaf base is common to T. catapa and it delimits the taxa from other species of Terminalia. However, the occurrence of numerous woolly or velvety hairs on the abaxial surfaces of leaves in T. avicennioides as well as petiole surfaces in T. avicennioides and T. ivorensis delimit the taxa from other members of the genus (Table 1). Pubescent pedicel surface is classificatory for T. ivorensis and
T. avicennioides and makes the species to be morphologically more closely related to each other than to any other species in the genus (Table 2).

Ripe fruit colour is also of diagnostic value in the genus Terminalia as dark-brown ripe fruit is peculiar to T. superba, T. ivorensis and T. avicennioides. This however is owing to the fact that they are forest species, while yellow/red ripe fruit delimits T. catapa and T. mantaly which are tropical and mesophytic taxa respectively.

Among all the eleven species of Combretaceae covered in this study, the presence of hairs on the adaxial and abaxial surfaces of leaf in Combretum zenkeri, Combretum dolichopetalum, Anogeissus leiocarpus and Combretum racemosum is of taxonomic importance and can be used to delimit the species from Terminalia avicennioides that is woolly hairy only on the abaxial surface. This however, can enhance the understanding of the relationship existing among members of the family Combretaceae. Leaf stalk on the other hand can also be used to separate the eleven species critically examined in this study. Among all the species, Combretum dolichopetalum and Terminalia mantaly are sub-sessile and this delineates the two species from others studied in their respective genera, useful in the identification and taxonomy of the family generally.

Data generated from both the quantitative vegetative and reproductive morphological attributes have proved to be useful in bringing to the fore, inter- and intrageneric relationships existing among members of the family Combretaceae. Character like leaf length, leaf width and petiole length vary significantly among some of the species of Combretaceae studied (Tables 3 and 4). This indicates that these characters are taxon specific, and could therefore be used in separating the species. However, some members of the Genus Combretum: C. zenkeri, C. racemosum, and the monotypic Genus-Quisqualis, represented by Q. indica show no significant difference in their leaf length indicating a close relationship in their leaf morphology. Leaf width is not significantly different also in Combretum zenkeri and Terminalia avicennioides as well as in Combretum dolichopetalum and Terminalia ivorensis, therefore, classificatory for the taxa as no significant difference was observed in the leaf length, leaf width and petiole length in Terminalia mantaly and Anogeissus leiocarpus. This established similarity enables us to be more informed about the intra – and intergeneric closeness that exist among members of the family Combretaceae (Table 3). The result of the vegetative and reproductive morphology of members of the family Combretaceae revealed that vegetative characters like leaf length, leaf width and reproductive characters like stamen length, style and stigma length, seed length and seed width had high factor loadings (Table 5).
### Table 1: Qualitative Vegetative Morphological Characters of Eleven Species of Combretaceae

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species Characters</th>
<th>Habbit</th>
<th>Stem surface</th>
<th>Nature of stem</th>
<th>Type of stem</th>
<th>Stem colour</th>
<th>Leaf shape</th>
<th>Leaf apex</th>
<th>Leaf margin</th>
<th>Leaf base</th>
<th>Hairs (abaxial)</th>
<th>Petiole surface</th>
<th>Leaf abaxial surface</th>
<th>Venation</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. platypterus</em></td>
<td><em>C. zenkeri</em></td>
<td>Forest</td>
<td>Coarse</td>
<td>Weak</td>
<td>Suffrutescent</td>
<td>Green/grey</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
</tr>
<tr>
<td><em>C. racemum</em></td>
<td><em>C. catapa</em></td>
<td>Forest</td>
<td>Coarse</td>
<td>Weak</td>
<td>Suffrutescent</td>
<td>Green/grey</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
</tr>
<tr>
<td><em>C. delphinocladum</em></td>
<td><em>C. superba</em></td>
<td>Tropical region</td>
<td>Coarse</td>
<td>Weak</td>
<td>Suffrutescent</td>
<td>Grey/dark brown</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
</tr>
<tr>
<td><em>C. dolichopetalum</em></td>
<td><em>C. ivorensis</em></td>
<td>Tropical region</td>
<td>Coarse</td>
<td>Weak</td>
<td>Suffrutescent</td>
<td>Grey/dark brown</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
</tr>
<tr>
<td><em>T. aspera</em></td>
<td><em>C. mantaly</em></td>
<td>Mesophytic</td>
<td>Coarse</td>
<td>Erect</td>
<td>Woody</td>
<td>Ashy grey</td>
<td>Elliptic</td>
<td>Acute to Lobate</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
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<tr>
<td><em>T. superba</em></td>
<td><em>T. mantaly</em></td>
<td>Savanna/forest</td>
<td>Coarse</td>
<td>Erect</td>
<td>Woody</td>
<td>Dark brown</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
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<td><em>T. ivorensis</em></td>
<td><em>T. mantaly</em></td>
<td>Savanna/forest</td>
<td>Coarse</td>
<td>Erect</td>
<td>Woody</td>
<td>Ashy grey</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
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<tr>
<td><em>T. dolichopetalum</em></td>
<td><em>T. superba</em></td>
<td>Mesophytic</td>
<td>Coarse</td>
<td>Erect</td>
<td>Woody</td>
<td>Dark brown / grey</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
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<tr>
<td><em>A. leiocarpus</em></td>
<td><em>T. mantaly</em></td>
<td>Mesophytic/ xerophytic</td>
<td>Coarse</td>
<td>Erect</td>
<td>Woody</td>
<td>Greyish brown</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
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<tr>
<td><em>Q. indica</em></td>
<td><em>T. mantaly</em></td>
<td>Mesophytic</td>
<td>Coarse</td>
<td>Erect</td>
<td>Woody</td>
<td>Greyish brown</td>
<td>Obovate</td>
<td>Acute</td>
<td>Entire</td>
<td>Acute/ cuneate</td>
<td>None</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Eucamptodromous</td>
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<tr>
<td>Species</td>
<td>Combretum platypterus</td>
<td>Combretum zenkeri</td>
<td>Combretum racemosum</td>
<td>Combretum dolichopetalum</td>
<td>Terminalia catappa</td>
<td>Terminalia superba</td>
<td>Terminalia ivorensis</td>
<td>Terminalia mantaly</td>
<td>Terminalia avicennioides</td>
<td>Anogeissus leiocarpus</td>
<td>Quisqualis indica</td>
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<tr>
<td>Stipule</td>
<td>Estipulate</td>
<td>Estipulate</td>
<td>Estipulate</td>
<td>Estipulate</td>
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<td>Estipulate</td>
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</tr>
<tr>
<td>Pedicel surface</td>
<td>Pubescent</td>
<td>Pubescent</td>
<td>Pubescent</td>
<td>Pubescent</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Slightly pubescent</td>
<td>Glabrous</td>
<td>Softly pubescent</td>
<td>Pubescent</td>
<td>Softly pubescent</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Corolla colour/apex shape</td>
<td>Pink/white/cream coloured/acute</td>
<td>Cream/coloured/acute</td>
<td>Red/cream coloured/acute</td>
<td>Yellow/light greenish/acute</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Whitish/purplish/rounded</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Style surface</td>
<td>Glabrous</td>
<td>Glabrous</td>
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<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
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</tr>
<tr>
<td>Filament surface</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
<td>Glabrous</td>
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<td>Glabrous</td>
<td>Glabrous</td>
<td></td>
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<tr>
<td>Floral aestivation</td>
<td>Valvate</td>
<td>Valvate</td>
<td>Valvate</td>
<td>Valvate</td>
<td>Valvate</td>
<td>Valvate</td>
<td>Valvate</td>
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<td>Valvate</td>
<td>Valvate</td>
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<tr>
<td>Floral symmetry</td>
<td>Actinomorphic</td>
<td>Actinomorphic</td>
<td>Actinomorphic</td>
<td>Actinomorphic</td>
<td>Actinomorphic</td>
<td>Actinomorphic</td>
<td>Actinomorphic</td>
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<td>Actinomorphic</td>
<td>Actinomorphic</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Inflorescence</td>
<td>Axillary spike</td>
<td>Globbose head</td>
<td>Axillary spike</td>
<td>Spike</td>
<td>Axillary spike</td>
<td>Axillary spike</td>
<td>Cluster</td>
<td>Axillary spike</td>
<td>Densely globbose</td>
<td>Racemose</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unripe fruit colour</td>
<td>Deep pink/red</td>
<td>Whitish/cream coloured</td>
<td>Whitish/cream coloured/panish</td>
<td>Light yellow/pinkish</td>
<td>Greenish/dark purplish</td>
<td>Greenish</td>
<td>Greenish</td>
<td>Greenish</td>
<td>Whitish</td>
<td>Greenish</td>
<td>Greenish</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ripe fruit colour</td>
<td>Pale yellow</td>
<td>Pale brown</td>
<td>Pale brown</td>
<td>Pale brown</td>
<td>Pale brown</td>
<td>Yellow/red</td>
<td>Dark brown</td>
<td>Yellow/red</td>
<td>Dark brown</td>
<td>Yellow/reddish brown</td>
<td>Blackish</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit shape</td>
<td>Tetramerous</td>
<td>Pentamerous</td>
<td>Tetramerous/pentamerous</td>
<td>Ovoid</td>
<td>Oblong/elliptic</td>
<td>Oblong</td>
<td>Ovate/elliptic</td>
<td>Oblong/elliptic</td>
<td>Orbicular</td>
<td>Ellipsoidal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The taxonomic implication is that vegetative and reproductive morpho-characters are important in separating the species of the family Combretaceae. Reproductive characters being more important and are therefore the characters responsible for the morphological variations observed among the eleven species of Combretaceae studied. The dendogram (Figures 1 and 2) revealed the clustering of the taxa based on their generic delimitations with slight overlap. It clearly shows the intra-and-intergeneric morphological relationships that exist among members of the family Combretaceae. In the genus *Combretum*, *C. dolichopetalum* is the only species in both figures distinct from other members of the genus due to the fact that it is the only sub-sessile taxon with elliptic leaf, cordate or occasionally acuminate leaf apex, lobate base and light yellow or occasional light-greenish petal. *C. racemosum*, *C. platypterum* and *C. zenkeri* are all at the same level (Figure 2) because they all have in common all the qualitative morphological characters studied except those taxon-specific characters peculiar to *C. dolichopetalum*. The second main cluster also has the genus *Terminalia* on the other side of it where *T. catapa*, *T. superba*, *T. ivorensis* and *T. avicennioides* show great closeness (Figure 2). This agrees with the intrageneric relationship and closeness previously enumerated by Hutchinson and Dalziel (1958). Within the genus *Terminalia*, *T. mantaly* is the only species showing little morphological dissimilarity to other members of the genus because it is an introduced and mesophytic species not recorded nor described by Hutchinson and Dalziel (1958). Its distinctive features include undulating leaf margin, ovate or elliptic fruit shape and sub-sessile leaf. *Anogeissus leiocarpus* occupies the first main cluster occurring clearly delineated from all other members of the family Combretaceae (Figure 1). However, the monotypic genus *Quisqualis*, may have shared some generic relationship with the genus *Combretum* but clearly distant from the genus *Terminalia* (Figure 1).

**Table 3: Quantitative Vegetative Morphological Characters of Eleven Species of Combretaceae with Duncan Mean Separation.**

<table>
<thead>
<tr>
<th>Genus</th>
<th>Species</th>
<th>Attributes</th>
<th>Leaf length (cm)</th>
<th>Leaf width (cm)</th>
<th>Petiole length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genus <em>Combretum</em></td>
<td><em>C. platypterum</em></td>
<td>13.61±0.26&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.98±0.17&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>1.45±0.23&lt;sup&gt;de&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. zenkeri</em></td>
<td>12.03±0.54&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.17±0.39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.67±0.07&lt;sup&gt;ef&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. racemosum</em></td>
<td>12.12±0.23&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.54±0.05&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.82±0.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>C. dolichopetalum</em></td>
<td>6.99±0.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.08±0.10&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.33±0.02&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Genus <em>Terminalia</em></td>
<td><em>T. catapa</em></td>
<td>22.28±1.07&lt;sup&gt;de&lt;/sup&gt;</td>
<td>13.17±0.54&lt;sup&gt;ad&lt;/sup&gt;</td>
<td>1.78±0.06&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>T. superba</em></td>
<td>17.86±0.46&lt;sup&gt;d&lt;/sup&gt;</td>
<td>8.98±0.26&lt;sup&gt;de&lt;/sup&gt;</td>
<td>4.18±0.16&lt;sup&gt;de&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>T. ivorensis</em></td>
<td>10.61±0.22&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.55±0.12&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.19±0.04&lt;sup&gt;cd&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>T. mantaly</em></td>
<td>2.69±0.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.39±0.08&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.19±0.01&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>T. avicennioides</em></td>
<td>14.67±0.41&lt;sup&gt;e&lt;/sup&gt;</td>
<td>7.75±0.19&lt;sup&gt;e&lt;/sup&gt;</td>
<td>3.26±0.09&lt;sup&gt;e&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Genus <em>Anogeissus</em></td>
<td><em>A. leiocarpus</em></td>
<td>2.31±0.10&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.45±0.09&lt;sup&gt;de&lt;/sup&gt;</td>
<td>0.20±0.16&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Genus <em>Quisqualis</em></td>
<td><em>Q. indica</em></td>
<td>12.14±0.26&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.32±0.15&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.02±0.03&lt;sup&gt;bc&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

* means with the same alphabet along the same column are not significantly different
Table 4: Quantitative Reproductive Morphological Characters of Eleven Species of Combretaceae with Duncan Mean Separation

<table>
<thead>
<tr>
<th>Species</th>
<th>Pedicel length (cm)</th>
<th>Sepal length (cm)</th>
<th>Petal length (cm)</th>
<th>Stamens length (cm)</th>
<th>Style and stigma (cm)</th>
<th>Fruit diameter (cm)</th>
<th>Fruit length (cm)</th>
<th>Fruit width (cm)</th>
<th>Seed length (cm)</th>
<th>Seed width (cm)</th>
<th>Seed number</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Combretum platypterum</em></td>
<td>0.42±0.01</td>
<td>1.65±0.08</td>
<td>2.0280±0.10</td>
<td>1.87±0.04</td>
<td>3.87±0.11</td>
<td>2.81±0.03</td>
<td>-</td>
<td>-</td>
<td>1.07±0.02</td>
<td>0.36±0.01</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td><em>Combretum zenkeri</em></td>
<td>0.20±0.00</td>
<td>0.15±0.00</td>
<td>0.2000±0.00</td>
<td>0.44±0.01</td>
<td>0.59±0.02</td>
<td>1.68±0.01</td>
<td>-</td>
<td>-</td>
<td>0.66±0.01</td>
<td>0.12±0.01</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td><em>Combretum racemosum</em></td>
<td>0.24±0.10</td>
<td>0.64±0.01</td>
<td>0.2740±0.01</td>
<td>1.40±0.02</td>
<td>1.57±0.03</td>
<td>2.33±0.03</td>
<td>-</td>
<td>-</td>
<td>0.96±0.02</td>
<td>0.30±0.00</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td><em>Combretum dolichopetalum</em></td>
<td>0.56±0.03</td>
<td>0.19±0.01</td>
<td>1.9280±0.04</td>
<td>2.71±0.02</td>
<td>0.26±0.00</td>
<td>1.93±0.03</td>
<td>-</td>
<td>-</td>
<td>1.09±0.03</td>
<td>0.34±0.01</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Terminalia catapa</td>
<td>0.31±0.02</td>
<td>0.25±0.01</td>
<td>-</td>
<td>0.44±0.01</td>
<td>0.61±0.02</td>
<td>-</td>
<td>4.75±0.21±</td>
<td>3.66±0.11±</td>
<td>1.98±0.06±</td>
<td>0.74±0.02±</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Terminalia superb a</td>
<td>0.44±0.01</td>
<td>0.26±0.01</td>
<td>-</td>
<td>0.33±0.00</td>
<td>0.46±0.01</td>
<td>-</td>
<td>1.79±0.01±</td>
<td>5.28±0.08±</td>
<td>1.05±0.01±</td>
<td>0.28±0.01±</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Terminalia ivorensis</td>
<td>0.48±0.02</td>
<td>0.33±0.01</td>
<td>-</td>
<td>0.46±0.01</td>
<td>0.51±0.12</td>
<td>-</td>
<td>6.42±0.08±</td>
<td>2.60±0.08±</td>
<td>0.92±0.02±</td>
<td>0.28±0.01±</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Terminalia mantaly</td>
<td>0.18±0.01</td>
<td>0.20±0.00</td>
<td>-</td>
<td>0.46±0.01</td>
<td>0.47±0.02</td>
<td>-</td>
<td>1.91±0.05±</td>
<td>0.97±0.04±</td>
<td>0.76±0.02±</td>
<td>0.30±0.00±</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Terminalia avicennioides</td>
<td>0.44±0.01</td>
<td>0.28±0.01</td>
<td>-</td>
<td>0.49±0.01</td>
<td>0.58±0.01</td>
<td>-</td>
<td>6.52±0.11±</td>
<td>2.50±0.03±</td>
<td>1.08±0.02±</td>
<td>0.33±0.01±</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Anogeissus leiocarpus</td>
<td>1.85±0.06</td>
<td>0.35±0.01</td>
<td>-</td>
<td>0.49±0.01</td>
<td>0.54±0.01</td>
<td>0.99±0.01</td>
<td>-</td>
<td>-</td>
<td>0.43±0.01±</td>
<td>0.14±0.00±</td>
<td>1.00±0.00</td>
</tr>
<tr>
<td>Quisqualis indica</td>
<td>0.92±0.02</td>
<td>0.37±0.02</td>
<td>0.2600±0.04</td>
<td>5.11±0.05</td>
<td>7.02±0.05</td>
<td>-</td>
<td>3.32±0.03±</td>
<td>1.77±0.04±</td>
<td>1.55±0.03±</td>
<td>5.11±0.08±</td>
<td>1.00±0.00</td>
</tr>
</tbody>
</table>

*means with the same alphabet along the same column are not significantly different
The principal component analysis scattered diagram of the species based on combined quantitative vegetative and reproductive morphological characters reveals the similarities that exist between the genera *Terminalia* and *Anogeissus* (Figure 3). *Terminalia mantaly* is morphologically related to *Anogeissus leiocarpus* in the family because of the similarities in their leaf lengths, leaf widths and petiole lengths, stamen lengths, style and stigma lengths, seed numbers as well as the similarities in their qualitative reproductive morphology such as sepal colour and shape of sepal apex, ripe fruit colour and seed colour, hence their monophyletic origin.

This study therefore shows that the combination of both vegetative and reproductive morphological characters can be used successfully in delimiting the species into genera and in the understanding of the pattern of inter- and-intra-generic similarities and differences in the family.

Figure 1: Dendogram of Combretaceae Species Based on Quantitative Reproductive Morphological Characters

<table>
<thead>
<tr>
<th>Characters</th>
<th>PCA1</th>
<th>PCA2</th>
</tr>
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<tbody>
<tr>
<td>Leaf length</td>
<td>0.91</td>
<td>-</td>
</tr>
<tr>
<td>Leaf width</td>
<td>0.89</td>
<td>-</td>
</tr>
<tr>
<td>Stamen length</td>
<td>-</td>
<td>0.90</td>
</tr>
<tr>
<td>Style and stigma</td>
<td>-</td>
<td>0.85</td>
</tr>
<tr>
<td>Seed length</td>
<td>0.88</td>
<td>-</td>
</tr>
<tr>
<td>Seed width</td>
<td>-</td>
<td>0.81</td>
</tr>
</tbody>
</table>
Figure 3: Principle Components Analysis (scattered diagram) of eleven species of Combretaceae
Based on Combined Quantitative Vegetative and Reproductive Morphological Characters.

Qi - Quisqualis indica, Al - Anogeissus leiocarpus, Cd – Combretum dolichopetalum, Cz - Combretum zenkeri, Cr - Combretum racemosum, Cp – Combretum platypterum, Tc – Terminalia catapa, Ti - Terminalia ivorensis, Ta - Terminalia avicennioides, Tm - Terminalia mantaly, TS – Terminalia superba.

Figure 2: Dendogram of Combretaceae Species Based on Combined Quantitative Vegetative and Reproductive Morphological Characters

Qi - Quisqualis indica, Al - Anogeissus leiocarpus, Cd – Combretum dolichopetalum, Cz - Combretum zenkeri, Cr - Combretum racemosum, Cp – Combretum platypterum, Tc – Terminalia catapa, Ti - Terminalia ivorensis, Ta - Terminalia avicennioides, Tm - Terminalia mantaly, TS – Terminalia superba.
CONCLUSION

The generic, classificatory and diagnostic features obtained in the study will serve as basis for proper classification, standardization and subsequent identification of members of the family Combretaceae.

Plates (1a – d): Morphological Study of Combretum platypterum.

Plates (2a - d): Morphological Study of Combretum zenkeri
(a): Habit of C. zenkeri (b): inflorescence (c): Fruits of C. zenkeri (d): Seeds of C. zenkeri
Plates (Plates 3a - d): Morphological Study of *Combretum racemosum*
(a): Habit of *C. racemosum* (b): Spike inflorescence
(c): Fruits of *C. racemosum* (d): Seeds of *C. racemosum*

Plates (4a - d) Morphological Study of *Combretum dolichopetalum*
(a): Habit of *C. dolichopetalum* (b): inflorescence of *C. dolichopetalum*
(c): Fruits of *C. dolichopetalum* (d): Seeds of *C. dolichopetalum*
Plates (5a - d): Morphological Study of *Terminalia catapa*

(a): Habit of *T. catapa*  
(b): Spike inflorescence  
(c): Fruits *T. catapa*  
(d): Seeds of *T. catapa*

Plates (6a - d): Morphological Study *Terminalia superba*

(a): Habit of *T. superba*  
(b): Spike inflorescence and Fruit of *T. superba*  
(c) and (d): Dried Fruits or *T. superba*

Plates (8a - d): Morphological Study of *Terminalia mantaly* (a): Habit of *T. mantaly* (b): Spike inflorescence (c): Fruits of *T. mantaly* (d): Seeds of *T. mantaly*
Plates (9a - d): Morphological Study of *Terminalia avicennioides*
(a): Habit of *T. avicennioides* (b): Spike-like raceme inflorescence
(c) and (d): Fruits of *T. avicennioides*

Plate (10a - d): Morphological Study of *Anogeissus leiocarpus*
(a): Habit of *A. leiocarpus* (b): Inflorescence
(c): Fruits of *A. leiocarpus* (d): Seeds of *A. leiocarpus*
ACKNOWLEDGEMENT
We appreciate the former curator of IFE Herbarium, Mr. Ibhanesebhor, as well as Mr. Bernard Omomoh of the Department of Forestry and Wood Technology, Federal University of Technology, Akure.

AUTHOR’S CONTRIBUTIONS
'Author 1' designed the study, wrote the first and second draft of the manuscript and joined Author 2 in performing the statistical analysis; 'Author 2' performed the statistical analysis together with Author 1; 'Author 3' wrote the protocol, managed and previewed the analysis of the study while 'Author 4' collected plant accessions from different parts of southern Nigeria. All authors read and approved the final manuscript.

REFERENCES