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European Journal of Experimental Biology, 2012, 2 (6):1962-1973



**Biosystematic Studies in Loganiaceae (Series 4): Phytomorphological characterization in relation to intraspecific delimitation among members of the tree species in the Genus - *Anthocleista* found in parts of the Niger Delta Tropical Rainforest, Nigeria**

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**ABSTRACT**

*Comparative morphological characterizations on four species of *Anthocleista* found in Nigeria were carried out in parts of Niger Delta area in order to determine the suitability for intraspecific taxonomic delimitation. Using the ecological standard procedure for random sampling the areas covered include States of Rivers, Bayelsa, Akwa-Ibom and Cross River. Though the species are generally perennial, shrubby trees with apparent similarity in diagnostic features, and with the study locality not actually influencing their morphology, they have recorded differences in their habit and branching pattern, ecology (habitat), bole texture, leaf and petiole sizes, inflorescence, flower and fruit. The variations observed on the vegetative and floral morphology could possibly prove taxonomically useful as a baseline in delimiting the different taxa at the intraspecific level and enhance the already existing Floristic information on the species.*

**Keywords:** Habit, Ecology, Inflorescence, Flower, Fruit and Leaves

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**INTRODUCTION**

Morphological features are of great taxonomic importance though it cannot always be used solely in delimiting plants of particular taxa. Stace [1] has though suggested that internal parts of a plant are useful in the taxonomic delimitation of the plant since the internal parts are less affected by environmental changes; however the value of diagnostic morphological features and characterization in comparative taxonomy have been studied extensively and documented in botanical literatures by botanists in various classes of plants [2, 3]. The usefulness of variation of gross morphology for diagnostic purposes among angiosperm groups is also well documented [4, 5, 1, 6, 7, 8]. Burkill [9], have reported on the ethnobotanical utilization of the species. The record available indicates that no in-depth morphological characterization of diagnostic features has been carried out on tree species of *Anthocleista* found in parts of Niger Delta Tropical Rainforest.

The genus *Anthocleista* Afzel ex. Br. is a medium size Tropical African genus composed usually of small trees or scrambling shrubs with soft white wood with a few herbs like *Spigelia* [10, 11]. It belongs to the family of the order

Loganiales [12]. The family Loganiaceae contains about thirty (30) genera and over 600 species [13]. About 50 species in the genus *Anthocleista* are endemic to Tropical Africa, Madagascar and Mascaree Island. Of the 50 species six (6) species are known to be found and of economic importance in various parts of Nigeria [11]. Of the six species in Nigeria, phytogeographical study has revealed four species of common occurrence in parts of Niger Delta [14]. Most of which are generally mesophytic in habitat adaptation and occur in some parts of tropical rainforest zone. However, with some level of disparity in certain ecological habitats, but generally are perennial shrubby trees with marked preference for tropical climate [14]. The delimitation of the family is a much debated taxonomic issue [10]. While Hutchinson [12] has placed *Loganiaceae* with six other families: *Potaliaceae*, *Buddlejaceae*, *Antoniaceae*, *Spigeliaceae*, *Strychnaceae* and *Oleaceae* in the order Loganiales, recent molecular, morphological and phytochemical evidence has moved the taxon to *Potaliaceae* [15]. Takhtajan [16] and Backlund *et al.*, [13] placed *Loganiaceae* with eight other families in the order Gentianales. This has heightened the need for a morphological study especially of valuable tree species of *Anthocleista* in the area. The information obtained is expected to aid as assessment of the taxonomic value of these features as well as their functions in the intraspecific taxonomic delimitation in this genus.

## MATERIALS AND METHODS

### *Species assessment.*

Observations on vegetative and floral characteristics were made on mature plants growing in the field and on materials collected during field trips in parts of Niger Delta, Nigeria. Using a random sampling method the areas covered include parts of Rivers, Bayelsa, Akwa Ibom, and Cross River States (Fig. 1). References were made to several books and Floras such as; Flora of West Tropical Africa [17], Trees of Nigeria [11] for proper identification. Photographs of relevant and accessible morphological features were taken on living plants in the field (Plates. 1- 4). A taxonomic key based on the outstanding diagnostic characteristics of the species (Table-1) has been developed to further demonstrate the value of these features in delimitation of *Anthocleista*. Summary of the morphological features are presented in Table -2.

## RESULTS

Data on morphological features are summarized in Table-2. The detailed botanical descriptions of the various species are presented below.

### *Anthocleista nobilis* G. Don. (Plates. 1a-d)

**Habit:** A mesophytic tree of unbranched vertical growth, **ecology:** Found in both terrestrial and swampy forest, **tree:** Unbranched slender bole with conspicuous spines, divergent and sometimes converging, **leaves:** Usually 94 -102cm long, 17-23-5cm broad; oblanceolate, narrowly rounded or bluntly pointed at the apex, tapering gradually to a cuneate base; with 18 -21 pairs of thin lateral nerves running out to the margin, veins practically invisible, leaves opposite, glabrous and leathery texture, light green abaxial and dark green adaxial surfaces crowded at the apices of the branchlets. Reduced petiole 15-3cm dilated at the base sometimes usually sessile with reduced leaf like wing running almost round the branchlet and joining the base of opposite petiole and leaving a conspicuous scar after falling. Branches conspicuously spiny, spines divergent, confluent at the base, paired or sometimes 3 – 4 together. Margin usually revolute and undulate. Leaves often drying black.

**Inflorescence:** Terminal, very short, pale yellow to light green, glabrous, branching in three with each lateral pairs of branches at right angles to the pair above and below. Bracts are small, persistent, slightly angled to round shape. **Flower:** Flower buds uniformly rounded or subtruncated at the apex. Mature corolla in bud usually less than 5 times as long as the calyx. Corolla tube 2-3 times as long as the lobes and 2.5-3.5 times as long as the calyx. **Fruit:** A greenish berry, ellipsoidal in shape. When dry with 4 more or less irregular dents or irregularly shriveled.

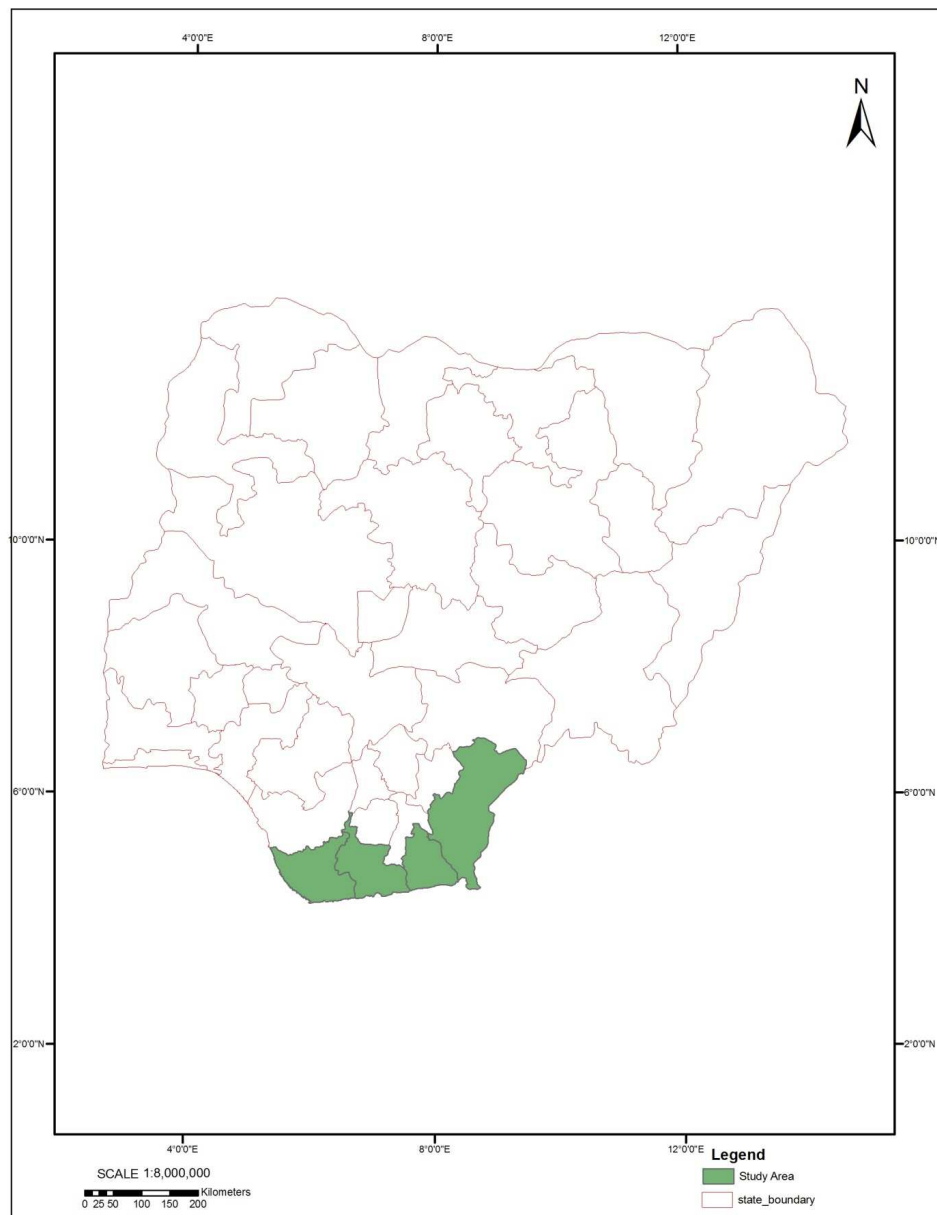


Fig. 1: Map of Nigeria showing sampling / study areas

*Anthocleista liebrechtsiana* De Wild and Th. Dur. (Plates. 2a-d)

*Habit:* A swamp-loving tree, similar to *A. nobilis* but with branching pattern, *ecology:* Swamp forest, *tree:* A slender bole with spreading branches with didymous converging and diverging spines arising at the axil point of petiole scar, each pair oppositely arranged and perpendicular to other. Bark grey with white blotches, slash whitish cream. *Leaves:* Usually 18.4-54.0cm long, 4.4-17.5cm broad. Oblanceolate, narrowly rounded or bluntly pointed at the apex, tapering gradually to a cuneate base,

A



B



C



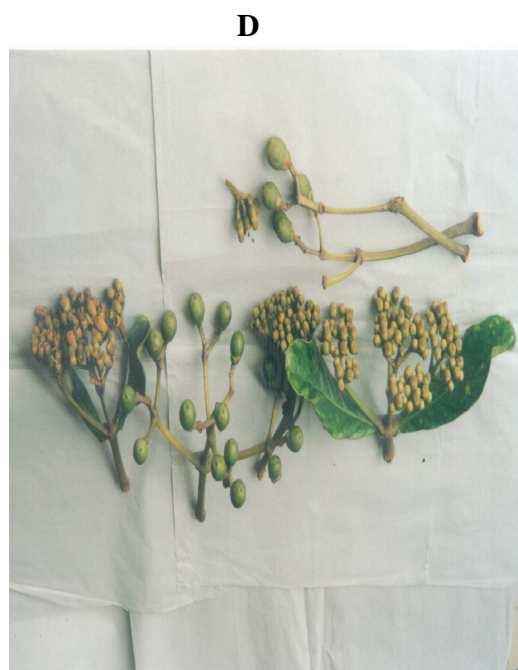
D



Plates. 1a and b showing the morphological feature of *Anthocleista nobilis*  
c and d showing the inflorescence of *Anthocleista nobilis*



Plates 2a and b showing the morphology features *Anthocleista liebrechtsiana*



Plates 2c and d showing the inflorescence and fruits formation of *Anthocleista liebrechtsiana*

with 9-16 pairs of thin lateral nerves running out to the margin, veins practically invisible, leaves opposite, glabrous and leathery texture, dark green adaxial and light green abaxial surfaces. Petiole 2.2-3.5cm dilated at the base, with leaf-like wing running the base of the opposite petiole and leaving a conspicuous scar after falling.

*Inflorescence:* Terminal, very stout, pale yellow to light brown and glabrous, branching in three with each lateral pair of branches at right angles to the pair above or below. Bracts are small, but persistent with round shape. *Flower:* The flowers have stout pedicels, 4 thick almost circular sepals overlapping in opposite pairs of a conspicuously tubular pale cream corolla. 10-16 narrow lobes imbricately overlapping each other to the right or left. An equal number of stamens attached to the corolla tube between the lobes with elongated anther and filament fused into a very short tube. The long slender style terminates in a fat bilobed stigma. *Fruit:* Greenish berry with yellow to dark brown leathery mesocarp enclosing numerous white small seeds. Ellipsoid about 1.91-2.46mm broad. Syncarpously enclosed at the base persistently, ovoid to obovoid in shape. *Ovule:* Parietal placentation, 4 loculed

*Anthocleista djalonesis* A. Chev. (Plates. 3a-i)

*Habit:* A tree species of secondary forest in drier areas than *A. vogelii*, similar to *A. vogelii* but with branched variety of bigger and smaller leaves. *ecology:* Secondary forest, in drier areas, *tree:* This is much like *A. vogelii*, bark grey, and slash cream, with few converging and diverging spines below each axil point of petiole scar. Each pair oppositely arranged and perpendicular to other. *Leaves:* Mature tree with variable leaf sizes, large with similar shape to those of *A. vogelii* and branched or unbranched with distinct petiole. Obovate and broadly rounded at the apex, usually cordate flaps at the base, sometimes cuneate. Usually 19-73cm long, 11-45cm broad, with 10-17 pairs of conspicuous lateral nerves running to the margin. Veins practically invisible, conspicuous midrib running from the base to the apex, triangular shape, protruding at the ventral surface with texture, dark / light green adaxial and abaxial surfaces respectively, petiole 2.5-20cm, dilated at the base angle, with leaf-like wing running almost round the branchlet and joining the base of the opposite petiole and leaving a conspicuous scar after falling. Leaves not conspicuous discolourous. Margin not revolute or undulate.

*Inflorescence:* Terminal, whitish, glabrous, branching in three with each lateral pair of branches at right angles to the pair above or below. Bracts are small, but persistent with rounded shape. *Flower:* (March-August) - white, sweet nectary, in upright terminal, branched inflorescence of varied dimension not stout as the inflorescences of *A. vogelii* pedicel not stout, 4 thick almost circular sepals overlapping in opposite pairs of a conspicuously tubular corolla 2.7-3.4cm long, with 11-14 narrow corolla lobes, imbricately arranged, shorter than the tube, bent right back and exposing the stamens of equal number, elongated anthers and the filament fused into a very short tube. The long slender style terminates in a fat bilobed stigma. Flower buds not rounded but tapering at the apex. Calyx narrowed, not definitely constricted at the mouth. Mature corolla in bud 199 5.5 - 6 times as long as the calyx. *Fruit:* An ellipsoidal berry, drying smooth.

*Anthocleista vogelii* Planch (Plates. 4a-c)

*Habit:* A tree species of secondary forest, *ecology:* Found frequently occurring on dry land and shore lines of swampy areas, *tree:* Much like *A. djolensis*. Bark – grey to pale brown, smooth to slightly fissured longitudinally, slash cream to pale brown. Sparsely located diverging spines, but less than *A. nobilis*, and. More than *A. djalonesis* in divergence. *Leaves:* Mature tree with variable leaf sizes, large and similar to *A. djalonesis*. Broad, obovate to oblanceolate, rounded at the apex, tapering gradually to the base. Usually 15-50cm broad, 50-170cm long, with 19-21 pair of conspicuous lateral nerves running to the margin, veins practically visible, conspicuous midrib running from the base to the apex, triangular shaped, protruding at the ventral surface with outward sharp edge. Leaves opposite, glabrous and leathery texture stout petiole 2-5cm length dilated at the base angle, leaf-like wing running almost round the branchlet and joining the base of the opposite petiole and leaving a conspicuous scar after falling. Leaves never dying black and often comparatively wider than *A. nobilis*. *Flower:* (Oct -Feb, Mar-May), orange brown, in conspicuous very stout upright branched inflorescences at the ends of the shoots, tubular corolla with 16 narrow lobes, imbricately overlapping each other to the right or left and an equal number of stamens attached to the corolla-tube between the lobes with elongated anthers. Corolla lobes bent over and concealing the stamens and stigma. Corolla tube 0.9-1.5 times as long as the lobes and 2.5 -3.5 times as long as the calyx. Fruits drying smooth neither shrivelled nor dented. *Fruits:* A greenish berry with leathery mesocarp, ellipsoid, with enlarged and persistent calyx at the base.

**A**



**B**



**C**



**D**



Plates. 3a-d: Showing the morphological features of *Anthocleista djalonesis*  
a-b: big leaf formation branched variety  
c-d: big leaf formation unbranched variety

E



F



G

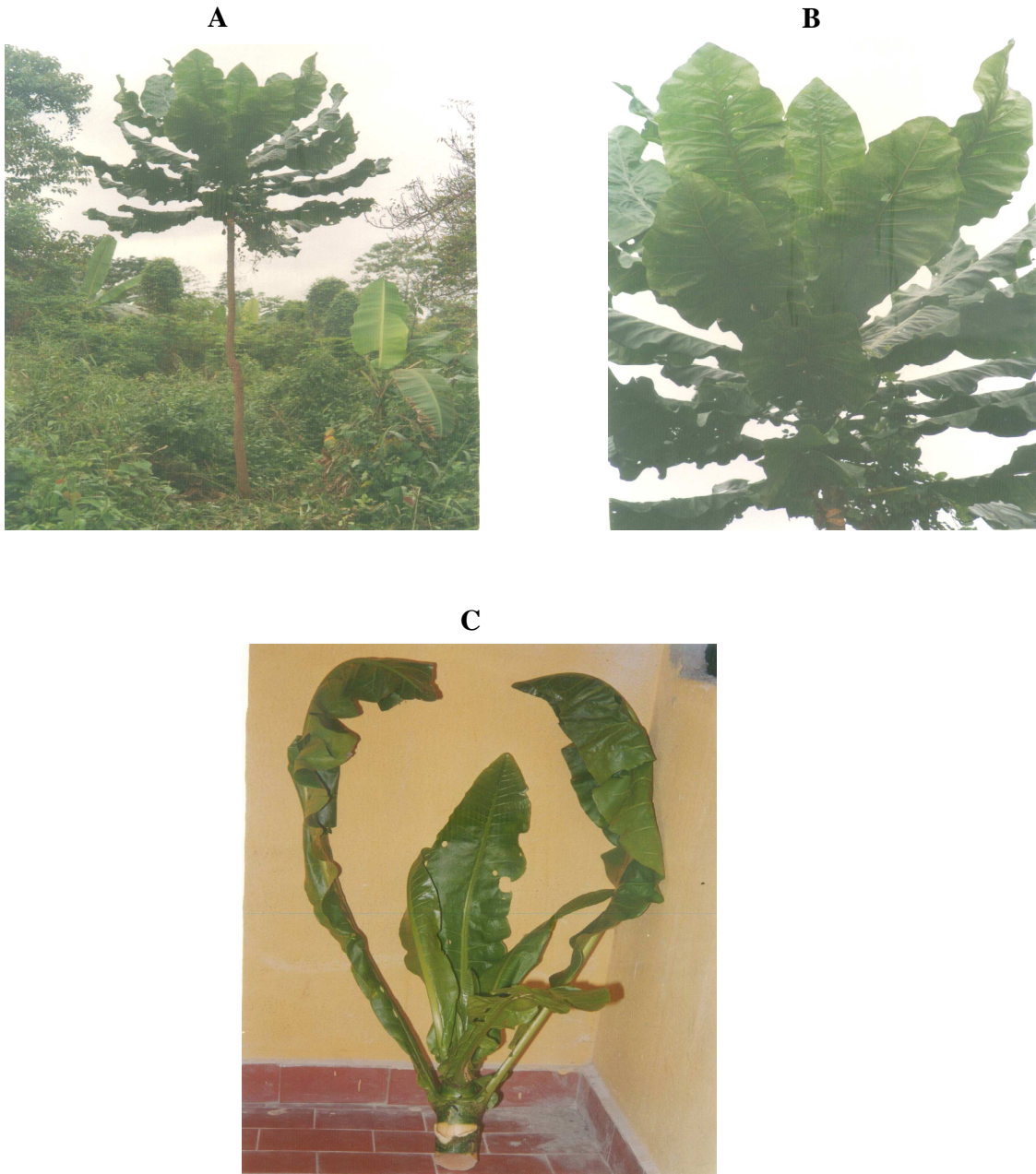


H



Plates. 3e-h: Showing the morphological features of *Anthocleista djalonesis*  
e-f: small leaf formation branched variety  
g-h: showing the fruit and flower formation





Plates. 4a – c: Showing the morphology features of *Anthocleista vogelii*

Table- 1: A bracketed dichotomous key to the identification of the species in the genus - *Anthocleista* occurring in the Niger Delta.

- 1. Monopodial, bole slender .....*A. nobilis*
- 1<sup>1</sup> Not monopodial but sympodial, bole not slender.....2
- 2. Habitat swamp .....3
- 2<sup>1</sup> Habitat not swamp but terrestrial .....*A. djalonesis*
- 3. Inflorescence branched with three round persistent bract.....*A. liebrechtsiana*
- 3<sup>1</sup> Inflorescence not branched, without three round persistent bracts but in a conspicuous stout upright branch .....*A. vogelii*

Table 2: Morphological features and variations in a summary

Features	Species			
	<i>A. nobilis</i>	<i>A. liebrechtsiana</i>	<i>A. djalonesis</i>	<i>A. vogelii</i>
Habit	Mesophytic tree with unbranched vertical growth	A swamp-loving tree with branching pattern.	A tree similar to <i>A. vogelii</i> but with branched variety of bigger and smaller leaves.	A tree species of secondary forest.
Habitat	Both terrestrial and swampy forest land.	Swampy forest	Secondary forest, indrier areas, mesophytic	Occur on dry land and shorelines of swampy areas.
Tree	Unbranched slender bole with sparsely diverging spines.	Slender bole with spreading branches didymous converging and diverging spines, bark grey with white blotches, slash whitish cream.	Bark grey, slash cream, converging and diverging spines.	Bark grey to pale brown smooth to slightly fissured longitudinally, slash cream to pale brown sparsely located diverging spines, < <i>A. nobilis</i> and <i>A. djalonesis</i> in divergence.
Leaves	94-102cm long; 17-23.5cm broad oblanceolate, narrowly rounded or bluntly pointed at the apex, tapering gradually to a cuneate base; 18-21 pairs of thin lateral veins, practically invisible, leaves glabrous and leathery. Petiole 1.5-3cm, dilated at the base.	Smaller and branching 18.4 – 54.0 cm long, 4.4-17.5cm broad oblanceolate, narrowly rounded or bluntly pointed at the apex, tapering gradually to a cumulate base, 9-16 pairs of thin lateral nerves, practically invisible, glabrous and leathery, 2.2-3.5cm petiole, dilated at the base.	Variable leaf sizes, large with similar shape to those of <i>A. vogelii</i> , branched or unbranched with distinct petiole 2.5-20cm dilated at the base, abovate and broadly rounded at the apex, cordate or cuneate at the base, 19-73cm long, 11-45cm broad, 10 -17 pairs of lateral nerves. Conspicuous midrib running from the base to the apex, triangular in shape and protruding at the ventral surface with outward sharp edge.	Variable leaf sizes, large and similar to <i>A. djalonesis</i> . Broad, obviate to oblanceolate, rounded at the apex, tapering gradually to the base. 15-50cm broad, 50-170cm long, 19-21 pairs of conspicuous lateral nerves, practically visible. Conspicuous mid rib running from the base to the apex, triangular shaped, protruding at the ventral surface with outward, sharp edge petiole stout, 2-5cm long, dilated at the base.
Inflorescence	Terminal, stout, pale yellow to light green, glabrous, branching in three and perpendicular, persistent bract slightly angled to round shape.	Terminal, stout, pale yellow to light brown, glabrous, perpendicular branching in three rounded persistent bract.	Terminal, whitish, glabrous, perpendicular branching in three, bracts rounded in shape.	Inflorescence orange-brown, conspicuous stout upright branch at the end of the short.
Flower	-	Stout pedicel; 4 thick circular sepals, pale cream corolla with 10-16 narrow lobes, imbricate, elongated anther, filament fused to a short tube, bilobed stigma.	White, sweet nectary in upright terminal branched inflorescence. Pedicel not stout, 4 thick circular sepals. 11-14 tabular corolla 2.7-3.4cm long, imbricately arranged. 11-14 stamens elongated anthers filament fused to a short tube bilobed stigma.	Tabular corolla with 16 narrow lobes, imbricate. Elongated anther, corolla lobes bent over, concealing the stamens and stigma.
Fruit		Greenish berry, yellow to dark brown leathery mesocarp numerous white seeds, ellipsoidal, 1.91-2.46 mm broad, ovoid to obovoid in shape.	A greenish berry with leathery mesocarp ellipsoid, with enlarged and persistent calyx at the base.	.
Ovule		Parietal placentation, 4 loculed		

## DISCUSSION

Morphological features though may not be used alone for taxonomic delimitation they are still of immense taxonomic importance. The usefulness of vegetative and floral morphological features has been highlighted by [4, 5, 1].

Morphological expressions of these four species provide a means for easy identification. Leaf morphology has remained totally useful tool for systematic studies of dicotyledons [18]. The diagnostic features with respect to leaf morphology include phylotaxy, symmetry, shape, size, colour, surface feature, margin, presence and nature of stipules, petioles, duration, venation and thickness. These different aspects of leaf morphological features have been extensively utilized for taxa delimitation [5, 1]. Of particular interest in the taxonomy of the Nigeria *Anthocleista* species are the leaf margin, leaf area (size), and petiole. Though the four species posses a glabrous and leathery textured leaf, the leaf margin of *A. nobilis* is usually characterized with revolute and undulated margins and often

turns black when dry. This distinguished it from other three species. The other differences in the leaf morphology in these species include the different sizes of the leaf and petiole. *A. nobilis* has a longer leaf length than others, ranging from 94-102cm; *A. djalonesis* 19-73cm *A. liebrechtsiana* 18.4 – 54.0cm and *A. vogelii* 15 -50cm while *A. vogelii* is more broader in size ranging from 50 -170cm; *A. djalonesis* 11- 45cm; *A. nobilis* 17-23.5cm and *A. liebrechtsiana* 4.4 – 17.5cm. The petiole also show variation in length with *A. djalonesis* having the longest 2.5-20cm; *A. vogelii* 2-5cm; *A. liebrechtsiana* 2.2-3.5 and *A. nobilis* with the shortest 1.5-3cm. Sometimes *A. vogelii* tend to be apetiolate. These features conform to the report of [11] and are of diagnostic value in the genus. Metcalfe and Chalk [5] pointed out that surface texture of the leaf is one of the useful taxonomic features. Keay [11] observed that though the species studied have in common a glabrous and leathery texture, the length and size of leaves are variable in response to environmental conditions. Thus this can frequently delimit species, genera even whole families.

The aspect of floral and fruit morphological features of these species are equally useful taxonomically. Floral characters according to Stace [1] have been and still are those mostly used in the classification of angiosperms. The type and nature of inflorescences and developmental pattern of arrangement in these four species are the same. All other floral characteristics explored showed the close resemblance of these species. There is though slight colour variation with *A. nobilis* showing pale yellow to light green; *A. liebrechtsiana* pale yellow to light brown, while *A. djalonesis* have whitish colour and *A. vogelii* has orange brown colour again other differences in the floral morphology in these species include the flowers.

*A. nobilis* has flower buds uniformly rounded or subtruncated at the apex, with corolla tube 2-3 times as long as the lobes and 2.5 -3.5 times as long as the calyx and has stout pedicel. *A. liebrechtsiana* has stout pedicel, corolla 10-16 narrow lobes. *A. djalonesis* has non stout pedicel, corolla 2.7-3.4cm long 11-14 narrow corolla lobes. Flower buds not rounded but tapering at the apex. Mature corolla in bud 5.5 -6 times as long as the calyx. *A. vogelii* flower with stout pedicel 16 narrow lobes with the tube 0.9-1.5 times as long as the lobes and 2.5-3.5 times as long as the calyx.

The broad pattern of the structure of fruits is in general a less reliable taxonomic criterion, but in such large families as the brassicaceae, apiaceae, euphorbiaceae, poaceae, the fruits provide the most useful characters of all [1]. Thus the fruits morphological features of these *Anthocleista* species play important roles in their individual taxonomy. Though all are typically greenish berry ellipsoidal in shape with leathery mesocarp, parietal placentation and persistent calyx at the base. *A. nobilis* when dried has 4 more or less irregular dents or irregularly shriveled wall while others have smooth dried wall.

## CONCLUSION

The genus *Anthocleista* Afzel ex. R. Br. has been described by Hutchison and Dalziel [17] and Keay [11]. Of the six species recorded in literature, four (4) of such species are found to exist in the Tropical rainforest in parts of Niger Delta, Nigeria. The species include *A. nobilis*, *A. liebrechtsiana*, *A. djalonesis* and *A. Vogelii*. All the species are wild mesophytic and perennial shrubby trees. Taxonomically early reports on the genus dwelt on morphology of few species. The present study has made an in-depth characterization of the morphological features and attempted to confirm most of the morphological result on the species of this genus as found in parts of Niger Delta Nigeria as useful diagnostic features for intraspecific delimitation. The ground is now set for further research into other lines of taxonomic evidence such as palynology, phytochemistry, cytology, anatomy, histology, phenology etc,

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