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Evidences from morphological investigations supporting APGIII and APGIV Classification of the family Apocynaceae Juss., nom. cons

IKRAM MADANI
Department of Botany, Faculty of Science
University of Khartoum, Sudan
LAYALY IBRAHIM ALI
Faculty of Science, University Shandi
EL BUSHRA EL SHEIKH EL NUR
Department of Botany, Faculty of Science
University of Khartoum, Sudan

Abstract:

Apocynaceae have traditionally been divided into into two subfamilies, the Plumerioideae and the Apocynoideae. Recently, based on molecular data, classification of Apocynaceae has undergone considerable revisions. According to the Angiosperm Phylogeny Group III (APGIII, 2009), and the update of the Angiosperm Phylogeny Group APG (APGIV, 2016) the family Asclepiadaceae is now included in the Apocynaceae. The family, as currently recognized, includes some 1500 species divided in about 424 genera and five subfamilies: Apocynoideae, Rauvolfioideae, Asclepiadoideae, Periplocoideae, and Secamonoideae. In this research selected species from the previous families Asclepiadaceae and Apocynaceae were morphologically investigated in an attempt to distinguish morphological important characters supporting their new molecular classification. 40 morphological characters were treated as variables and analyzed for cluster of average linkage between groups using the statistical package SPSS 16.0. Resulting dendrograms confirm the relationships between species from the previous families on the basis of their flowers, fruits,

and seeds morphology. Close relationships were reported between species from the same subfamilies.

Key words: Evidences, Taxonomy, Morphology, APGIII , Apocynaceae

INTRODUCTION:

Family Apocynaceae, which is known as the dogbane family is composed of trees, shrubs, or vines, and rarely subshrubs and herbs, with latex or rarely watery juice. This family which belongs to the order Gentianales, historically includes about 155 genera and 2000 species distributed mainly in the tropics and subtropics, and rarely exist in the temperate regions (Cronquist, 1981). Since the classification of Schumann (1895), the Apocynaceae have traditionally been divided into two subfamilies, the Plumerioideae and the Apocynoideae. Recently, based on molecular data, classification of Apocynaceae has undergone considerable revisions. According to the Angiosperm Phylogeny Group III (APGIII, 2009) the family Asclepiadaceae is now included in the Apocynaceae. This revision is also updated in Angiosperm Phylogeny Group IV (APGIV, 2016). The family, as currently recognized, includes some 1500 species divided in about 424 genera and five subfamilies: Apocynoideae, Rauvolfioideae, Asclepiadoideae, Periplocoideae, and Secamonoideae. The former two subfamilies were part of the Apocynaceae sensu stricto, while the latter three subfamilies used to belong to the Asclepiadaceae. It is considered now as one of the ten largest families of angiosperms which include five subfamilies 25 tribes and 49 sub tribes. Asclepiadoideae is the largest sub family with five tribes, 15 sub tribes and 164 genera followed by Rauvolfioideae with 11 tribes, 17 sub tribes and 83 genera, while Apocynoideae comprises nine tribes, 17 sub tribes and 82 genera. The two

smaller subfamilies, Periplocoideae and Secamonoideae consist of one tribe, 33 and eight genera respectively (APGII, 2003; APG III, 2009; Endress et al, 2014; APGIV, 2016). Apocynaceae is one of the most popular families, due to the traditional use of some of its species as ornamental plants (e.g., *Allamanda cathartica* L., *Catharanthus roseus* (L.) G. Don, *Nerium oleander* L., *Plumeria rubra* L., *Thevetia peruviana* (Pers.) K. Schum.). In Sudan, Andrews (1952) recorded four species belonging to three genera of Apocynaceae: *Adenium honghel* in Jebel Marra and Nuba Mountains, *Adenium speclosum* and *Landolphia comorensis var. florida* in central sudan and *Carissa edulis* which is widespread. He also reported about 36 species of 20 genera belonging to the family Asclepidaceae which are distributed in different localities. The aim of this paper is to evaluate the taxonomic significance of morphological variations within the selected species of the family Apocynaceae as evidence supporting its recent molecular classification

MATERIAL AND METHODS

The present study is based on fresh plant specimens. Wild plant materials which are *Calotropis procera* (Aiton) Dryand, *Solenostemma argel (*Delile) Hayne, *Oxystelma bornouense* R.Br, *Leptadenia arborea* (Forssk.) *Schweinf, Leptadenia pyrotechnica* (Forssk.) Decne, and *Pergularia tomentosa* L were collected from their natural habitats reported by Andrews (Andrews, 1952) while cultivated ones which are *Carissa spinarum* L, *Cascabela thevetia* (L.) Lippold, *Catharanthus roseus (*L.) G.Don, and *Nerium oleander* L. were collected from different (plant nurseries) in Khartoum state. Confirmation of identification of the specimens was done consulting taxonomic keys in relevant floras and publications as well as comparing some of them with the already identified herbarium specimens kept in the University of Khartoum Herbarium. 40

morphological characters were investigated in the studied species concerning gross morphology; leaf and petiole characters such as arrangement, length, base, apex and blade shapes ; Inflorescence and flowers characters such as sepal lobe shape, colour, length, apex shape, corolla lobe shape, colour, length, and apex shape, tube length, anthers position, and corona insertion; fruits characters such as type, colour , length and shape and Seeds characters such as shape, colour, margin and size; hilum position; coma colour, duration, and position, and seed coat shape and thickness. Cluster of Average linkage between different species was done according to Sokal and Sneath (1963) using the statistical package SPSS 16.0 in which all characters were treated as variables. Resulting dendrograms were analyzed to estimate the possible relationships between different species within and between the studied subfamilies. Taxonomic key was also constructed for the studied species on the basis of key characters of the vegetative, floral and seed morphology.

RESULTS AND DISCUSSION

Numerical analysis of the morphological characters studied for members from the recently constructed subfamilies Asclipiadoidae, Apocynoidae, and Rauvolfioideae reported similarities between different species which were previously treated as members of two different families Asclepiadaceae and Apocynaceae. The most closely related pairs are (*Catharanthus roseus* and *Calotropis procera*) and (*Nerium oleander* and *Oxystelma bornouense*) which are delimited in separate pairs on the basis of their seeds and fruits morphology and further linked to other species as a separate group. Species in the linked group are *Nerium oleander*, *Catharanthus roseus*, *Calotropis procera*, *Oxystelma bornouense, Solenostemma argel* and *Pergularia tomentosa*

figures 1. Concerning flower morphology, high similarity was recorded between species. This is clearly shown in the cluster analysis dendrograms figure2. In this dendrogram four species were linked together in one group. These are *Calotropis procera*, *Oxystelma bornouense, Solenostemma argel and Pergularia tomentosa* from subfamily Asclepiadoidae and *Nerium oleander* from subfamily Apocynoidae, and *Cascabela thevetia, Catharanthus roseus,* and *Carissa spinarum* from the subfamily Rauvolfioideae.

Confirmation of the morphological similarities within and between different species appears when all characters of studied parts utilized in one cluster analyses dendrogram figure3. (*Solenostemma argel* and *Oxystelma bornouense*), (*Pergularia tomentosa* and *Nerium oleander*), (*Cascabela thevetia* and *Carissa spinarum*) as clustered pairs and (*Nerium oleander*, *Pergularia tomentosa*, *Oxystelma bornouense*, *Solenostemma argel*, *Calotropis procera*) and (*Cascabela thevetia*, *Catharanthus roseus,* and *Carissa spinarum)* as separately clustered groups. Clustered groups were further linked together in one clade. The two linked groups were also linked to both *Leptadenia* spp.

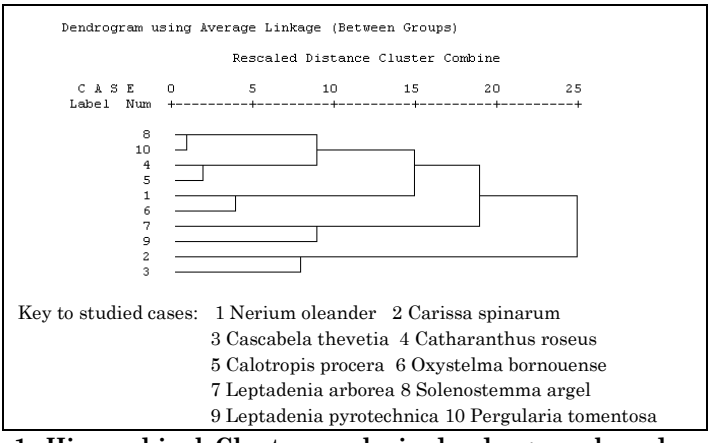

Figure 1: Hierarchical Cluster analysis dendrogram based on fruits and seeds characters

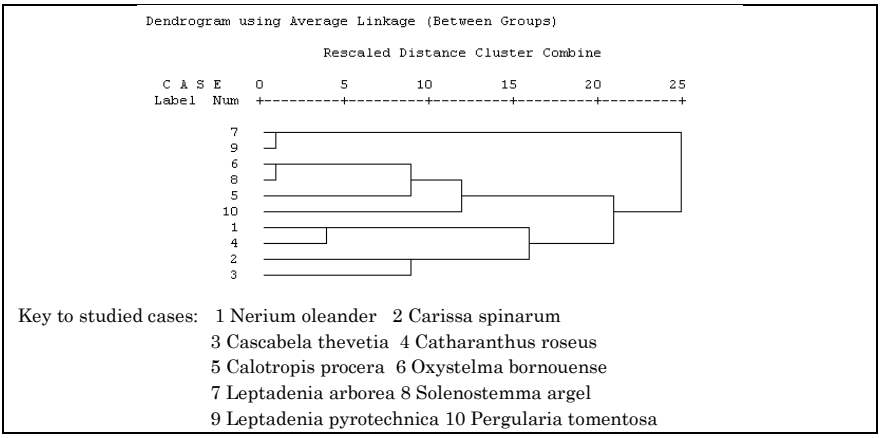

Figure 2: Hierarchical Cluster analysis dendrogram based on flowers characters

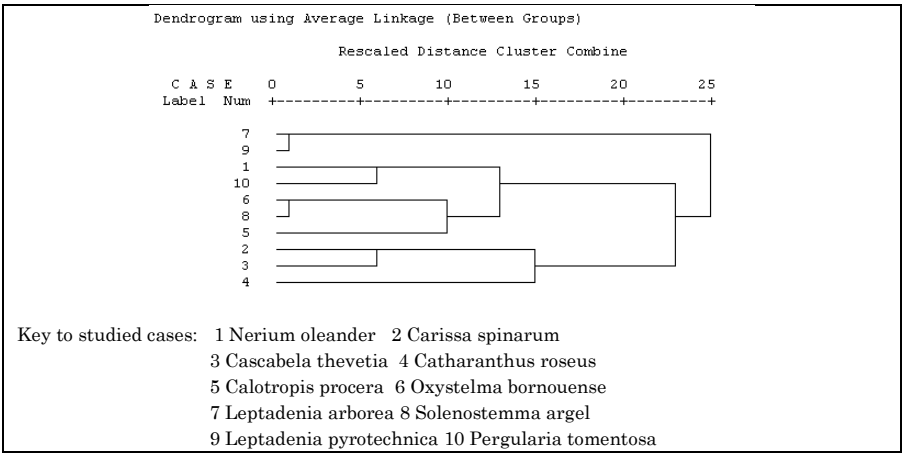

Figure 3: Hierarchical Cluster analysis dendrogram based on flowers, fruits, and seeds characters

Taxonomic key on the basis of some vegetative, floral, and seed characters:

a. Anthers free from style head, seed coma absent

b. Corolla tube funnel form, helium terminal..... ***Cascabela thevetia***

bb. Corolla tube salver form, helium central

cc. Corolla lobe overlapping to right …….. ***Carissa spinarum***
cc. Corolla lobe overlapping to left ……...***Catharanthus roseus***
aa. Anthers attached to style head, seed coma present
d. Inflorescence terminal cymes, seed coma persistent…. ***Nerium oleander***
dd. Inflorescence axillary cymes, seed coma deciduous
e. Corona insertion on corolla
f. Sepal lobe ovate, fruit shape lanceolate…..…… ***Leptadenia arborea***
ff. Sepal lobe triangular, fruit shape spindle….***Leptadenia pyrotechnica***
ee. Corona insertion on stamen
g. Corolla in flower bud inflexed, stem twining
h. Corolla purple, seed ovate……..……***Oxystelma bornouense***
hh. Corolla white, seeds flask shaped..……***Solenostemma argel***
gg. Corolla in flower bud not inflexed, stem erect
i. Sepal lobe ovate, fruit green……..…...***Calotropis procera***
ii. Sepal lobe oblong, fruit purple…..…...***Pergularia tomentosa***

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