

Biosystematic Studies in Annonaceae I. Vegetative and Floral Morphological Studies of Some Species of *Annona* in Nigeria

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Abstract: A morphological study of four species of *Annona* found in Nigeria and characterized as important under-utilized species was conducted in search of intrageneric characters which may be of taxonomic value in the identification and classification of the genus. Life plants, fruits, flowers and seeds were studied from mature plants in the experimental garden. Both qualitative and quantitative characters were recorded. Additional morphological characters of taxonomic value are eucamptodromous venation, inflated petiole, chasmogamous flower and distichous phyllotaxy.

Key words: Morphological, *Annona*, intrageneric, taxonomic, eucamptodromous

Introduction

Annona is a genus of tropical fruit tree belonging to the family Annonaceae (Nakasone and Paull, 1998). It has approximately 119 species of which seven and one hybrid are grown for domestic/commercial use. Five species have been selected as important under-utilized species (ICUC, 2002).

Economically, *Annona* trees can be categorized into two groups. In the first group are *A. reticulata* (custard apple) and *A. senegalensis* (wild soursop), which are grown by subsistence farmers under smallholder conditions, resulting in low income to their growers. The second group includes *A. muricata* (soursop) and *A. squamosa* (sugar apple) which are grown on commercial farms as highly remunerative crops for both small and medium scale farmers (Vogt, 1995). *Annonas* are generally consumed as fresh fruits, but are also widely used in semi-processed and processed products (Salunkhe and Desai, 1986).

The taxonomic value of morphological characters has been stressed by several workers, including Metcalfe and Chalk (1950, 1979), Palmer and Tucker (1981), Adedeji and Illoh (2005). Noonman *et al.* (1997) in their study of the family annonaceae, used morphological characters of flowers, fruits and seeds of annonaceous genera to perform a cluster analysis. The clusters were differentiated mainly by seed characters. Suggested relationships within the family were compared with classifications published before (Noonman *et al.*, 1997). The present study studies the intrageneric relationships in the genus *Annona* with a view to providing additional features that may be of taxonomic value in the identification and classification of the genus.

Materials and Methods

Four species out of the five species categorized as important under-utilized species, which are found in Nigeria were studied between 2000 and 2005 within the experimental garden of Obafemi Awolowo University Campus, Ile-Ife, Nigeria. They are:

A. reticulata (Custard apple)

A. senegalensis (Wild soursop)

A. muricata (Soursop)

A. squamosa (Sugar apple)

Seeds of various accession were germinated in plastic buckets and transplanted directly into the soil in the experimental garden. Life plants, fruits, flowers and seeds were studied from mature plants in the experimental garden. The habit and habitat of the different species were noted. Qualitative morphological characters studied include the shape, base, apex, margin, veins and petioles of leaf, phyllotaxy, presence of stipule, growth type, fruit type, shape and fruit colour when ripe. Also studied, are colours of the petals, petal texture, sepal colour, number of stamen and flower type.

The quantitative morphological characters measured are length and breadth of leaves, length and breadth of sepals, length and breadth of petals, length and bread of fruit, length and breadth of seed, petiole length and pedicel length. Counts were taken of number of veins, seeds, sepals and petals. Free-hand diagrams of morphological characters of each species used for the study were also made to highlight some intrageneric differences.

Results

The vegetative, floral, fruit and seed characteristics of the species studied are presented below.

A. senegalensis: Fig. 1

Habit: Small shrubby tree

Habitat: Savanna woodland

Leaf: Alternate, elliptic, coriaceous, apex obtuse, base obtuse, margin entire

Venation: Eucamptodromous

Phyllotaxy: Distichous

Petiole: inflated, circular in cross section

Growth: Sympodial

Stipule: Absent

Flower: Chasmogamous

Epicalyx: Absent

Sepal: Light green, 3 in number, margin entire

Petal: Fleshy, light yellow, margin entire, cordate, 6 in number

Fruit: Yellow, syncarpous, oval in shape, smooth skin, one seed/carpel.

A. squamosa: Fig. 2

Habit: Shrub

Habitat: Cultivated for ornament

Leaf: Alternate, elliptic, chartaceous, apex acute, base acute, margin entire.

Venation: Eucamptodromous

Phyllotaxy: Distichous

Petiole: inflated, circular in cross section

Growth: Sympodial

Stipule: Absent

Flower: Chasmogamous

Epicalyx: Absent

Sepal: Green, 3 in number, margin entire, fleshy

Petal: Light yellow, margin entire, lanceolate, 3 in number

Fruit: Yellowish green, syncarpous, oval in shape, rough skin.

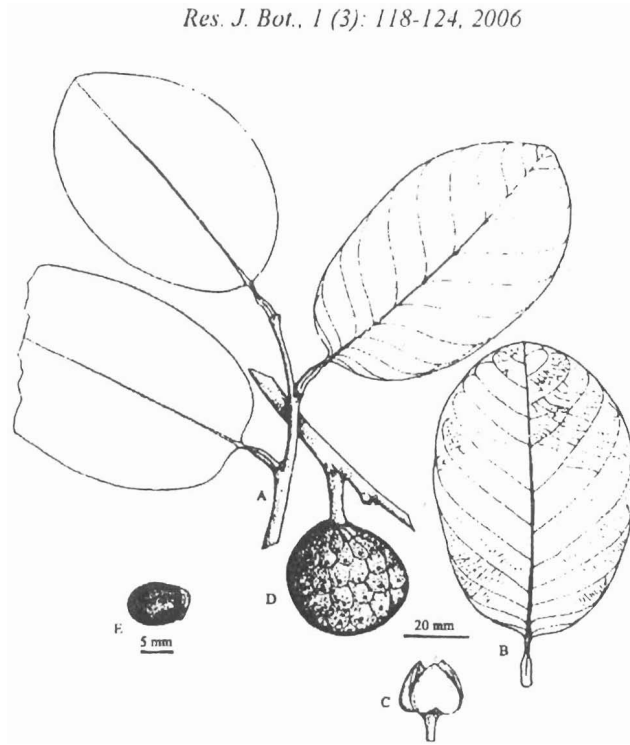


Fig. 1: Diagram of some morphological features of *Annona senegalensis*. A = Branch, B = Leaf, C = Flower, D = Fruit, E = Seed

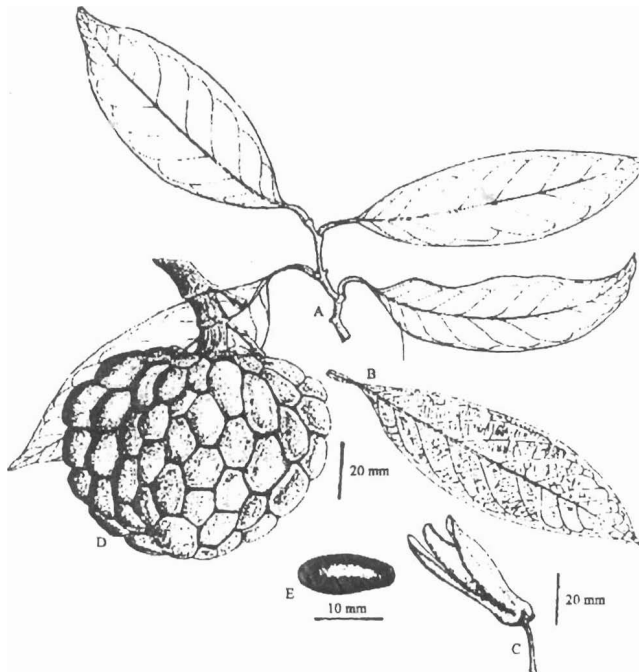


Fig. 2: Diagram of some morphological features of *Annona squamosa*. A = Branch, B = Leaf, C = Flower, D = Fruit, E = Seed

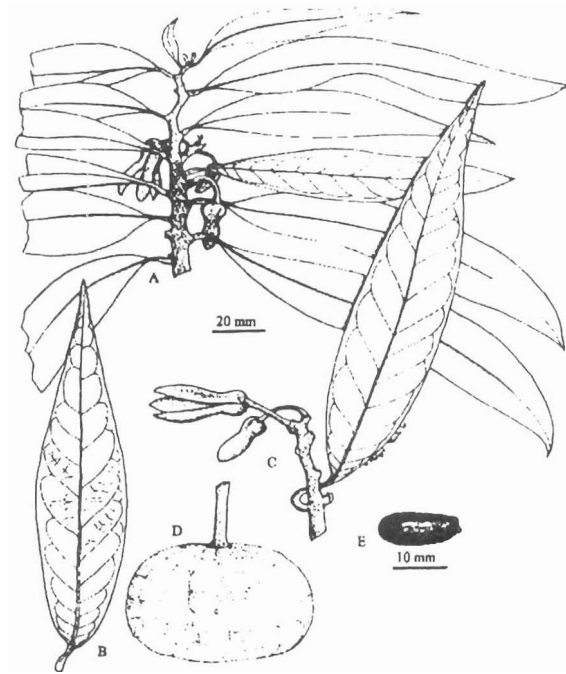


Fig. 3: Diagram of some morphological features of *Annona reticulata*. A = Branch, B = Leaf, C = Flower, D = Fruit, E = Seed

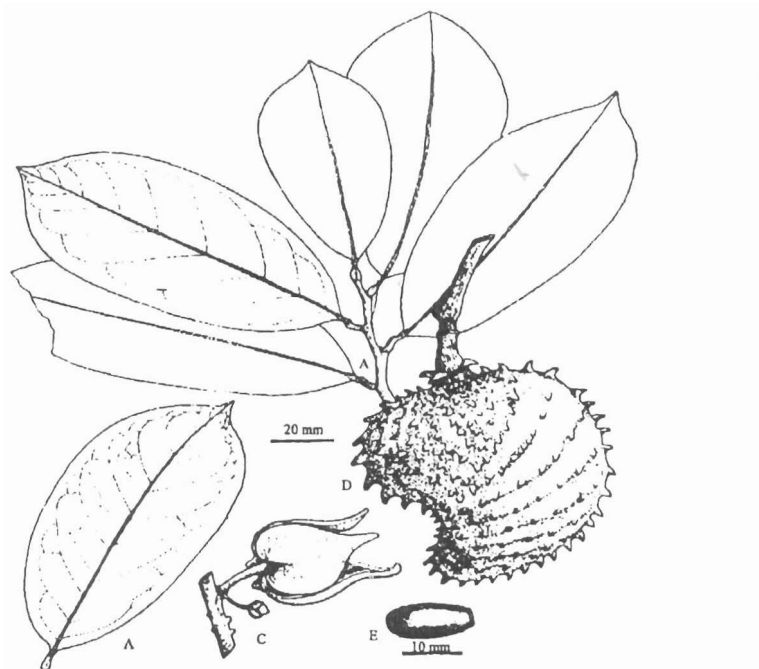


Fig. 4: Diagram of some morphological features of *Annona muricata*. A = Branch, B = Leaf, C = Flower, D = Fruit, E = Seed

A. reticulata: Fig. 3

Habit: A small tree

Habitat: Cultivated for ornament

Leaf: Alternate, elliptic, chartaceous, apex attenuate, base acute margin entire

Venation: Eucamptodromous

Phyllotaxy: Distichous

Petiole: inflated, circular in cross section

Growth: Sympodial

Stipule: Absent

Flower: Chasmogamous

Epicalyx: Absent

Sepal: Greenish yellow, 3 in number, margin entire

Petal: Fleshy, light yellow, margin entire, lanceolate, 3 in number.

Fruit: Pink, syncarpous, oval, smooth skin.

A. muricata: Fig. 4

Habit: A small tree

Habitat: Cultivated for ornament

Leaf: Alternate, obovate, coriaceous, apex acute, base obtuse, margin entire

Venation: Eucamptodromous

Phyllotaxy: Distichous

Petiole: Inflated, circular in cross section

Growth: Monopodial

Stipule: Absent

Flower: Chasmogamous

Epicalyx: Greenish yellow

Sepal: Greenish yellow, 3 in number, margin entire

Petal: Fleshy, light yellow, margin entire, elliptic, 6 in number

Fruit: Green, syncarpous, oblong and spiny.

Table 1 shows the qualitative characters in the morphology of vegetative parts of the *Annona* species, interestingly the leaves are of pinnate type, largely camptodromous and typically eucamptodromous. Similarly, Table 2 provides summary of the qualitative characters in the morphology of their floral parts. Petal textures are largely coriaceous and the stamens are generally many in the *Annona* species. The quantitative characters in the morphology of vegetative and floral parts of these *Annonas* are as shown in Table 3. Each of the characters varied from the other. Of special interest is the seed number which decreased from *A. squamosa* (75) to *A. muricata* (57) to *A. reticulata* (44) to *A. senegalensis* (41).

Table 1: Qualitative Characters in the morphology of vegetative parts of the species of *Annona*

Qualitative characters	Habitat	Habit	Stipule	Petiole	Venation	
<i>A. senegalensis</i>	Savanna wood land	Small shrubby tree	Absent	Inflated round	Eucamptodromous	
<i>A. squamosa</i>	Cultivated for ornament	Small tree	Absent	Inflated round	Eucamptodromous	
<i>A. reticulata</i>	Cultivated for ornament	Small tree	Absent	Inflated round	Eucamptodromous	
<i>A. muricata</i>	Cultivated for ornament	Small tree	Absent	Inflated round	Eucamptodromous	
Qualitative characters	Phyllotaxy	Growth	Leaf shape	Leaf apex	Leaf base	Leaf margin
<i>A. senegalensis</i>	Distichous	Sympodial	Elliptic	Obtuse	Obtuse	Entire
<i>A. squamosa</i>	Distichous	Sympodial	Elliptic	Acute	Acute	Entire
<i>A. reticulata</i>	Distichous	Sympodial	Elliptic	Attenuate	Acute	Entire
<i>A. muricata</i>	Distichous	Monopodial	Obovate	Acute	Obtuse	Entire

Table 2: Qualitative Characters in the morphology of floral parts of the species of *Annona*

Qualitative characters	Flower	Stamen	Sepal colour	Petal colour
<i>A. senegalensis</i>	Chasmogamous	Many	Light green	Light yellow
<i>A. squamosa</i>	Chasmogamous	Many	Green	Light yellow
<i>A. reticulata</i>	Chasmogamous	Many	Greenish yellow	Light yellow
<i>A. muricata</i>	Chasmogamous	Many	Light green	Light yellow
Qualitative characters	Fruit	Fruit colour when ripe	Fruit shape	Petal texture
<i>A. senegalensis</i>	Syncarpous	Yellow	Oval	Coriaceous
<i>A. squamosa</i>	Syncarpous	Yellowish green	Oval	Coriaceous
<i>A. reticulata</i>	Syncarpous	Pink	Oval	Coriaceous
<i>A. muricata</i>	Syncarpous	Deep green	Oblong	Coriaceous

Table 3: Quantitative characters in the morphology of floral parts of the species of *Annona*

Plant	Leaf length	Leaf breadth	Vein No.	Petiole length	Sepal length	Sepal breadth	Petal length	
<i>Annona</i>								
<i>senegalensis</i>	7.5±8.9	5.5±2.4	10±1.4	1.95±0.1	0.35±0.1	0.35±0.1	1.35±0.4	
<i>A. squamosa</i>	11.3±4.6	4.0±1.0	13±1.4	1.2±0.4	0.15±0.1	0.15±0.1	2.6±0.1	
<i>A. reticulata</i>	13.7±6.4	3.8±1.3	16±3.5	1.4±0.4	0.25±0.1	0.25±0.1	1.7±0.7	
<i>A. muricata</i>	10.9±4.7	4.9±2.6	11±2.8	0.8±0.4	4.25±0.4	3.75±0.4	4.35±0.2	
Plant	Petal breadth	Pedicel lcr.gth	Fruit Length	Fruit breadth	Seed length	Seed breadth	Seed No.	Fruit stalk
<i>Annona</i>								
<i>senegalensis</i>	0.75±0.6	0.6±0.1	4.0±0.4	4.4±0.4	1.0±0.1	0.7±0.1	41	2.25±0.1
<i>A. squamosa</i>	0.45±0.1	1.6±0.1	7.5±3.2	7.0±3.0	1.5±0.1	0.6±0.1	75	1.5±0.1
<i>A. reticulata</i>	0.40±0.1	2.45±0.1	6.5±1.5	7.0±1.0	1.5±0.1	0.7±0.1	44	2.5±0.1
<i>A. muricata</i>	3.25±0.4	1.10±0.4	15.3±2.5	10.0±1.4	1.5±0.1	0.8±0.1	57	2.25±0.1

Discussion

Generally in floras and taxa identification literature, the target morphological characters are those that separate taxa. But even at that only the few so-called diagnostic characters are emphasized. The morphological characters among all the species of Annonaceae had been reported by Hutchinson and Dalziel (1958). However, some morphological characters which were also common among the species were not included. These characters which are typical of the *Annonas* include, eucamptodromous venation, inflated petiole and chasmogamous flower.

All the species of *Annona* studied have distichous phyllotaxy and sympodial growth except *A. muricata* that has monopodial growth. Therefore, distichous phyllotaxy and sympodial growth may be regarded as primitive characters since *Annona* is the type genus. Other species with spiral phyllotaxy and monopodial growth can therefore be considered as advanced species (Johnson, 2003). *A. muricata* in this sense is said to be more highly because of its monopodial growth characteristic.

A consideration of the morphological characters revealed an intrageneric relationships among the *Annona* species. Leaf shape is a strong factor in the clustering of Annonaceae. *A. senegalensis*, *A. squamosa* and *A. reticulata* have elliptic leaves, leaf shape is obovate in *A. muricata*. Based on the fruit shape, *A. senegalensis*, *A. squamosa* and *A. reticulata* are intrageneric with oval fruit shape while the fruit shape in *A. muricata* is oblong. It is noteworthy that the savanna species that is *A. senegalensis* comparably has smaller seeds size than the forest species (Table 3), this corroborates the generalized opinion that seed size is ecologically determined; large seed sizes are associated with closer communities such as forests.

In conclusion, there are intrageneric relationships among the *Annonas* as revealed in this study Eucamptodromous venation, distichous phyllotaxy, inflated petiole and chasmogamous flower among other characters may be of taxonomic value in the identification and classification of the genus.

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