

Important Morphological Characters in Several Species of *Cassiinae* (*Leguminosae*) in South-Western Nigeria

Sefiu Adekilekun SAHEED, Herbert Chukwuma ILLOH

Obafemi Awolowo University, Faculty of Science, Department of Botany, Ile-Ife 220005, Nigeria; saheed@oauife.edu.ng (corresponding author)

Abstract

Macromorphological characters of some species of *Cassia* L. emend. Gaertner, *Senna* Miller and *Chamaecrista* Moench occurring in South Western Nigeria were studied. The aim was to search for stable, distinctive and diagnostic characters for the identification of these genera and their species. Qualitative characters were noted and recorded while quantitative observations were done by the use of a metric ruler and the measurements were taken to the nearest centimeters. The habit ranges from all shrubs in *Senna*, shrubs and herbs in *Chamaecrista* while the *Cassia* species studied are all trees. The shape of the leaflet apex varies in both *Senna* and *Cassia* species, while it is distinctly mucronate in *Chamaecrista* genus. Occurrence of foliaceous stipule in the genus *Chamaecrista* clearly separates it from *Senna* and *Cassia*, which are completely exstipulate. In general, other characters such as number of leaflet pairs, length and width of leaflets, leaflet base, and number of leaflets lateral nerves revealed generic distinctions. Others include the degree of hairiness in sepals, petals shape, types of inflorescence, fruit shape and fruit length. The attributes that delimits the species are mainly quantitative. The results of this investigation suggest macromorphological characters that clearly enhance the taxonomy of these genera and their species and they can be subsequently employed in their delimitation.

Keywords: *Cassia*, *Chamaecrista*, floral pattern, habit, morphological characters, *Senna*, taxonomy

Introduction

Prior to the work of Irwin and Barneby (1981), the genus *Cassia* used to be a very large genus that comprises of about 500 to 600 species (Airy-Shaw, 1973). The genus ranks among the 25 largest genera of the dicotyledonous plants (Irwin and Turner, 1960). Bentham (1871) and Bentham and Hooker (1876) did a lot of work in the general classification of this genus, these two works recognizes that there are three subgenera in these genus, viz: *Cassia*, *Senna* and *Lasiorbegma*. In West Africa, the genus contains about 22 indigenous species apart from those introduced or cultivated (Hutchison and Dalziel, 1958). There is a great diversity of habit within the genus ranging from trees approaching 34 m in height to prostrate annual herbs. Some members of the genus are important ornamentals e.g. *Cassia siamea* (Olorode, 1984), this plant is used for afforestation programmes in drier areas. Other members of the genus could be useful as commercial timbers and a great number of them have been reported to be of great use in herbal medicines especially as laxatives and in the treatment of skin diseases (Ayensu, 1978; Olorode, 1984; Di Stasi *et al.*, 1989).

Paripinnate compound leaves and many leaflets characterize the genus; however, Oloruntoba (1984) reported a simple leaf accession to which Adebowale (2000) suggested that the accession is probably a product of recent reverse mutation event in *Cassia occidentalis* because of its restricted distribution. The flower is one of the constant characters found in this genus despite its great diversity

of form. The flowers are hermaphroditic and generally monocarpellate, zygomorphic and arranged in conspicuous axillary or terminal racemes (Hutchison and Dalziel, 1958). The stamens are ten in number and they are heteromorphic, some may be reduced to staminodes (Hutchison and Dalziel, 1958). The fruit that is many seeded is a pod of varying lengths that may be from 3 cm to 1 m and may assume different shapes and sizes (Olorode, 1984).

Interestingly in 1981, Irwin and Barneby subjected the genus into some nomenclatural and taxonomic changes that eventually led to the revision of the genus *Cassia* (Irwin and Barneby, 1982) and splitting of the genus into smaller genera viz: *Cassia*, *Senna* and *Chamaecrista*. However, Lock (1988) observed that series of problems have arisen due to this name changes because many taxonomists especially on the African flora may prefer to continue to use *Cassia* in its broad sense, which would be acceptable if there was no overlap between floras of Africa and South America. However, many species in this genus are endemic in the tropics because of dispersal or deliberate introduction as exotic plants, this will further results into confusion, as several species will be given different names in different continents (Lock, 1988). Additional information on this very important group of plants, which will provide insights into detailed diagnostic characters that would be of help to taxonomist after this new classification are scanty. Therefore this study aims to provide a comprehensive description of the macromorphological characters of the new *Cassia*, *Senna* and *Chamaecrista* species, thereby adding more to the scanty information on the morphology

of these genera and eventually their taxonomy. We equally hope that the outcome of this study would be employed along with other diagnostic features for proper identification and classification of these genera and their species as well as to justify or otherwise, the separation from the initial genus *Cassia* as defined by Bentham (1871) and Betham and Hooker (1876).

Materials and methods

Five species were selected from the genus *Senna* and they are: *S. alata* (L.) Roxb, *S. hirsuta* (L.) *S. obtusifolia* (L.) Irwin and Barneby, *S. occidentalis* (L.) Link and *S. sophora* (L.) Roxb. Three species were selected from the genus *Chamaecrista* namely *C. kirkii* (Oliver) Standley, *C. mimosoides* (L.) Greene and *C. rotundifolia* (Pers.) Greene, while two species from the genus *Cassia* were studied these are: *C. fistula* L. and *C. siberiana* DC. All the specimens were collected from different location within South-Western part of Nigeria (10°00' N, 8°00' E), an abridged listing of the specimens cited are shown (Tab. 1), dried herbarium specimens of all the species were also studied morphologically at the Obafemi Awolowo University Herbarium (IFE) and the herbarium at the Forest Research Institute of Nigeria, Ibadan (FHI).

The habit and habitat of each species were recorded. Qualitative morphological characters studied include: leaflet shape, base and apex, their margins, vein, petioles, fruit types, their shape and apex. Others characters studied include presence or absence of stipule, colours of petals, pedicel, epicalyx, sepals, style, filament, anther and stigma as well as the shapes of petals, sepals and epicalyx were also observed and recorded. Quantitative morphological characters measured include length and breadth of leaflets, length and diameter of fruits, petal, style and stamen lengths, this was done by the use of a metric ruler and the measurements were taken to the nearest centimeters. Counts were taken of the number of sepals, petals and epicalyx. Fresh materials collected in the field were pressed and processed immediately as voucher specimens and they were deposited at IFE herbarium after the photograph of a representative specimen of each species were taken and imported into Corel Draw 12 for presentation.

Results

The macromorphological features of each species are described in the following presentation, grouping them under their respective genera.

Genus Senna

S. alata (L.) Roxb. (Fig. 1A)

The plant is found cultivated around habitations because of its medicinal value or found as weed growing in wastelands, abandoned lands and along roadsides. The

habit is mostly perennials, shrub, suffrutescent usually about 4.5 m high or more. The stem is greenish at top and woody below, glabrous; petiole is terete 2.6-10 cm long (Tab. 2), connecting the leaflets. Leaf is paripinnate, exstipulate, leaflets about 5-12 pairs, arranged oppositely along a transverse ridge. The leaf is oblong to obovate at the base and the apex is mostly rounded, sometimes emarginate apex is found. The margin is mostly entire 6-18 cm long, 4.3-16 wide (Tab. 2). The venation shows primary veins that are straight in course with lateral veins been around 9-23 per leaflet mostly alternate some are opposite. The inflorescences are a terminal raceme (Tab. 3), compact, conspicuous with elliptic bracts ranging from 2.5cm long and 1.2 cm wide. The pedicel is greenish, sparsely pubescent about 0.6 cm long while the sepal is about 1.3-1.7 cm long and 0.4-0.6 cm wide glabrous, yellowish, connate at base pentamerous, lanceolate. Petals are deep yellow, pentamerous, assymetrical about 1 cm long and 0.7 cm wide. The stamen is about 0.6 cm long, filament greenish brown, anther yellowish. Style is greenish about 1.3 cm long and the stigma dark brown. The fruit is a samaroid pod (Tab. 3), black when mature and dry, oblong in shape, 17-27 cm long and 1.4-2.0 cm wide.

S. hirsuta L. (Fig. 1B)

This is a weed commonly found near habitations, on roadsides, farmlands, wastelands as well as abandoned areas. They are shrub (Tab. 2), suffrutescent, mostly up to 2 m high, mostly annuals sometimes biennial or perennial. The stem is greenish at the top and woody brownish base, densely pubescent. The petiole is mostly polygonal 3.5-5.8 cm long. The leaf is paripinnate, exstipulate, leaflets arranged oppositely in 4-5 pairs, it is broadly lanceolate to ovate in shape, margin mostly entire, sometimes few minor serration present base acute, apex attenuate, 4.5-11 cm long, 2.6-5.2 cm wide (Tab. 2). The venation consist of primary veins that are straight in course with lateral veins in pairs ranging from 5-13 pairs per leaflets, mostly alternate, more prominent on the abaxial surface. Inflorescence is a raceme (Tab. 3). The pedicel is greenish, pubescent 0.6-1.2 cm long, sepals are greenish yellow, pentamerous, lanceolate densely pubescent 0.4-0.8 cm long and 0.2-0.4 cm wide, while petals is brilliant yellow, pentamerous, ovate to assymetrical, 0.7-1.6 cm long and 0.4-0.9 cm wide. The stamen is about 0.5-1.3 cm long, filament brown to dark brown, anther brownish yellow. The style is Greenish yellow, densely pubescent, stigma 1.5-2.3 cm long dark to black in colour, curved at the apex. The fruit is a flat pod (Tab. 3), yellowish brown, densely pubescent, about 17 cm long and 0.5 cm wide, apex acute.

S. obtusifolia (L.) Irwin and Barneby (Fig. 1C)

This is a weed commonly found along roadsides near habitations and wastelands. They are shrub, suffrutescent, mostly about 1.5 m high (Tab. 2), annual, sometimes biennial. The stems are greenish at the top and brownish at

Tab. 1. Site description of some of the specimens cited

<i>Senna</i> <i>S. alata</i>	Daramola, IFE 13918, About 12 km on Moniya Iseyin Road, Oyo State. Ogunyemi, IFE 3118, Ife Varsity, Near Ornamental Garden, Osun State. Odewo <i>et al.</i> FHI 88147, Along Owode Road, Ogun State. Ajulo OO FHI 102263, Road 7, University of Ife Quarters, Osun State. Saheed 133, Beside Car Park, Osogbo Road, Offa, Kwara State (IFE) Saheed 137, Ayedun Quarters, Dele-Dealer Junction Akure, Ondo State (IFE)
<i>S. birsuta</i>	Akabogu AO IFE 3124, University of Ife Agric Farm, Osun State. Guile DPM IFE 3126, Near University of Ife Campus, Ibadan. Oyo State. Odewo <i>et al.</i> FHI 91160, Pillot Sawmill, High Forest, Akure Ondo State. Latilo MG FHI 18222, Esie Forest Reserve, High Forest, Ilorin, Kwara State. Saheed, 126, Along Lagos Road, Abeokuta, Ogun State (IFE) Saheed, 138, Around Central Praying Ground. Agege Motor Road, Mushin Lagos State. (IFE)
<i>S. obtusifolia</i>	Faremi, IFE 3136, Remnant of Old Bussa Village Near Shagunu Research Station, Niger State Hall, IFE 3134, South of Jebba on Ilorin Road, Ilorin, Kwara State. Gbile, FHI 84319, Cleared Plot, Idiode Ijebu-Igbo. Ogun State. Daramola <i>et al.</i> FHI 78423, Near Federal Housing Scheme Calabar, Calabar River State. Saheed, 113, Behind 440 Junction, Osogbo Road, Ede, Osun State (IFE) Saheed, 116, Along Staff Quarters, FUTA, Akure, Ondo State (IFE)
<i>S. occidentalis</i>	Daramola, IFE 13037, O.A.U. Campus, Ile-Ife Osun State. Faremi, IFE 3141, Shagumu Research Station, Ilorin Kwara State. Magbagbeola <i>et al.</i> FHI 94866, Festac Village, Lagos State. Olorunfemi <i>et al.</i> FHI 84639, Iyere, Ondo State. Saheed, 134, Ansar-Udeen, Primary School, Ijebu-Ode Ogun State (IFE) Saheed, 142, Along Sango Road, Samonda Area, Ibadan, Oyo State (IFE)
<i>S. sophora</i>	Esiofor, FHI 19844, Share, Ilorin Kwara State. Thomas: FHI 27057, Olobo, Alongside Path Beside Cocoa Farm, Ibadan, Oyo State. Ajulo, FHI 102271, Ilare Street, Near Oduduwa College, Ile-Ife, Osun State. Saheed, 121, Ayedun Quarters, Akure Ondo State (IFE) Saheed, 155, Dumping Site / Uncompleted Building Alagbado area, Lagos State (IFE) Saheed 161, Ago-Iwoye Road, by Ijebu-Ode-Ibadan Road Junction, Ogun State (IFE)
<i>Chamaecrista</i> <i>C. kirkii</i>	Guile, IFE, 3082b, University of Ibadan Campus, Ibadan Oyo State. Faremi, IFE 3109, Erin-Odo Village on the way to the Falls Ondo State. Gbile and Others, FHI 64104, Oro, Omun Aran, Kwara State. Keay, FHI 22563, About 3 Miles East of Ondo, North of Akure road, Ondo State. Saheed, 107, Beside Guest Houses, Kanji Lake National Park, Borgu, Niger State (IFE) Saheed, 119, Collection from Ugbo-Uku Anambra State by Dr. H.C. Illoh (IFE)
<i>C. mimosoides</i>	Daramola, IFE 13060, Isua, Ipe Akoko Southeast Ondo State. Faremi, IFE 3094, Near Iwo on Gbongan-Iwo road, Osun State. Odewo <i>et al.</i> FHI 105769, FRIN Conservation Plot, Oloye, Badagri, Lagos State. Gbile <i>et al.</i> FHI 94193, Obudu Cattle Ranch, Cross River State. Saheed, 160, Kainji Lake National Park, Borgu Sector Along Hippo Pool, Niger State (IFE). Saheed, 172, Akure-Ita Ogbolu-Ikere Ekiti Road, Akure, Ondo State. (IFE)
<i>C. rotundifolia</i>	Ogunyemi, IFE 14569, Moor Plantation, Ibadan Oyo State. Sanford, IFE 3115b, Ogbomoso-Ilorin Road, Kwara State. Oyayomi <i>et al.</i> FHI 82357, Ikog-Nadagru Road, Lagos State. Olorunfemi <i>et al.</i> FHI 86799, Orin Ekiti, Ekiti State. Saheed, 165, Ansar-Udeen Primary School Ijebu-Ode Ogun State (IFE) Saheed, 186, Around Senate Building FUTA Akure Ondo State (IFE).
<i>Cassia</i> <i>S. fistula</i>	Odu, IFE, 3071, Moor Plantation, Ibadan Oyo State. Ogunyemi, IFE 3069, Moor Plantation, Ibadan, Oyo State. Okkeke, FHI, 44305, Forest Research Headquarters Ibadan Oyo State. Ajulo, FHI, 102265, Near Oduduwa Hall, University Ife, Ile-Ife, Osun State. Saheed, 154, Academic Area FUTA, Akure, Ondo State (IFE) Saheed, 171, Along Sonde Road, Ilorin, Kwara State (IFE)
<i>C. siberiana</i>	Daramola, IFE 13057, Between Orile Ilugun and Olokemeji, Ogun State. Medler, IFE 3075, Central Borgu Game Reserve, Ilorin, Kwara State. Oguntayo <i>et al.</i> FHI 89593, Yankari Games Reserve, Bauchi State. Soladoye, FHI 93054, Between School of Forestry and Main Office Ibadan, Oyo State. Saheed, 109, Around Oduduwa Hall, Complex O.A.U. Ile-Ife Osun State. (IFE) Saheed, 182, Beside Ansar-Udeen Primary School Ijebu-Ode Ogun State. (IFE)

the base, they are glabrous. The petiole is mostly round 2.5-14.6 cm long. Leaf is pinnate, paripinnate, exstipulate leaflets arranged in 3 pairs oppositely 2.4-4.8 cm long and 0.6-2.3 cm wide obovate, margin entire, base acute, apex

obtuse. Venation consists of primary veins that are straight in course with lateral veins about 5-8 pairs per leaflet often alternate, more prominent on abaxial surface. The inflorescence is a raceme (Tab. 3), sometimes solitary, axillary

Tab. 2. Summary of the important vegetative morphological characters

Characters Species	Plant Habit			Leaf Shape							Leaf Apex					Leaf Base				Leaf margin		Stipule		Leaf (cm)						
	Petiole length (cm)	Trees	Shrubs	Herbs	Oblong	Obovate	Ovate	Elliptic	Broadly Lanceolate	Narrowly lanceolate	Assymetrical Linear	Acute	Rounded	Emarginate	Attenuates	Obruse	Acuminate	Mucronate	Rounded	Acute	Assymetrical	Obruse	Acute	Entire	Minor serration	Leaflets No in Pairs	Absent	Present Foliaceous	Length	Width
<i>Senna alata</i>	2.6-10	-	+	-	+	+	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	+	-	5-12	+	-	6-18	4.4-11	
<i>S. hirsuta</i>	3.8-5.8	-	+	-	-	-	+	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	+	+	4-5	+	-	4.5-11	2.6-5.2	
<i>S. obtusifolia</i>	2.5-14.6	-	+	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	+	-	3	+	-	2.4-2.8	0.6-2.3	
<i>S. occidentalis</i>	4.6-6.3	-	+	-	-	-	+	-	+	-	-	-	-	+	-	+	-	-	+	-	-	-	+	-	4-5	+	-	4.3-11.4	1.5-3.0	
<i>S. sophera</i>	4.6-5.8	-	+	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	-	-	-	+	-	6-9	+	-	4.1-7.3	0.8-1.7	
<i>Chamaecrista kirkii</i>	0.3-0.5	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	16-38	-	+	0.8-1.3	0.2	
<i>C. mimosoides</i>	0.5-0.5	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	+	-	-	+	-	25-70	-	+	0.3-0.7	0.1-0.2	
<i>C. rotundifolia</i>	0.3-0.6	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	-	1	-	+	0.6-2.0	0.4-1.2	
<i>Cassia fistula</i>	6.5-8.3	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	+	-	7-9	+	-	7.6-18.2	4.2-8.3	
<i>C. siberiana</i>	3-5.6	+	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	5-8	+	-	4.3-8.4	2.4-4.3

(Key: + = present; - = absent)

Tab. 3. Summary of the important floral morphological characters

Characters	Pedicel surface		Pedicel colour		Sepal surface			Petal colour				Petal shape				Inflorescence type				Fruit shape		Fruit size								
	Sepal width	Pubescent	Short/slightly Pubescent	Glabrous	Greenish	Greenish-yellow	Greenish-brown	Pedicel length (cm)	Shortly pubescent	Highly pubescent	Glabrous	Sepal length (cm)	Deep-yellow	Brilliant-yellow	Pinkish-yellow	Reddish-yellow	Assymetrical	Ovate	Obovate	Elliptic	Petal-length (cm)	Racemose terminal dense with bracts	Racemose terminal dense with bracts	Racemose, few flowered	Solitary, axillary, or 2-3 flowers	Racemose dense	Flat pod	Rod-like/round pod	Length (cm)	Width/Diameter
<i>Senna</i>	0.4-0.6	-	+	-	+	-	-	0.6	-	-	+	1.3-1.7	+	-	-	-	+	-	-	-	1.0	0.7	+	-	-	-	+	-	17-27	1.4-2.0
<i>S. alata</i>	0.4-0.6	-	+	-	+	-	-	0.6	-	-	+	1.3-1.7	+	-	-	-	+	-	-	-	1.0	0.7	+	-	-	-	+	-	17-27	1.4-2.0
<i>S. hirsuta</i>	0.2-0.4	+	-	-	+	-	-	0.6-1.2	-	+	-	0.4-0.8	-	+	-	-	+	+	-	-	0.7-1.6	0.4-0.9	-	+	-	-	+	-	17.0	0.5
<i>S. obtusifolia</i>	0.4-0.7	+	-	-	+	-	-	0.6-2.7	-	+	-	0.5-1.0	-	+	+	-	+	-	+	-	0.6-1.7	0.5-1.0	-	-	+	-	+	-	20	0.5
<i>S. occidentalis</i>	0.1-0.3	+	-	-	+	-	-	0.3-1.3	+	-	-	0.4-0.6	-	+	-	-	+	-	-	-	0.5-0.7	0.3-0.5	-	+	-	-	+	-	8.4-13.6	0.4
<i>S. sophora</i>	0.4	+	-	-	-	+	-	1.0-1.3	+	-	-	0.6	-	+	-	+	+	-	-	-	0.8	0.4	-	+	-	-	+	-	8.0	0.4
<i>Chamaecrista</i>	0.1-0.2	+	-	-	-	-	+	1.0-1.4	-	-	+	0.6	-	+	-	-	-	+	-	-	0.6	0.3	-	-	+	-	+	-	3.2-6.8	0.4-0.6
<i>C. kirkii</i>	0.1-0.2	+	-	-	-	-	+	1.0-1.4	-	-	+	0.6	-	+	-	-	-	+	-	-	0.6	0.3	-	-	+	-	+	-	3.2-6.8	0.4-0.6
<i>C. mimosoides</i>	0.4	+	-	-	-	-	+	1.2-2.2	-	-	+	0.4	-	+	-	-	-	+	-	-	0.4	0.2	-	-	+	-	+	-	1.5-3.5	0.3-0.5
<i>C. rotundifolia</i>	0.1	-	-	+	+	-	-	2.6-3.7	-	-	+	0.3	-	+	-	-	-	+	-	-	0.3	0.2	-	-	+	-	+	-	2.0-3.2	0.2-0.4
<i>Cassia</i>	0.3-0.6	-	+	-	+	-	-	5.6-12.3	-	+	-	0.4-1.2	-	+	-	-	-	-	+	+	1.6-3.2	1.4-2.1	-	-	-	+	-	+	80	1.6
<i>S. fistula</i>	0.3-0.6	-	+	-	+	-	-	5.6-12.3	-	+	-	0.4-1.2	-	+	-	-	-	-	+	+	1.6-3.2	1.4-2.1	-	-	-	+	-	+	80	1.6
<i>C. siberiana</i>	0.4-0.6	+	-	-	+	-	-	3.4-4.8	-	+	-	0.8-1.3	-	+	-	-	-	-	+	+	2.1-2.9	1.0-1.8	-	-	-	+	-	+	42-76	1.3

(Key: + = present; - = absent)

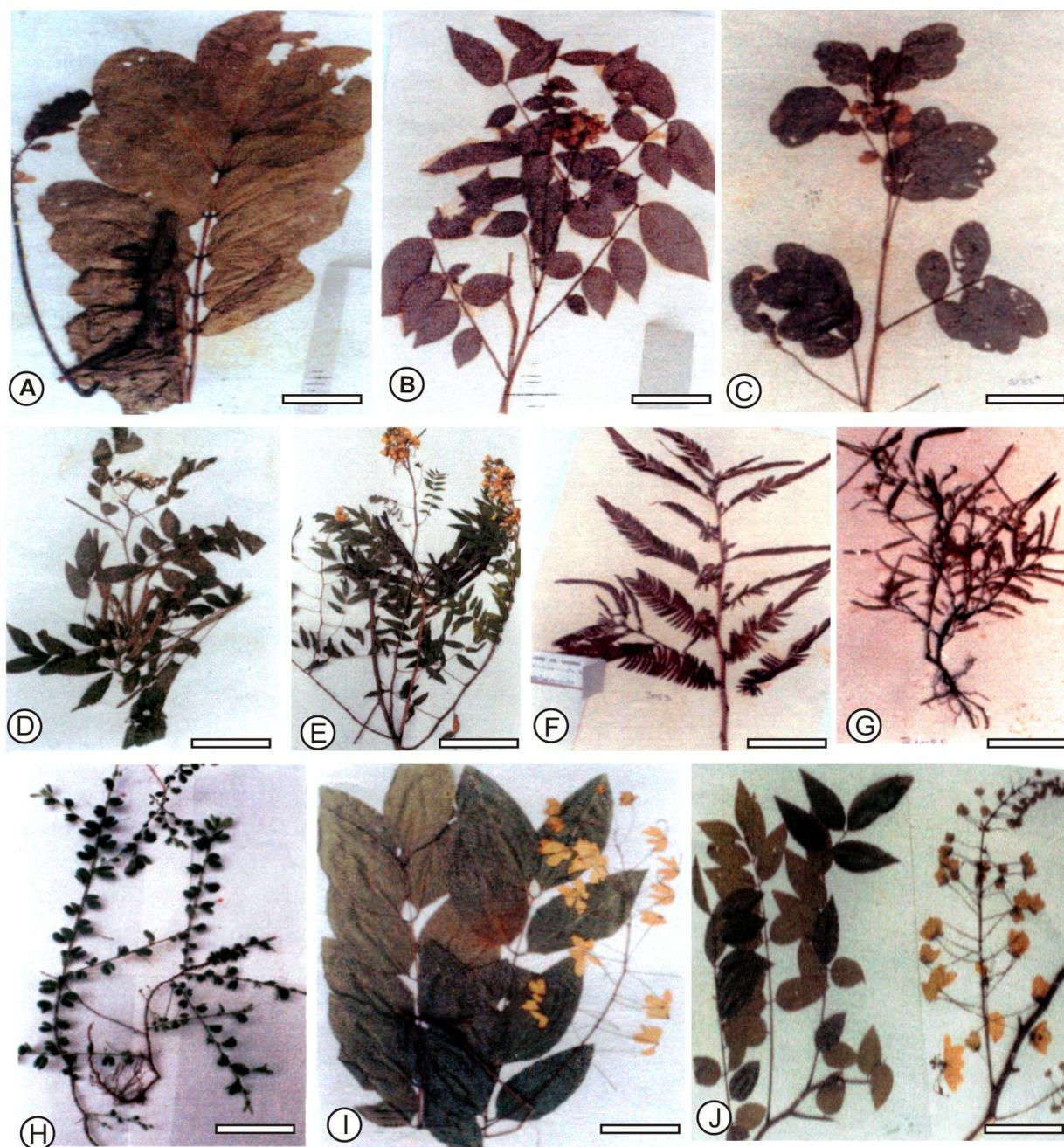


Fig. 1. Prepared herbarium samples of the species studied: A = *S. alata*; B = *S. hirsuta*; C = *S. obtusifolia*; D = *S. occidentalis*; E = *S. sophora*; F = *C. kirkii*; G = *C. mimosoides*; H = *C. rotundifolia*; I = *C. fistula*; J = *C. siberiana*. Scale bars = 5cm

or paired. Pedicel is greenish, pubescent 0.6-2.7 cm long. The sepal is pubescent, greenish yellow, connate at base, pentamerous, mostly ovate, about 0.5-1.0 cm long and 0.4-0.7cm wide. The petal is pinkish-yellow, some brilliantly yellow, pentamerous, obovate few are assymetrical about 0.6-1.7 cm long and 0.5-1.0 cm wide. Stamen is about 0.4-1.0 cm long filament reddish brown, anther brown. Style is light green, about 1.5 cm long, stigma dark brown. The fruits are a brownish pod (Tab. 2), polygonal in shape about 20cm long and 0.5 cm wide, apex acuminate.

S. occidentalis (L.) Link (Fig. 1D)

This is a common weed found near habitations, along roadsides as well as wastelands. They are shrub, suffrutescent up to 1.5 m tall (Tab. 2), mostly annuals, sometimes they are biennials. The stem is greenish at the top and grayish to brown at the base, with glabrous surface. Petiole is polygonal 4.6-6.3 cm long. The leaf is pinnately compound, paripinnate, exstipulate leaflets 4-5 pairs arranged oppositely, the top pair being the largest about 4.3-11.4 cm long and 1.5-3.0 cm wide, broadly lanceolate to ovate. The mar-

gin is entire, base acute, apex mostly attenuate sometimes acuminate (Tab. 2). Venation consists of primary veins that are straight in course, the lateral veins are about 7-14 in pairs per leaf, and they are mostly alternate, more prominent on the abaxial. Inflorescences are a raceme (Tab. 3), flowers are few in number, the pedicel is green, pubescent about 0.3-1.3 cm long. Sepals are greenish-yellow sparsely pubescent, connate at base, pentamerous, lanceolate about 0.4-0.6 cm long and 0.1-0.3 cm wide. The petals are brilliant yellow, pentamerous, asymmetrical in shape, about 0.5-0.7 cm. Stamen is about 0.6-1.2 cm long, filament greenish-yellow, anther brownish yellow. Style and stigma are greenish up to 1.3 cm long, the stigma is dark brown. The fruit is a flat pod (Tab. 2), dark-grey in colour about 8.4-13.6 cm long about 0.4 cm wide.

S. sophera (L.) Roxb. (Fig. 1E)

A weed commonly found near habitation and farmlands, along roadsides, often found close to *S. occidentalis*. They are shrub (Tab. 2), suffrutescent up to 1.5 m tall mostly annual, sometimes biennial. Their stem is glabrous, greenish at the top and brownish at the base. Petiole is mostly round about 4.6-5.8 cm long. The leaf is pinnately compound, paripinnate, exstipulate, leaflets 6-9 pairs arranged oppositely, 4.1-7.3 cm long and 0.8-1.7 cm wide, narrowly lanceolate (Tab. 2), margin entire, base acute, apex attenuate, some are very acute. The venation consists of primary veins that is straight in course, lateral veins 8-12 pairs per leaflets, mostly alternate, more prominent on abaxial. Inflorescence is racemose (Tab. 3), few-flowered. Pedicel is greenish yellow, sparsely pubescent 1.0-1.3 cm long, sepals are shortly pubescent, greenish yellow connate at base; about 0.6 cm long and 0.4 cm wide, pentamerous and lanceolate. Petals are brilliant-yellow in colour sometimes they may be reddish yellow, pentamerous, asymmetrical in shape about 0.8 cm long and 0.4 cm wide. Stamens are about 0.5-1.2 cm long, the filament is yellowish, anther, is reddish-yellow. The style is light green, about 1 cm long, while the stigma is dark to brown in colour. The fruit is a flat pod (Tab. 2), dark green in colour about 8 cm long and 0.4 cm wide.

Genus *Chamaecrista*

C. kirkii (Oliver) Standley (Fig. 1F)

This is a weed that is commonly found on vegetations, lawns, farmlands and along roadsides common on sandy soils. They are erect shrub (Tab. 2), subwoody, grow up to 1.5 m high. The stem is greenish to reddish brown and they are pubescent. The petiole is mostly round about 0.3-0.5 cm long. Stipule is foliaceous, asymmetrical in shape, about 0.4-1.0 cm long and 0.1-0.2 cm wide, attenuate at the apex, and base is truncate in shape, pubescent. The leaf is pinnately compound (Tab. 2), paripinnate, leaflets, 16-38 pairs, oppositely arranged 0.8-1.3 cm long and about 0.2 cm wide, asymmetrical, oblong-linear, obliquely acute

and mucronate at the apex and asymmetrical at the base, the margin is entire and the leaf is sparsely pubescent. Venation is actinodromous; perfect, basal and reticulate, primary vein is straight in course. The inflorescence is solitary (Tab. 3); sometimes 2-3 flowers occur at the axil. Pedicel is greenish to brown, 1.0-1.4 cm long, pubescent. Sepal is glabrous, 0.6 cm long and 0.1-0.2 cm wide, greenish yellow in colour, pentamerous, lanceolate, and connate at the base. Petals are brilliantly yellow, 0.6 cm long and 0.3 cm wide, pentamerous, ovate in shape. Stamens are about 0.3-0.5 cm long, filaments; greenish yellow, while anther is dark brown. Style is about 0.6 cm long, greenish yellow stigma dark brown in colour. The fruit is a pod (Tab. 3), 3.2-6.8 cm long and about 0.4-0.6 cm wide, brownish to black in colour, greenish when young, flat, linear, oblong, slightly curved and densely pubescent.

C. mimosoides (L.) Greene (Fig. 1G)

This is a weed commonly found along roadside, as well as in vegetations, farmland and grasslands, common on sandy soil. They are herbaceous (Tab. 2) or low shrub; grow up to 1.5 m high or sometimes diffuse. The stem is greenish to brown and pubescent. The petiole is mostly round 0.3-0.5 cm long. Stipule is foliaceous, asymmetrical in shape 0.6-1.3 cm long and 0.2-0.4 cm wide attenuate apex, truncate base, pubescent. Leaf is pinnately compound, paripinnate, leaflets 25-70 pairs oppositely arranged 0.3-0.7 cm long and 0.1-0.2 cm wide, asymmetrical, linear, obliquely acute and mucronate at the apex, asymmetrical at the base, margin entire, they are sparsely pubescent (Tab. 2). The venation is actinodromous, perfect, basal and reticulate, primary vein straight in course. Inflorescences are solitary (Tab. 3); sometimes 2-3 flowers occur at the axil. The pedicel is greenish to brown, about 1.2-2.2 cm long and they are pubescent. Sepals are glabrous, greenish yellow, pentamerous, connate at base, lanceolate, about 0.4 cm long and 0.1 cm wide. Petals are brilliant yellow, pentamerous, ovate in shape, about 0.4 cm long and 0.2 cm wide. The stamens are about 0.3 cm long; filament is brownish yellow while anther is dark brown. The style is greenish yellow, about 0.4 cm long, stigma dark brown in colour. Fruits are a pod, about 1.5-3.5 cm long (Tab. 3) and about 0.3-0.5 cm wide, they are dark brown to black, greenish when young, linear, oblong, slightly curved and pubescent.

C. rotundifolia (Pers.) Greene (Fig. 1H)

They are weed commonly found around habitations, especially growing within grasses on lawns, they are occasionally found in weedy environment, along road side and farmlands. They are herbaceous (Tab. 2), prostrate, about 0.5 m long or more. The stem is greenish in colour, light brown at the base and pubescent. Petiole is round, about 0.3-0.6 cm long. The stipule is foliaceous, asymmetrical in shape up to 0.7 cm long and about 0.4 cm wide, attenuate apex and cordate base pubescent. Leaf is pinnately compound, paripinnate, 1 pair leaflets are oppositely arranged,

obovate, assymetrical at base, apex mucronate, 0.6-2.0 cm long and 0.4-1.2 cm wide, the margin is entire and the leaf is pubescent (Tab. 2). Venation is actinodromous, basal, perfect and reticulate, primary vein straight in course. Inflorescences are axillary, solitary, or occasionally paired (Tab. 3). Pedicel is greenish, about 2.6-3.7 cm long, glabrous. Sepals are glabrous, greenish yellow, pentamerous, 0.3 cm long and 0.1 cm wide. Petals are yellowish, pentamerous, and ovate in shape, about 0.3 cm long and 0.2 cm wide. Stamens are about 0.3 cm long; filament is greenish yellow, while anther is yellowish. Style is greenish yellow, about 0.3 cm long, while stigma is pale yellow. The fruit is a pod, dark brown or black brown, linear to oblong (Tab. 3), slightly curved, about 2.0-3.2 cm long and 0.2-0.4 cm wide.

Genus *Cassia*

C. fistula L. (Fig. 1I)

This is an ornamental plant used as vegetation cover, for shade and decoration. They are Tree, perennial, erect around 15 m tall (Tab. 2). The stem is brownish to grey, greenish when young and glabrous. Petiole is round, 6.5-8.3 cm long. The leaf is pinnately compound, paripinnate about 7.6-18.2 cm long 4.2-8.3 cm wide, exstipulate, leaflets are arranged oppositely, margin is entire, ovate in shape while the shape of the base and apex is acute (Tab. 2). Venation pattern shows that the primary vein is straight in course, lateral nerves are about 12-24 pairs per leaflet, alternate mostly, more prominent on the abaxial surface. Inflorescence is racemose-Corymb (Tab. 3). Pedicel is greenish in colour, sparsely pubescent, long 5.6-12.3 cm long. Sepals are pubescent, greenish yellow, connate at base, pentamerous, lanceolate about 0.4-1.2 cm long and 0.3-0.6 cm wide. Petals are brilliant yellow, pentamerous, elliptic in shape 1.6-3.2 cm long and 1.4-2.1 cm wide. Stamens are about 2.2-3.6 cm long; filaments are greenish yellow while anthers are brown. Style is greenish, about 3.6-5.1 cm long with greenish stigma. Fruit is a pod, black in colour, mostly straight to curved (Tab. 3), rod-like or round in shape, the length varies could be as long as 80 cm and 1.6 cm in width.

C. siberiana DC. (Fig. 1J)

This is an ornamental plant usually planted for shade and decoration. They are trees, perennial, usually about 15 m high (Tab. 2). The stem is brownish to grey in colour. The petiole is mostly round, about 3-5 cm long and 0.1-0.4 cm wide. Leaf is pinnately compound, paripinnate, exstipulate, about 4.3-8.4 cm long, 2.4-4.3 cm wide, the leaflets are in 5-8 pairs, arranged oppositely, margin entire, elliptic in shape, the shape of the base and apex is obtuse (Tab. 2). The venation primary veins are straight in course, lateral veins are about 10-16 pairs per leaflet, mostly alternate, more prominent on abaxial surface. Inflorescence is racemose-Corymb (Tab. 3), the pedicel is greenish in colour,

about 3.4-4.8 cm long and they are pubescent. Sepals are pubescent, greenish yellow, connate at the base, pentamerous, lanceolate, about 0.8-1.3 cm long and 0.4-0.6 cm wide. Petals are bright yellow, pentamerous, elliptic in shape about 2.1-2.9 cm long and 1.0-1.8 cm wide. Stamens are about 2.0-5.2 cm long; filaments are yellow while the anther is brown. Style is greenish, about 4.6-5.8 cm long, stigma is also greenish. Fruits are a pod, black, could be straight, sometimes curved (Tab. 3), rod-like or round in shape, apex is acuminate about 42-76 cm long and about 1.3 cm wide.

Discussion

The morphological characters studied in this work correspond largely with those of Hutchison and Dalziel (1958). Watson and Dallwitz (1993) used morphological features in characterizing some genera in *Leguminosae-Calsalpinioidea* and tribe Swartzieae. However, few salient morphological characters that were not recorded by these authors and which may enhance the taxonomy of these genera and species in Nigeria have been established in this study. The habit encountered in the three genera are variable, members of *Senna* genus are all shrubs in the five species studied, though Lock (1988) presented the genus as consisting of trees, shrubs or herbs. The *Chamaecrista* genus consist of shrubs and herbs, *C. kirkii* and *C. mimosoides* are shrubs while *C. rotundifolia* is herbaceous, but the *Cassia* genus are all trees, this results correspond largely with the previous work carried out by Lock (1988). All the species of the three genera are mostly perennial, though there may be combinations of annual, biennials and sometimes perennial habit in the genus *Senna*, where *S. hirsuta*, *S. obtusifolia*, *S. occidentalis* and *S. sophera* integrate the three habits. The only purely perennial in the genus is *S. alata*. In the *Chamaecrista* genus, all the species are mostly annuals and sometimes biennials while all *Cassia* species are perennials.

The shape of the leaflet apex varies in the species of *Senna*, while it is rounded and sometimes emarginated in *S. alata*, it is attenuate in *S. hirsuta*, *S. sophera* and *S. occidentalis*, although acuminate apex sometimes occur in *S. occidentalis* while in *S. obtusifolia* the apex is mainly obtuse. In the genus *Chamaecrista*, the leaflet apices are distinctly mucronate whereas in the *Cassia* genus acute apices are found in *C. fistula* while it is obtuse in *C. siberiana*. Interestingly, the leaflet base is quite delimiting for the three genera, it is acute in the species of *Senna* except in *S. alata* where it is rounded. Assymetrical base is found in all the three species of *Chamaecrista* studied, however, there are variations with the *Cassia* genus with *C. fistula* being acute while *C. siberiana* is obtuse.

Recently, Kahraman and Doğan (2010) used leaf morphological characters to separate two closely related species of *Salvia* in Turkey. Hitherto leaflet numbers which are found taxonomically useful in this study was not been

used by previous authors like Hutchison and Dalziel (1958) and Irwin and Barneby (1981) as distinguishing characters. In this study, the leaflet pairs differ and ranges from three pairs found in *S. obtusifolia* to 5-12 pairs that are found in *S. alata* for the *Senna* species. In *Chamaecrista* genus, it ranges from 1 pair found in *C. rotundifolia* to 25-70 pairs in *C. mimosoides* while in *Cassia* it ranges from 5-8 pairs found in *C. siberiana* to 7-9 pairs that are present in *C. fistula*. Similarly, lateral nerves can be used taxonomically to distinguish species. In *Senna* genus the number ranges from 5-8 pairs in *S. obtusifolia* to 9-23 pairs that is found in *S. alata*, in the *Chamaecrista* genus, the range is from 4-7 pairs that occurs in *C. mimosoides* to 6-12 pairs that occurs in *C. rotundifolia*, while in *Cassia* genus it is from 10-16 pairs found in *C. siberiana* to 12-24 pairs that is present in *C. fistula*.

The presence of foliaceous stipule in the genus *Chamaecrista* separate it clearly from the other two genera-*Senna* and *Cassia*-which are completely exstipulate. Pedicels are generally pubescent in all the three genera except in *C. rotundifolia* where it is glabrous. The colour of the pedicels are mostly greenish in all the genera but greenish yellow in *S. sophera* and greenish brown in *C. kirkii* and *C. mimosoides*. The degree of hairiness in sepals is also distinctive, in *Senna* genus, the sepals are glabrous in *S. alata*, densely pubescent in *S. hirsuta* and *S. obtusifolia* but it is pubescent in *S. occidentalis* and *S. sophera*. The sepals are all glabrous in *Chamaecrista* genus while they are densely pubescent in *Cassia* species studied. The shape of the petals is very delimiting in the three genera. Assymetrical petals are common in *Senna* genus except in *S. hirsuta* where it is sometimes ovate while obovate petals can be encountered in *S. obtusifolia*. In the genus *Chamaecrista* petals are generally ovate while in *Cassia* species they are elliptic. Floral parts characters have been found useful in delimiting species in the genus *Salvia* (Celep and Doğan 2010; Kahraman and Doğan, 2010) and the two Turkish subspecies of *Astrantia maxima* (Kaya, 2003).

Several authors have emphasized the usefulness of inflorescences in characterizing plants species (Hutchison and Dalziel, 1958; Okpon, 1969 a and b; Kaya, 2003; Celep and Doğan 2010; Kahraman and Doğan, 2010). The type of inflorescence encountered in the three genera studied in this work can clearly differentiate them. Solitary, axillary inflorescence and occasionally 2-3 flowers are found in *Chamaecrista* genus, whereas dense racemose (Corymb) is a common feature in all *Cassia*, but in *Senna* genus there are variations. Few flowered raceme are present in *S. hirsuta*, *S. occidentalis* and *S. sophera*, terminal raceme with bracts are found in *S. alata* while solitary, axillary flowers is a common feature in *S. obtusifolia* although sometimes it may contain 2-3 flowers. The fruit shape is equally important in the delimitation of the species of *Cassia* genus studied which are characterized by round and rod-like pod unlike in the *Chamaecrista* and *Senna* genera that are characterized by pods that are flat in nature. Of importance is

the length of the fruits, in *Senna* species, it ranges from 8.0-27.0 cm with *S. sophera* having the lowest length of about 8.0 cm while *S. alata* having the longest range of 8.0-27.0 cm. in *Chamaecrista* genus the length ranges from 1.5-6.8 cm with *C. mimosoides* having the lowest range of 1.5-3.5 cm and *C. kirkii* having the highest range of 3.2-6.8 cm whereas in *Cassia* genus the range is between 42-80 cm long with *C. siberiana* having about 42-76 cm while *C. fistula* have a length of 80 cm long.

In summary, irrespective of the fact that some of the characters measured overlaps, which is still an indication of some relative closeness of these genera and their species, leaf anatomical characters have been shown previously (Saheed and Illoh, 2010) to be useful in the delimitation of these same genera and species. The current work like the previous leaf anatomical studies (Saheed and Illoh, 2010) also justifies the separation of *Senna* and *Chamaecrista* from their initial *Cassia* genus thereby supporting the work of Irwin and Barneby (1981). To delimit these genera, morphological characters that were found to be useful in this study includes habit, leaflet apex and base, presence and absence of stipule, hairiness of sepals and the types of inflorescence, while those characters that could be employed in separating species include leaflet shape, apex, number in pairs, length and width as well as the length of the fruit.

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