

## VEGETATIVE AND REPRODUCTIVE MORPHOLOGICAL STUDY OF SOME SPECIES IN THE FAMILY COMBRETACEAE IN NIGERIA

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### ABSTRACT

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.

The present study is therefore aimed at describing the qualitative and quantitative morphological characters of eleven species belonging to four genera-*Combretum*, *Terminalia*, *Anogeissus* and *Quisqualis* of the family Combretaceae in Nigeria. The representative species of the genus *Combretum* include: *C. platypterum* Hutch. & Dals., *C. racemosum* Engl. & Diels., *C. zenkeri* P. Beauv., *C. dolichopetalum*

Engl. & Diels., genus *Terminalia*: *T. catapa* L, *T. superba* Engl. & Diels., *T. ivorensis* A. Chev., *T. mantaly* H. perr., *T. avicennioides* Guill. & Perr., *Anogeissus leiocarpus* (DC.) Guill. & Perr. and *Quisqualis indica* L., the only West African representative species of the genera *Anogeissus* and *Quisqualis*.

### 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,  $13.61 \pm 0.26$  cm long and  $5.98 \pm 0.17$  cm wide. Petiole round, glabrous,  $1.45 \pm 0.23$  cm long

**Venation:** Eucamptodromous

**Inflorescence and Flower:** cluster, axillary, spike-like raceme, generally more or less tomentose. Flowers are bisexual, regular, and are borne in axillary or terminal branched or unbranched spikes, and are bracteates. Flowers are 4-or 5-merous

**Pedicel:** pubescent,  $0.42 \pm 0.01$  cm long.

**Sepal and Petal:** fused with petals in an alternate manner, cream or pinkish, acute at the apex,  $1.65 \pm 0.08$  cm long. Petal vary from white, cream-coloured, yellow, but are sometimes pale to deep pink or bright red, ovate, apex acute,  $2.03 \pm 0.10$  cm long.

**Stamens:** inserted on the hypanthium, usually twice as many as the petals, and usually extended beyond the petals, filaments red, anthers vary in colour from yellow, orange, pinkish, crimson or reddish to red-brown,  $1.87 \pm 0.43$  cm long.

**Style and Stigma:** fairly glabrous, cream coloured or pinkish,  $3.87 \pm 0.11$  cm long.

**Fruit and Seed:** fruit glabrous or covered with short hairs and is mainly a 4-5 winged samara, red at first then pale yellow,  $2.81 \pm 0.03$  cm in diameter; Seed whitish, spindle-shaped,  $1.07 \pm 0.02$  cm long and  $0.36 \pm 0.01$  cm wide.

**Combretum zenkeri Engl. & Diels. (Plates 2a - d)**

**Habitat & 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,  $12.03 \pm 0.54$  cm long and  $7.17 \pm 0.34$  cm wide. Petiole round and pubescent,  $1.67 \pm 0.07$  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,  $0.20 \pm 0.00$  cm long.

**Sepal and Petal:** short ( $0.15 \pm 0.00$  cm) long, cream-coloured or slightly whitish, acute at the apex. Petals cream-coloured, acute, densely pubescent,  $0.20 \pm 0.00$  cm long

**Stamen:** short ( $0.44 \pm 0.01$  cm) long and whitish.

**Style and Stigma:** densely pubescent,  $0.59 \pm 0.02$  cm long.

**Fruit and Seed:** one-seeded, dry indehiscent, variable in shape and size, almost round, 5-winged, whitish, cream to pale-brown,  $1.65 \pm 0.01$  cm in diameter; Seed tiny ( $0.67 \pm 0.01$  cm long and  $0.12 \pm 0.01$  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 flaking and peeling in stringy strips or threads.

**Leaf and Petiole:** opposite, leathery, green to dark-green, young leaves pubescent at the upper surface glabrous beneath, matured leaves glabrous at both surfaces, leaves opposite, sub-opposite, unarmed, obovate, margins entire, estipulate, apex acute, base cordate,  $12.12 \pm 0.23$  cm long and  $5.54 \pm 0.05$  cm wide. Petiole round, pubescent,  $0.82 \pm 0.03$  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,  $0.24 \pm 0.01$  cm long

**Sepal and Petal:** greenish, cup-like, acute at the

apex,  $0.64 \pm 0.01$  cm long. Petals red or crimson, pilose outside, not incurved, elliptic to ovate, acute at the apex,  $0.27 \pm 0.01$  cm long

**Stamen:** curly and pinkish,  $1.40 \pm 0.02$  cm long.

**Style and Stigma:** glabrous,  $1.57 \pm 0.03$  cm long.

**Fruit and Seed:** one-seeded, white, cream or pinkish, sometimes dark-red, fruit is four to five-winged. Fruit is  $2.53 \pm 0.03$  cm in diameter. Seed elliptic or spindle – like, greenish,  $0.96 \pm 0.02$  cm long and  $0.30 \pm 0.00$  cm wide

*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.

**Leaf and Petiole:** pubescent at both surfaces, leaves are opposite or sub-opposite, unarmed, obovate or elliptic, margins entire, estipulate, apex cordate or acuminate, base cordate or lobate,  $6.99 \pm 0.19$  cm long and  $4.08 \pm 0.48$  cm wide. Petiole short ( $0.33 \pm 0.02$  cm long), sub sessile, round and pubescent.

**Venation:** Eucamptodromous.

**Inflorescence and Flower:** inflorescences terminal and axillary with long spreading hairs. Flower regular, 5-merous, and often hidden by the large yellow-green bracts;

**Pedicel:** pubescent,  $0.56 \pm 0.03$  cm long.

**Sepals and Petals:** sepal short ( $0.19 \pm 0.01$  cm long), triangular, acute at the apex. Petals lanceolate,  $1.93 \pm 0.04$  cm long, usually yellow with crimson streak within.

**Stamens:** usually 10, free and glabrous,  $2.71 \pm 0.02$  cm long, ovary inferior.

**Style and Stigma:** style short ( $0.26 \pm 0.00$  cm long), glabrous.

**Fruit and Seed:** one seeded, glabrous or softly covered with hairs, fruits mainly a 4-5winged samara;  $1.93 \pm 0.03$  cm in diameter. Seed:  $1.09 \pm 0.03$  cm long and  $0.34 \pm 0.01$  cm wide.

*Terminalia catapa* Linn. (Plates 5a - d)

**Habitat and Habit:** sub-tropical and tropical regions. A woody tree (up to 24.10m high), extensively flat topped, with a wide horizontal canopy of evenly distributed foliage arising from the apex of the straight bole.

**Stem:** unarmed, stem surface coarse and shallowly fissured, grey to dark-brown.

**Leaf and Petiole:** leaf leathery, glabrous at both surfaces, dark-green, turning bright yellow then vivid to dark red before falling, crowded at the terminal ends of branchlets, unarmed, obovate, margins entire, estipulate, apex acute, obtuse to retuse, base acute, cordate to lobate,  $22.28 \pm 1.07$  cm long and  $13.17 \pm 0.54$  cm wide. Petiole round, petiole of matured leaves pubescent, those of young leaves almost glabrous,  $1.78 \pm 0.06$  cm long

**Venation:** Eucamptodromous.

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

**Pedicel:** short ( $0.31 \pm 0.02$  cm long), flowers subsessile, fruits sessile.

**Sepal and Petal:** sepals regularly arranged, triangular with acute apex, white to cream in colour,  $0.25 \pm 0.01$  cm long. Petal absent

**Stamens:** filaments tiny ( $0.44 \pm 0.01$  cm long) and glabrous.

**Style and Stigma:** furcate, distinguishable from filament, glabrous,  $0.61 \pm 0.02$  cm long.

**Fruit and Seed:** sessile, one seeded, fleshy, laterally compressed, and ovoid to ovate, smooth-skinned drupe. Unripe fruit green to dark-purplish, ripe fruit yellow to red, fruit  $4.75 \pm 0.21$  cm long and  $3.66 \pm 0.11$  cm wide. Seed enclosed in a rind of light, pithy or corky tissue,  $1.98 \pm 0.06$  cm long and  $0.73 \pm 0.02$  cm wide.

*Terminalia superba* 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.

**Stem:** unarmed, with slightly coarse ashy-grey surface, almost glabrous, bark surface smooth and grey in young trees; inner bark soft-fibrous and pale yellow.

**Leaf and Petiole:** thinly leathery and glabrous, crowded at the terminal ends of branchlets, pinnately veined, unarmed, obovate, margins entire, estipulate, apex acute, base acute,  $17.86 \pm 0.46$  cm long and  $8.98 \pm 0.26$  cm wide. Petiole

round, glabrous,  $4.18 \pm 0.16$  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 ( $0.44 \pm 0.01$  cm long) and glabrous.

**Sepal and Petal:** triangular, ( $0.26 \pm 0.01$  cm long). Petal absent

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

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

**Fruit and Seed:** a winged samara or nut, one seeded, transversely oblong-elliptical in outline,  $1.79 \pm 0.01$  cm long and  $5.28 \pm 0.08$  cm wide, including the wings. Seed golden brown, glabrous,  $1.048 \pm 0.01$  cm long and  $0.28 \pm 0.01$  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  $10.61 \pm 0.22$  cm long and  $4.55 \pm 0.12$  cm wide. Petiole round, long-petiolate, pubescent, petiole  $1.19 \pm 0.04$  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 ( $0.48 \pm 0.02$  cm long), slightly pubescent, spindle-shaped.

**Sepal and Petal:** triangular and short,  $0.33 \pm 0.01$  cm. Petal absent

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

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

**Ovary:** inferior, unilocular

**Fruit and Seed:** longitudinally winged nut, one seeded, oblong in outline, variable in size,

elongated and narrow, finely tomentose with very short reddish or orange-brown hairs,  $6.52 \pm 0.08$  cm long and  $2.60 \pm 0.08$  cm wide, including the wings. Seed oval and glabrous,  $0.92 \pm 0.02$  cm long and  $0.28 \pm 0.01$  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 unarmed, obovate, margins wavy, occasionally entire, estipulate, apex obtuse, base acute,  $2.69 \pm 0.14$  cm long and  $1.39 \pm 0.08$  cm wide. Petiole sub-sessile, round and glabrous;  $0.19 \pm 0.01$  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 ( $0.18 \pm 0.01$  cm long), glabrous, flowers sub-sessile.

**Sepal and Petals:** whitish or creamson, connate and acute at the apex,  $0.20 \pm 0.00$  cm high. Petal absent

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

**Style and Stigma:** glabrous,  $0.47 \pm 0.02$  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  $1.91 \pm 0.05$  cm long and  $0.97 \pm 0.04$  cm wide. Seed is spindle-shaped, glabrous,  $0.76 \pm 0.02$  cm long and  $0.30 \pm 0.00$  cm wide.

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

**Habitat and Habit:** savannah or forest. A woody

tree (up to 19.81m 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, stipulate, apex acute or obtuse, base acute,  $14.66 \pm 0.41$  cm long and  $7.75 \pm 0.19$  cm wide. Petiole round and pubescent,  $3.26 \pm 0.09$  cm long

**Venation:** Eucamptodromous, pinnately veined with 10-12 pairs of barely prominent lateral veins.

**Inflorescence and Flower:** terminal and axillary, spikes, racemes, or sometimes panicles, bracteates 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,  $0.44 \pm 0.01$  cm long.

**Sepal and Petal:**  $0.28 \pm 0.01$  cm high, acute and velvety hairy. 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;  $0.49 \pm 0.01$  cm high.

**Ovary:** inferior and unilocular

**Style and Stigma:** style 1, simple, usually free from distal part of calyx tube, stigma capitate or inconspicuous,  $0.58 \pm 0.01$  cm long.

**Fruit and Seed:** one seeded, fruit a winged nut, majorly oblong-elliptical in outline, fleshy or dry, indehiscent, often longitudinally 2-5-winged,  $6.42 \pm 0.11$  cm long and  $2.50 \pm 0.03$  cm wide including the wings, velvety hairy and whitish. Seed is spindle shaped  $1.08 \pm 0.02$  cm long and  $0.33 \pm 0.01$  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 21.34m high

**Stem:** unarmed but coarse; bark is grey to mottled pale and dark brown, scaly, flaking off in rectangular patches, fibrous and exuding a dark gum.

**Leaf and Petiole:** alternate or nearly opposite, simple and entire, broadly elliptic or ovate in outline, apex acute, base acute, pubescent or covered in dense silky hair when young; stipulate;  $2.31 \pm 0.10$  cm long and  $1.45 \pm 0.09$  cm wide. Petiole round and pubescent, petioles are short without glands; ( $0.20 \pm 0.02$  cm) long

**Venation:** Eucamptodromous

**Inflorescence and Flower:** inflorescence cluster, dense globose head, one or more peduncle from the same leaf axil, bracteote very minute, nearly pubescent. Flower pentamerous, pale yellow or greenish yellow and fragrant.

**Pedicel:** round, pubescent,  $1.85 \pm 0.06$  cm long.

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

**Stamens:** Stamens 10, exserted,  $0.50 \pm 0.01$  cm long, filaments filiform.

**Style and Stigma:** style simple, filiform,  $0.54 \pm 0.01$  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,  $0.60 \pm 0.01$  cm in diameter. Seed enclosed horizontally in a dense cone-like fructification,  $0.43 \pm 0.01$  cm long and  $0.14 \pm 0.00$  cm wide.

*Quisqualis indica* Linn. (Plates 11a - d)

**Habitat and Habit:** secondary forests and often in river banks; cultivated and naturalized in tropical areas. A scandent (climbing) shrubby vine, mesophytic to xerophytic, or helophytic; widely cultivated as an ornamental plant.

**Stem:** suffrutescent, green when young and greyish-brown at maturity.

**Leaf and Petiole:** opposite (or sub-opposite), oblong; obovate or elliptic, petiolate and simple, base obtuse; apex acute; margin entire; pinnately veined; glabrous at both surfaces and exstipulate.  $12.14 \pm 0.26$  cm long and  $6.32 \pm 0.15$  cm wide. Petiole short ( $1.02 \pm 0.03$  cm long) petiole round and glabrous.

**Venation:** Eucamptodromous

**Inflorescence and Flower:** cluster and terminal, or axillary; usually racemose. Flower pale-pink,

white to red, star shaped and fragrant; corymb; shallow corolla sinus.

**Pedicel:** greenish to brownish, softly pubescent;  $0.92 \pm 0.02$  cm long.

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

**Stamens:** filaments tiny and glabrous,  $5.11 \pm 0.05$  cm long.

**Style and Stigma:** style ( $7.02 \pm 0.07$  cm long) and glabrous.

**Fruit and Seed:** one seeded; non-fleshy; indehiscent, schizocarp or drupe; oblong with sharp angles, glabrous black; usually pentamerous and ellipsoidal,  $3.32 \pm 0.03$  cm long and  $1.77 \pm 0.04$  cm wide. Seed non-endospermic; ellipsoidal, embryo well differentiated; cotyledons 1-3,  $1.55 \pm 0.03$  cm long and  $1.00 \pm 0.03$  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. platypterum* 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. platypterum* 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. platypterum* and *C. zenkeri* (Table 2). Petal colour in this genus varies and has classificatory value as pink/white/cream petal colour in *C. platypterum* 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. platypterum* 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

Genus Species Characters	Genus Combretum				Genus Terminalia				Genus Anogeissus <i>A. leiocarpus</i>	Genus Quisqualis <i>Q. indica</i>
	<i>C. platypterum</i>	<i>C. zenkeri</i>	<i>C. raemosom</i>	<i>C. dolichopetalum</i>	<i>T. catapa</i>	<i>T. superba</i>	<i>T. inornata</i>	<i>T. mantaly</i>		
<b>Habitat</b>	Forest	Forest	Forest	Forest	Tropical/ Ornamental	Tropical region	Tropical region	Mesophytic	Savanna/ forest	Savanna/ forest border
<b>Habit</b>	Scandent shrub/liana Coarse	Scandent shrub/liana Coarse	Scandent shrub/liana Coarse	Scandent shrub/liana Coarse	Tree Coarse	Tree Slightly coarse	Tree Coarse	Tree Slightly coarse	Tree Coarse	Tree Coarse
<b>Stem surface</b>	Weak	Weak	Weak	Weak	Erect	Erect	Erect	Erect	Erect	Erect
<b>Nature of stem</b>	Suffrutescent	Suffrutescent	Suffrutescent	Suffrutescent	Woody	Woody	Woody	Woody	Woody	Woody
<b>Type of stem</b>	Green/grey	Green/grey	Green/grey	Green/grey	Grey/dark brown	Ashy grey	Dark brown	Ashy grey	Dark brown/ grey	Dark brown/ grey
<b>Stem colour</b>	Obovate	Obovate	Obovate	Elliptic	Obovate	Obovate	Oval/ obovate	Obovate	Obovate	Obovate/oblong
<b>Leaf shape</b>	Acute/ acuminate	Acute	Acute	Cordate/ acuminate	Acute to Retuse	Acute	Acute/ obtuse	Obtuse	Acute/obtuse	Acute
<b>Leaf apex</b>	Entire	Entire	Entire	Entire	Entire	Entire	Entire	Entire/ undulating	Entire	Entire
<b>Leaf margin</b>	Acute/ cuneate	Cordate	Cordate	Cordate/lobate	Acute to Lobate	Acute	Acute	Acute	Acute	Acute
<b>Leaf base</b>	None	Numerous	None	Numerous	None	None	None	None	Numerous	Numerous
<b>Hairs (abaxial)</b>	Glabrous	Pubescent	Pubescent	Pubescent	Glabrous / pubescent	Glabrous	Glabrous	Glabrous	Pubescent	Pubescent
<b>Petiole surface</b>	Glabrous	Pubescent	Pubescent	Pubescent	Glabrous	Glabrous	Glabrous	Glabrous	Pubescent	Pubescent
<b>Leaf abaxial surface</b>	Glabrous	Pubescent	Young leaf pubescent; mature leaf glabrous	Pubescent	Glabrous	Glabrous	Glabrous	Glabrous	Woolly or velvety pubescent	Pubescent
<b>Venation</b>	Eucamptodromous	Eucamptodromous	Eucamptodromous	Eucamptodromous	Eucamptodromous	Eucamptodromous	Eucamptodromous	Cladodromous	Eucamptodromous	Eucamptodromous

**Table 2: Qualitative Reproductive Morphological Characters of Species of Combretaceae**

Species Character	Combretum platypterum	Combretum zenkeri	Combretum racemosum	Combretum dolichopetalum	Terminalia catapa	Terminalia superba	Terminalia ivorensis	Terminalia mantaly	Terminalia avicennitoides	Anogeissus leiocarpus	Quisqualis indica
<b>Stipule</b>	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate	Estipulate
<b>Pediceal surface</b>	Pubescent	Pubescent	Pubescent	Pubescent	Glabrous	Glabrous	Slightly pubescent	Glabrous	Sofly pubescent	Pubescent	Sofly pubescent
<b>Sepal colour/apex shape</b>	Pink/cream coloured/acute	Creamson/whitish/acute	Green/acute	Green/acute	White/cream coloured/acute	Cream coloured/acute	Cream coloured/acute	Crimson/whitish/acute	Cream coloured/acute	Cream coloured/acute	Green/acute
<b>Corolla colour/apex shape</b>	Pink/white/cream coloured/acute	Cream coloured/acute	Red/cream coloured/acute	Yellow/light greenish/acute	Absent	Absent	Absent	Absent	Absent	Absent	Whitish/purplish/reddish/rounded
<b>Style surface</b>	Glabrous	Densely pubescent	Glabrous	Glabrous	Glabrous	Densely pubescent	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
<b>Filament surface</b>	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous	Glabrous
<b>Floral aestivation</b>	Valvate	Valvate	Valvate	Valvate	Valvate	Valvate	Valvate	Valvate	Valvate	Valvate	Valvate
<b>Floral symmetry</b>	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic	Actinomorphic
<b>Inflorescence</b>	Axillary spike	Globose head	Axillary spike	Axillary spike	Spike	Axillary spike	Axillary spike	Cluster	Axillary spike/raceme	Densely globose	Racemose
<b>Unripe fruit colour</b>	Deep pink/red	Whitish/cream coloured	Whitish/cream coloured/pinkish	Light yellow/pinkish	Greenish/dark purplish	Greenish	Greenish	Greenish	Whitish	Greenish	Greenish
<b>Ripe fruit colour</b>	Pale yellow	Pale brown	Pale brown	Pale brown	Yellow/red	Dark brown	Dark brown	Yellow/red	Dark brown	Yellow/reddish brown	Blackish
<b>Fruit shape</b>	Tetramerous	Pentamerous	Tetramerous/pentamerous	Tetramerous/pentamerous	Ovoid	Oblong/elliptic	Oblong	Ovate/elliptic	Oblong/elliptic	Orbicular	Ellipsoidal
<b>Seed colour/shape</b>	Whitish/spindle-shaped	Greenish/brownish/spindle-shaped	Greenish/spindle-shaped	Greenish/spindle-shaped	Brownish/ovoid	Palebrown/ovoid	Pale brown/ovoid	Brownish/narrow ovate	Pale brown/spindle shaped	Brownish/elliptic	Whitish/ellipsoidal

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 dendrogram (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.**

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

\*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**

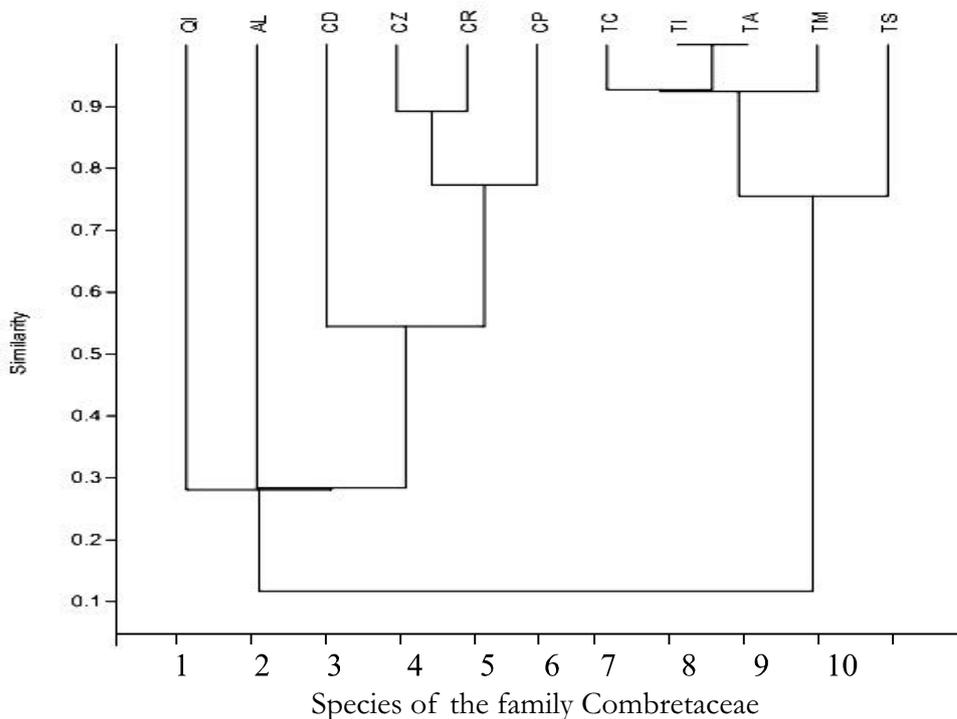
Species	Pediceal length (cm)	Sepal length (cm)	Petal length (cm)	Stamen length (cm)	Style and stigma (cm)	Fruit diameter (cm)	Fruit length (cm)	Fruit width (cm)	Seed length (cm)	Seed width (cm)	Seed number
Combretum platypterum	0.42±0.01 <sup>c</sup>	1.650±0.08± <sup>h</sup>	2.0280±0.10 <sup>c</sup>	1.87±0.04 <sup>d</sup>	3.87±0.11 <sup>d</sup>	2.81±0.03 <sup>c</sup>	-	-	1.07±0.02 <sup>c</sup>	0.36±0.01 <sup>d</sup>	1.00±0.00 <sup>a</sup>
Combretum zenkeri	0.20±0.00 <sup>a</sup>	0.15±0.00 <sup>a</sup>	0.2000±0.00 <sup>a</sup>	0.44±0.01 <sup>b</sup>	0.59±0.02 <sup>b</sup>	1.65±0.01 <sup>b</sup>	-	-	0.66±0.01 <sup>b</sup>	0.12±0.01 <sup>a</sup>	1.00±0.00 <sup>a</sup>
Combretum racemosum	0.24±0.10 <sup>a</sup>	0.64±0.01 <sup>g</sup>	0.2740±0.01 <sup>a</sup>	1.40±0.02 <sup>c</sup>	1.57±0.03 <sup>c</sup>	2.53±0.03 <sup>d</sup>	-	-	0.96±0.02 <sup>d</sup>	0.30±0.00 <sup>bc</sup>	1.00±0.00 <sup>a</sup>
Combretum dolichopetalum	0.56±0.03 <sup>d</sup>	0.19±0.01 <sup>ab</sup>	1.9280±0.04 <sup>b</sup>	2.71±0.02 <sup>c</sup>	0.26±0.00 <sup>a</sup>	1.93±0.03 <sup>c</sup>	-	-	1.09±0.03 <sup>c</sup>	0.34±0.01 <sup>cd</sup>	1.00±0.00 <sup>a</sup>
Terminalia catapa	0.31±0.02 <sup>b</sup>	0.25±0.01 <sup>bc</sup>	-	0.44±0.01 <sup>b</sup>	0.61±0.02 <sup>b</sup>	-	4.75±0.21 <sup>c</sup>	3.66±0.11 <sup>d</sup>	1.98±0.06 <sup>g</sup>	0.74±0.02 <sup>e</sup>	1.00±0.00 <sup>a</sup>
Terminalia superba	0.44±0.01 <sup>c</sup>	0.26±0.01 <sup>bcd</sup>	-	0.33±0.00 <sup>a</sup>	0.46±0.01 <sup>b</sup>	-	1.79±0.01 <sup>a</sup>	5.28±0.08 <sup>e</sup>	1.05±0.01 <sup>c</sup>	0.28±0.01 <sup>bc</sup>	1.00±0.00 <sup>a</sup>
Terminalia ivorensis	0.48±0.02 <sup>c</sup>	0.33±0.01 <sup>def</sup>	-	0.46±0.01 <sup>b</sup>	0.51±0.12 <sup>b</sup>	-	6.42±0.08 <sup>d</sup>	2.60±0.08 <sup>c</sup>	0.92±0.02 <sup>d</sup>	0.28±0.01 <sup>b</sup>	1.00±0.00 <sup>a</sup>
Terminalia mantaly	0.18±0.01 <sup>a</sup>	0.20±0.00 <sup>ab</sup>	-	0.46±0.01 <sup>b</sup>	0.47±0.02 <sup>b</sup>	-	1.91±0.05 <sup>a</sup>	0.97±0.04 <sup>a</sup>	0.76±0.02 <sup>c</sup>	0.30±0.00 <sup>bc</sup>	1.00±0.00 <sup>a</sup>
Terminalia avicennioides	0.44±0.01 <sup>c</sup>	0.28±0.01 <sup>ede</sup>	-	0.49±0.01 <sup>b</sup>	0.58±0.01 <sup>b</sup>	-	6.52±0.11 <sup>d</sup>	2.50±0.03 <sup>c</sup>	1.08±0.02 <sup>e</sup>	0.33±0.01 <sup>bcd</sup>	1.00±0.00 <sup>a</sup>
Anogeissus leiocarpus	1.85±0.06 <sup>f</sup>	0.35±0.01 <sup>ef</sup>	-	0.49±0.01 <sup>b</sup>	0.54±0.01 <sup>b</sup>	0.59±0.01 <sup>a</sup>	-	-	0.43±0.01 <sup>a</sup>	0.14±0.00 <sup>b</sup>	1.00±0.00 <sup>a</sup>
Quisqualis indica	0.92±0.02 <sup>e</sup>	0.37±0.02 <sup>f</sup>	0.2600±0.04 <sup>d</sup>	5.11±0.05 <sup>f</sup>	7.02±0.07 <sup>e</sup>	-	3.32±0.03 <sup>b</sup>	1.77±0.04 <sup>b</sup>	1.55±0.03 <sup>f</sup>	5.11±0.05 <sup>f</sup>	1.00±0.00 <sup>a</sup>

\*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.

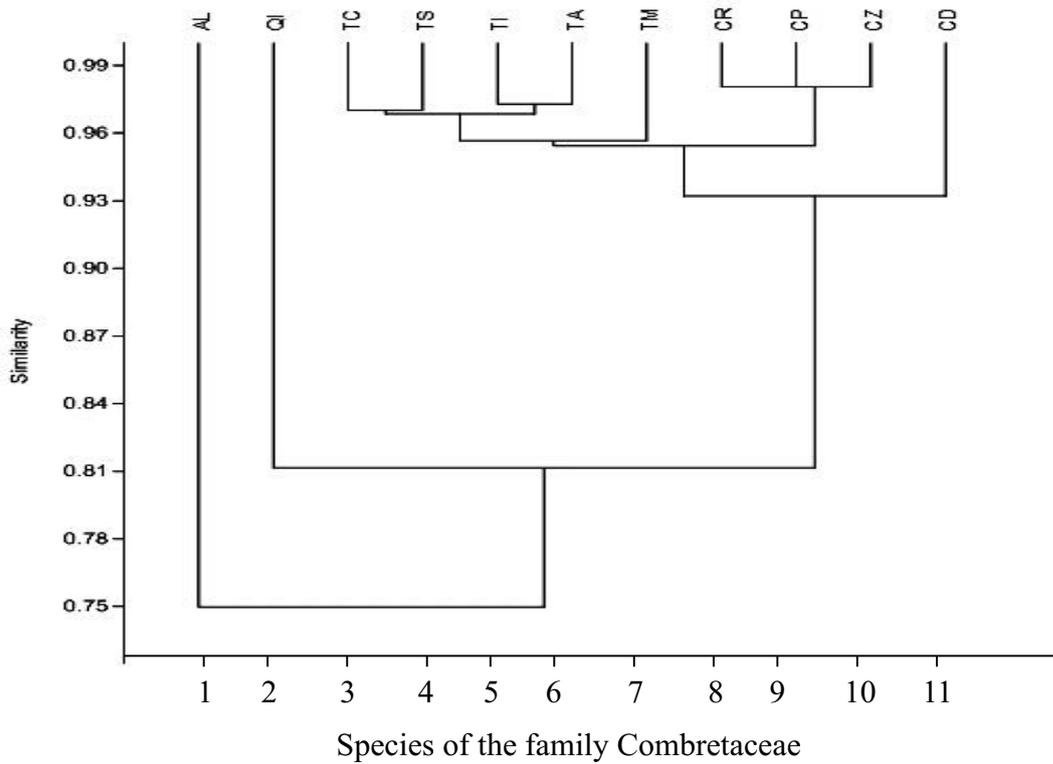


**Figure 1: Dendrogram of Combretaceae Species Based on Quantitative Reproductive Morphological Characters**

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

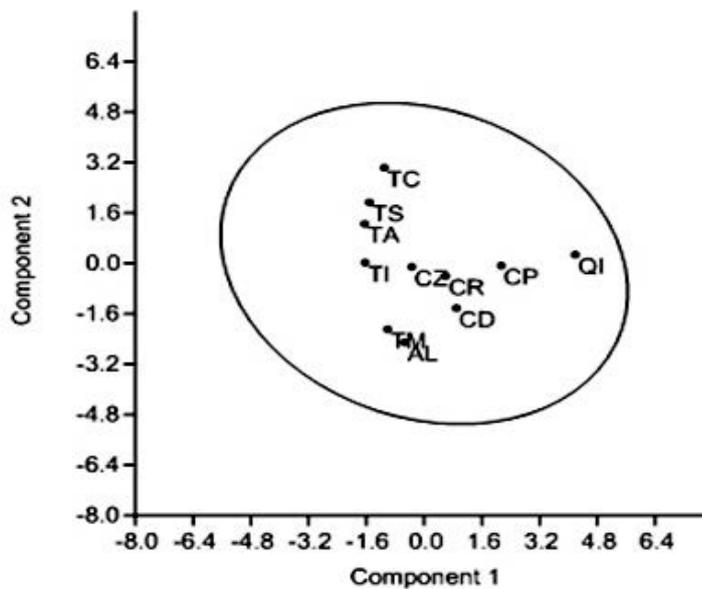
**Table 5: Principal Components Analysis (PCA) Factor Loadings of Some Important Quantitative Vegetative and Reproductive Morphological Characters of Eleven Species of Combretaceae**

Characters	PCA1	PCA2
Leaf length	0.91	-
Leaf width	0.89	-
Stamen length	-	0.90
Style and stigma	-	0.85
Seed length	0.88	-
Seed width	-	0.81



**Figure 2: Dendrogram 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*.



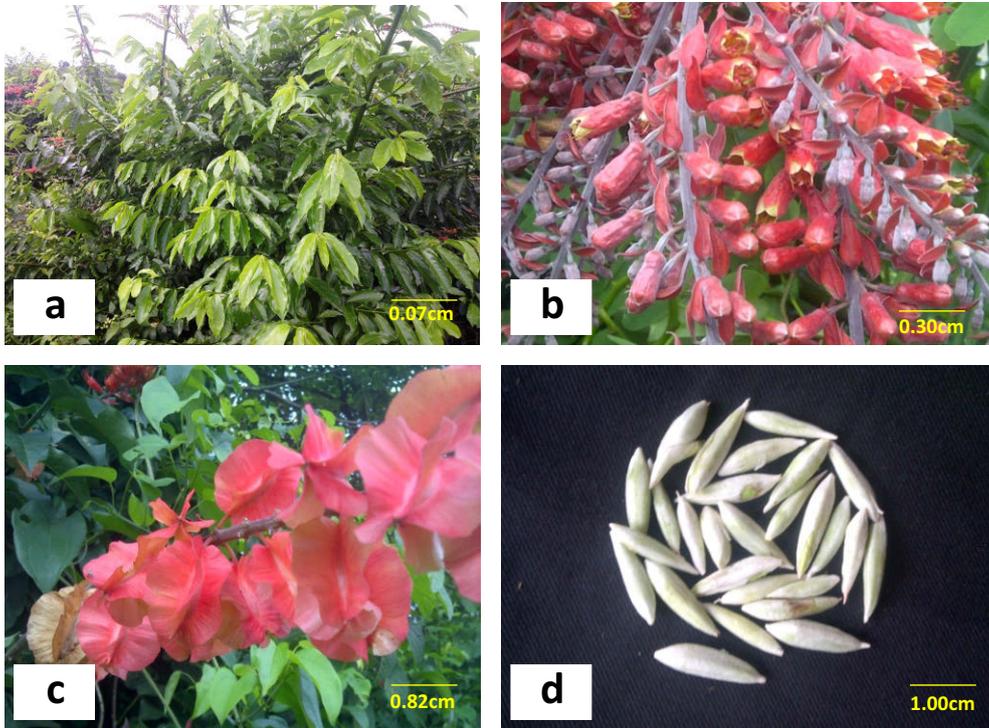
**Figure 3: Principle Components Analysis (scattered diagram) of eleven species of Combretaceae Based on Combined Quantitative Vegetative and Reproductive Morphological Characters.**

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*.

**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*.  
 (a): Habit of *C. platypterum* (b): spike-like raceme inflorescence of *C. platypterum*  
 (c): Fruits of *C. platypterum* (d): Seeds of *C. platypterum*



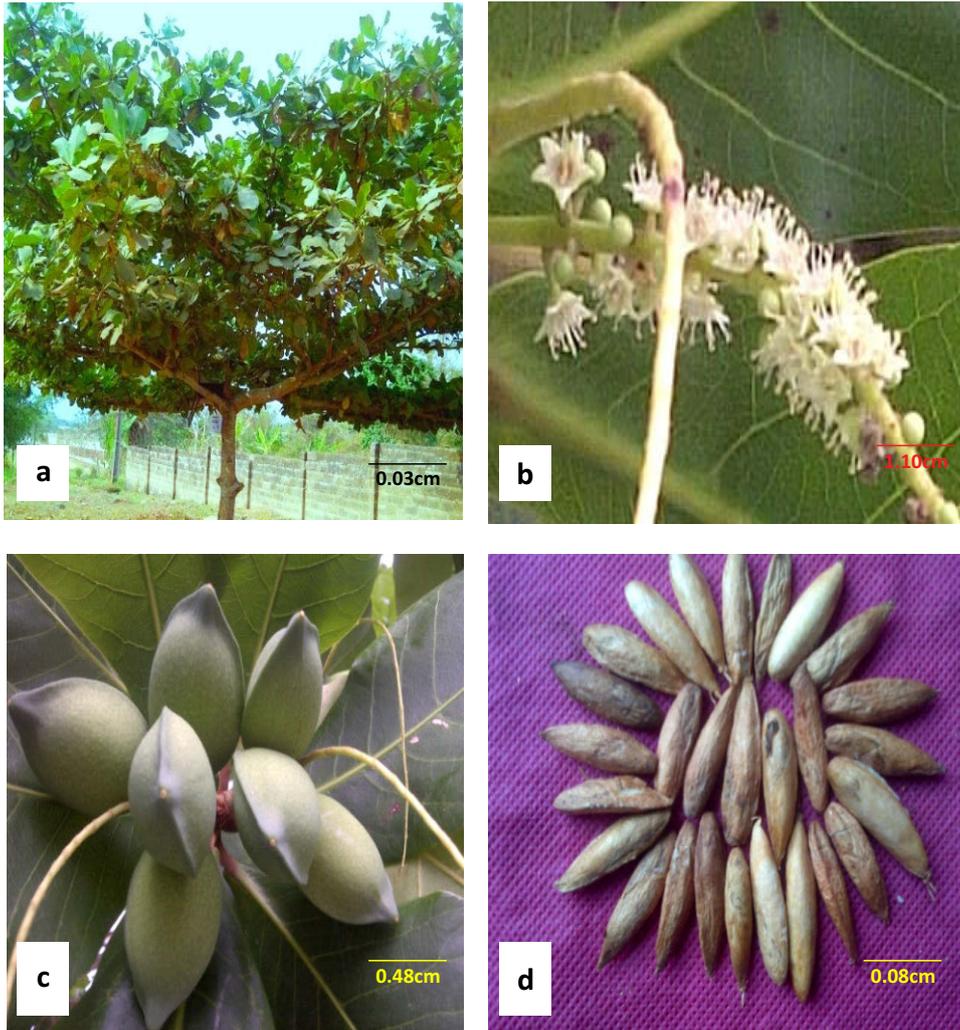
Plates (2a - d): Morphological Study of *Combretum zenkeri*  
 (a): Habit of *C. zenkeri* (b): inflorescence (c): Fruits of *C. zenkeri* (d): Seeds of *C. zenkeri*



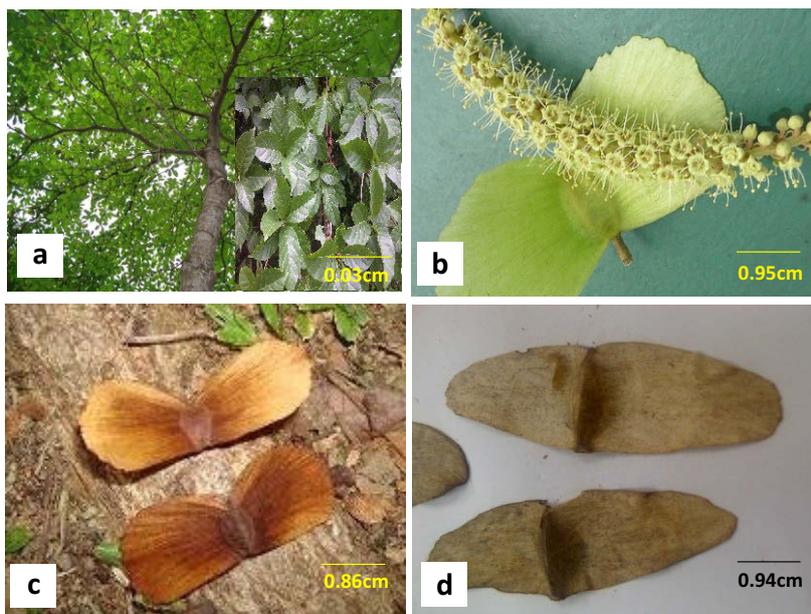
Plates (Plates 3a - d): Morphological Study of *Combretum racemosum*  
 (a): Habit of *C. racemosum* (b): Spike inflorescence  
 (c): Fruits of *C. racemosum* (d): Seeds of *C. racemosum*



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*



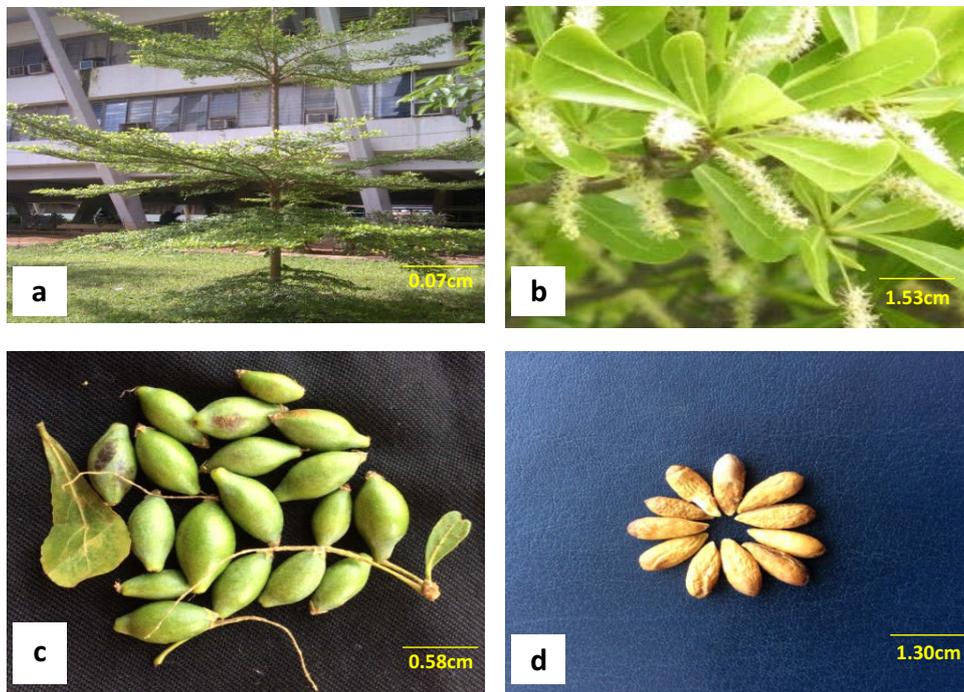
Plates (5a - d): Morphological Study of *Terminalia catapa*  
 (a): Habit of *T. catapa* (b): Spike inflorescence (c): Fruits *T. catapa* (d): Seeds of *T. catapa*



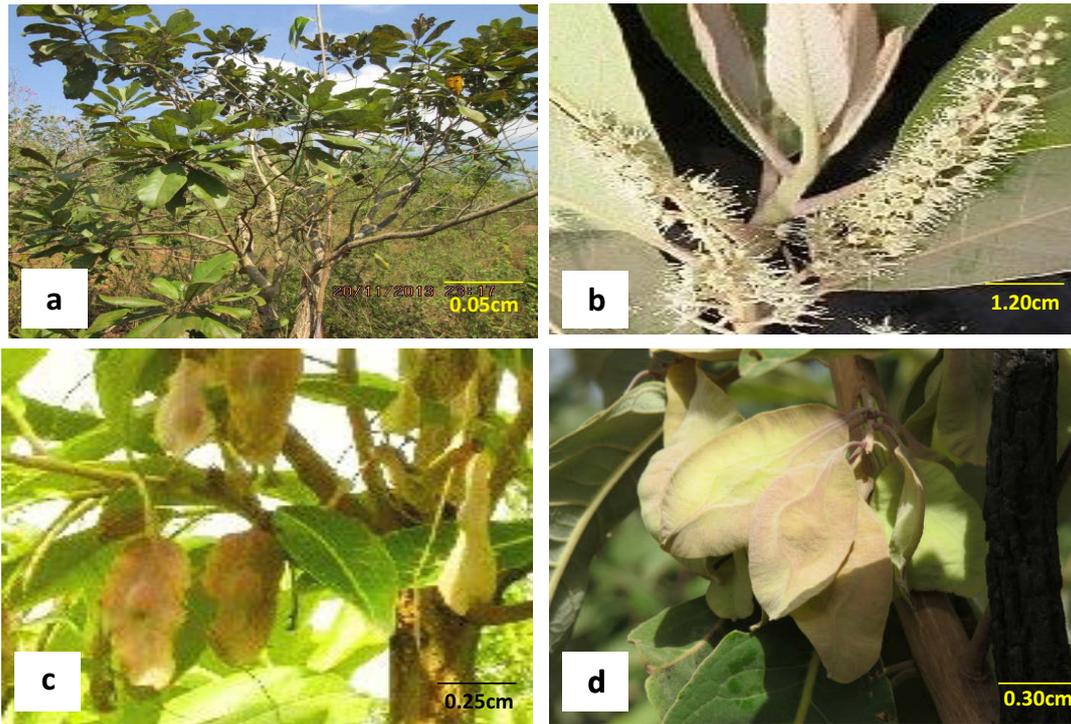
Plates (6a - d): Morphological Study *Terminalia superba*  
 (a): Habit of *T. superba* (b): Spike inflorescence and Fruit of *T. superba*  
 (c) and (d): Dried Fruits or *T. superba*



Plates (7a - d): Morphological Study of *Terminalia ivorensis* (a): Habit of *T. ivorensis* (b): Inflorescence (c): Dried Fruits of *T. ivorensis* (d): Fruits of *T. Ivorensi*



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*

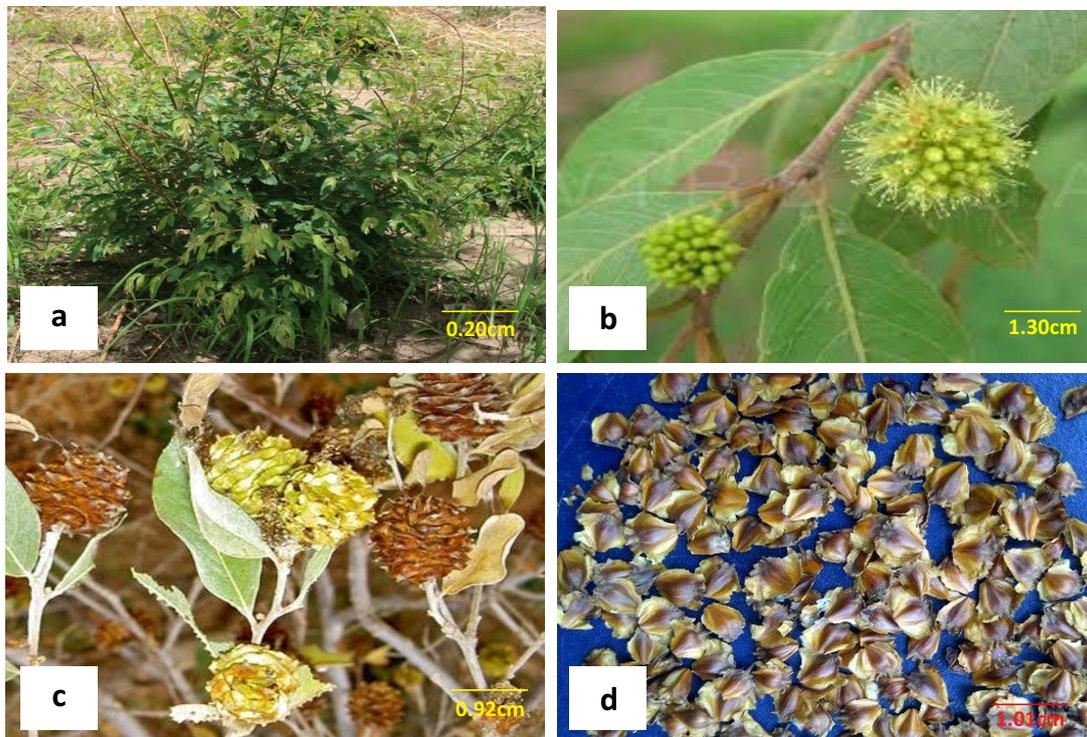


Plate (10a - d): Morphological Study of *Anogeissus leiocarpus*  
 (a): Habit of *A. leiocarpus* (b): Inflorescence  
 (c): Fruits of *A. leiocarpus* (d): Seeds of *A. leiocarpus*



Plate (11a - d): Morphological Study of *Quisqualis indica*  
 (a): Habit of *Q. indica* (b): Racemose inflorescence of *Q. indica*  
 (c): Fruits of *Q. indica* (d): Seeds of *Q. indica*

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#### 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.

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