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Morphological Features in Some Sp. of *Indigofera* L. Leguminosae-Papilionoideae

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Abstract: Studies on the morphological (vegetative and flora)l features in *I. hirsuta*, *I. paniculata*, *I. prieureana*, *I. pulchra*, *I. senegalensis*, *I. stenophylla*, *I. terminalis* and *I. tinctoria* were conducted. This was with the main aim of ascertaining the taxonomic importance of morphological features in determining interspecific relationships among these taxa. The morphological studied of these taxa showed distinct characteristics that can be used for taxonomic decision. Taxonomically significant characters among the taxa studies include the variation in habit-herbs in *I. hirsuta*, *I. prieureana*, *I. senegalensis* and *I. stenophylla*, while shrub in *I. paniculata*, *I. pulchra*, *I. terminalis* and *I. tinctoria*. Similarly stem colour among the taxa varies from grey in *I. pulchra* and *I. senegalensis* to dark brown in *I. hirsuta*, *I. paniculata*, *I. prieureana*, *I. stenophylla*, *I. terminalis* and *I. tinctoria* while the nature of the bark reveal smooth in *I. prieureana*, *I. stenophylla* and *I. terminalis*, rough in *I. senegalensis* while it is twiggy and pubescent in *I. paniculata* and *I. hirsuta*. The interspecific affinity that characterized *I. prieureana*, *I. paniculata* and *I. stenophylla* showed that these species could be phylogenetically related. The biosystematic implications of this finding have been discussed in the light of the current literature.

Key words: Vegetative, morphology, *Indigofera*, leguminosae-pailionoideae, taxa, taxonomy

INTRODUCTION

The *Indigofera L.* is one of the largest genus in the family Leguminosae-Papilionoideae. According to the taxonomic systems of Willis[1] there are 700 species of this genus, which are found in the warm tropical and subtropical regions of the world. Bentham and Hooker[2] considered the order *Leguminales* as a whole to constitute one family Leguminosae among the dicotyledons with nine tribes. One of the tribes is Galegeae which consist of nine genera one of which is the genus *Indigofera*. On a global scale the genus *Indigofera* was further sub divided by Hutchinson and Daziel[3] into five sub genera. Hutchinson and Dalziel[3] further divided the sub genus *Indigofera* into three sections namely *Latestipulata*, *Paniculata* and *Indigofera*. The section *Indigofera* was further sub divided into seven sub sections[3]. Worthy of note is the incosistency in the number of species identified by various authors. Daniel[4] identified 200 species while Mattson[5] recognised over 300 species.

In west Africa Burkill[6] recognised 60 species of *Indigofera* while Hutchinson and Dalziel[3] identified 78 species two of which *I. heterocarpa* Welw.ex Bak and *I. variabilis* Berhaut are imperfectly known species. The reason for this confusion and discrepancies in estimation of the number of taxa in this group of plant could be due to the perceived similarities in structural and reproductive biology of these legumes. In Eastern Nigeria eight commonly occurring species of *Indigofera* were identified and used for the present investigation for botanical variability. These are *I. hirsuta L. I. paniculata Guill et Perr*, *I. prieureana Guill et Perr*, *I. pulchra Wild*, *I. senegelensis Lam. I. stenophylla Guill* and *Perr. I. terminalis Baker* and *I. tinctoria L. Indigofera* species have been found to possess wide range of uses to mankind ranging from medicinal, ornamental, feed for livestock and as dye for commercial purposes. Furthermore, the crushed leaves are useful against skin itching. The fruit is reported to be used in Borno (Northern Nigeria) for ophthalmices[6,7]. A root decoction is applied in most parts of Nigeria to counteract various poisons[6]. Similarly, the fact that no specific investigation has been conducted on the Morphological features of some species of *Indigofera* to the author's best knowledge neccessitated this study.

Indigofera sp. are creeping, prostrate or erect annual, biennual or perennial herb or semi woody

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undershurbs and trees[8]. Stem may be slender, erect or conspicuously branched with bright green or tinged with red colour. The leaves are mostly alternate openly spaced on the stems around 10 cm long and may be roughly or velvety smooth to the touch[7]. The fruit is a pod usually smooth, reddish brown and cylindrical with 2-15 seeds in most species[5,9]. The variation in the morphological features is significant and showed that these features possess many attributes of potential taxonomic importance that are diagnostic. The works of[10-15].

This study assesses the relevance of and discusses the extent to which the different morphological features might be utilised in the systematic consideration of some *Indigofera* species in view of many suggestions on this direction by different authors[6,3].

MATERIALS AND METHODS

Several trips were undertaken to both the University of Ibadan Herbarium (UIH) and the Forestry Herbarium Ibadan (FHI) Nigeria in October between 2003-2004 to obtain the necessary literature materials as well as to examine some herbarium specimens for a compilation of the important morphological characters for the eight species of *Indigofera* and these eight plants selected for the present study are *Indigofera hirsuta*, *I. paniculata, I. prieureana* and *I. pulchra*, others are *I. senegalensis, I. stenophylla, I. terminalis* and *I. tinctoria:* Furthermore, field trips were undertaken to collect living (fresh) and mature materials from some parts of Eastern Nigeria such as Imo, Rivers, Enugu, Abia, Anambra, Ebonyi, Bayelsa, Akwa-Ibom and Cross River States while the study was carried out in the laboratory of Micheal Okpara University of Agriculture, Umudike Umuahia Nigeria.

MORPHOLOGICAL STUDIES

Morphological studies were carried out on the mature living and herbarium specimens. Thrty matured leaves from the middle portion of the plants were measured. Leaves of the *indigofera* species were collected from different locations such as Orji, Choba, Nsukka, Umudike, Umuchu, Abakaliki, Yenogoa, Uyo, Ikot- ekpene between October 2003-2004 Fig. 1 and 2. Length and width of the leaves were measured using a 30cm meter rule. The length of the leaf was obtained by spreading the middle leaflet on a flat surface on the laboratory bench, while for the width the same median leaflet was chosen and measured to ensure uniformity Olowokudejo[12]. In all, 30 matured leaves were measure for each of the species and data collected were statistically analysed and recorded.

The seed number per pod was obtained by counting the number of seed in the longest pod so as to ensure consistency. Photographs of the herbarium specimens were taken using ordinary camera. The characters of the plants were divided into vegetative and floral morphology and the results are summarized in Table 1-3, respectively.

Fig. 1(a-d): Morphology of *Indigofera* species (a) *I. hirsuta*. An annual erect herb (b) *I. paniculata*. Annual much branched herb or under shrub. (c) *I. prieureana*. Herbaceous annual and sparingly branched. (d) *I. pulchra*-semi woody under shrub

RESULTS

The morphological features of the eight species of *Indigofera* are summarized in Table 2 and 3 and illustrated in Fig. 1 and 2a-d. The result of the vegetative morphology of the eight species of *indigofera* investigated showed distinct vegetative variations that could be used for taxonomic delineation. The habit of *I. stenophylla I. prieureana*, *I. hirsuta* and *I. senegalensis* (all herbs) is distinctive w hich separates them from *I. terminalis, I. paniculata, I. tinctoria* and *I. pulchra* which are shrubs Table 2. Observation of the stem colour and nature of the bark is also significant among the species studied. The results showed that the stem colour varied from grey in *I. pulchra* and *I. senegalensis* to dark

Table 1: List of *Indigofera* sp. investigated from fresh specimens

Collection number	Taxon locality	Collector(s)	Voucher specimen
001 *I. terminalis* Baker.	Rumuigbo Choba Uniport Orji	Onyeachusim Ariwodo Nwachukwu Nwachukwu	MOUAUOOI
002 *I. paniculata* Perrs.	Ikot- Ekpene Uyo Yenogoa	Onyeachusim Ariwodo Oforma	MOUAUOO2
003 *I. stenophylla* Guill and Perrs.	Egbu, Enugu, Umuahia	Oforma Ariwodo Okeke	MOUAU003
004 *I. prieureana* Guill and Perrs.	Umuahia, Owerri, Awka, Abakaliki	Onyeachusim Ozoh	MOUAU004
005 *I. tinctoria L.*	Ndioro, Amakohia Choba	Ariwodo, Ozoh Onyeachusim	MOUAU005
006 *I. pulchra* Willd.	Ishielu, Rumuokoro, Umuchu	Ozoh, Okeke Onyeachusim	MOUAU006
007 *I. hirsuta L.*	Owerri, Nsukka Ezza, Ikot Ekpene, Calabar, Amakohia	Onyeachusi Ariwodo Umoh	MOUAU007
008 *I. senegalensis* Lam.	Umudike, Aboh Mbaise	Okeke Onyeachusim	MOUAU008

MOUAUH: Michael okpara university of agriculture, umudike herbarium

Table 2: Vegetative characters of the eight indigofera sp. studied

Character	*I. Hirsute*	*I. Paniculata*	*I. Prieureana*	*I. Pulchra*	*I.Senegalensis*	*I.Stenophylla*	*I.terminals*	*I.tinctoria*
Habit	Annual biennual herb	Shrub/ Branched	Herb	Under shrub with erect stem	Herb	Herb	Semi woody stem	Shrub
Height	5-7.5 cm	2.5 cm	30-45 cm	5-12.5 cm	2.5-5 cm	2.5-7.5 cm	2.5-10 cm	10-17.5 cm
Stem								
Type	Erect and Moderately Branched	Slender and branched	Erect and sparingly branched	Erect	Erect, branched from base	Sparingly branched	Slender branched	Conspicuously
Colour	Brown	Dark brown	Dark brown	Grey	Grey	Dark brown	Purplish brown	Dark brown
Bark	Pubescent	Twiggy	Smooth	Grey and hairy	Rough	Grey and Smooth	Brown and Smooth	Brown
Leaf								
Texture	Rough and Hairy	Thick and Hairy	Thick and hairy	Thick and papery	Thick and hairy	Thick and hairy	Thick and hairy	Smooth
Arrangement	Opposite	Alternate	Opposite	Opposite	Opposite	Opposite	Opposite	Alternate
Shape	Obovate	Linear	Oblong/ Obovate	Oblong/ Obovate	Oblong/ Obovate	Linear	Obovate/ Oblong	Oblong/ Obovate
Apex	Mucronate	Attenuate	Mucronate	Mucronate	Mucronate	Attenuate	Mucronate	Mucronate
Base	Acute	Attenuate	Acute	Acute	Cuneate	Attenuate	Cuneate	Cuneate
Type	Compound	Simple	Compound	Compound	Compound	Compound	Compound	Compound
Length cm	3.72±0.20	3.31±0.78	2.82±0.50	0.74±0.40	1.75±0.19	3.94±0.55	0.89±0.80	1.65±0.10
Width cm	1.84±0.90	0.50+0.90	0.82±0.18	0.32±0.20	0.46±0.40	3.34±0.40	0.34±0.40	1.34±0.30

brown in *I. terminalis*, *I. paniculata*, *I. stenophylla*, *I. tinctoria*, *I. hirsuta* and *I. prieureana* Table 2. This observation futher surports earlier reports of[15,16] on the important of Morphological features in taxonomic clasification of plants. Furthermore, the mode of leaf arrangement showed distinct alternate arrangment in *I. terminalis* and *I. paniculata*, while *I. stenophylla*, *I. prieureana*, *I. tinctoria*, *I. pulchra*, *I. hirsuta* and *I. senegalensis*, are opposite. The leaf shape *varies* from linear in *I. paniculata* and *I. stenophylla*, to obovate-oblong in *I. terminalis*, *I. tinctoria*, *I. prieureana*, *I. pulchra* and *I. senegalensis* Table 2. The leaf margin is entire in all the species and venation is reticulate with up to four pairs of lateral veins present, each of which is curved upwards close to the margin; joining into a loop of the lateral veins immediately above it, thus forming a prominent intramarginal vein parallel to the margin a major characteristics of dicotyledons plants. This is in agreement with the work of Okeke and Nwachukwu[17] in Euphorbiaceae.

The mean leaf length shows that *I. stenophylla* has the highest mean leaf length while *I. terminalis* has the least mean length. The variations in the vegetative characters among the eight species of *Indigofera* studied are important and diagnostic and could be used taxaonomically in the delimitation of these taxa. This is reflected in the inter-specific affinity between

Table 3: Floral morphology characters of the eight *indigofera* species studied

Character	*I. Hirsute*	*I. Paniculata*	*I. Prieureana*	*I. Pulchra*	*I.Senegalensis*	*I.Stenophylla*	*I.terminals*	*I.tinctoria*
Inflorescence	0.6-2.5 cm	2.5-3.7 cm	1.2-2.5 cm	1.2-25 cm	1.2-16 cm	1.6-2.5 cm	1.6-25 cm	2.5-3.7 cm
Flower type	simple raceme	terminal panicle	Axillary raceme	Panicle	Axillary raceme	Axillary raceme	Terminal panicle	Axillary raceme
Floral Symmetry	Actino-morphic	Zygo-morphic	Actino-morphic	Actino-morphic	Zygo-morphic	Actino-morphic	Actino-morphic	Zygo-morphic
Arrangement	Nearly sessile	Alternate	Nearly sessile	Nearly sessile	Alternate	Nearly sessile	Nearly sessile	Opposite
Pedicel	Cernuous	short	Very short	Very short	Short and silky	Very short	Very short	Very short
CALYX/ SEPAL								
Colour	Brown silky	Rose	Silky	Silky-pubescence	Silky	Silky	Rose	Silk
Shape	Elliptic	Elliptic	Elliptic	Elliptic	Elliptic	Elliptic	Linear	Elliptic
COROLLA								
Colour	Scarlet	Red	Rose	Scarlet and Rose	Rose	Pubescent	Rose	Yellow Purplish
Freedom and Fused	Free	Free	Free	Solitary	Fused	Free	Free	Imbricate
FRUIT TYPE	Pod	Pod	Terete	Pod	Pod	Pod	Pod	Pod
Shape	Linear	Ovoid	Linear	Oblong	Linear	Linear	Ovoid/ Mucronate	Ovoid
Seed number per pod	6-8 seeded	4 seeded	12-15 seeded	2 seeded	10-15 seeded	12-15 seeded	8-12 seeded	8-12 seeded
Pod length (cm)	2.07±0.30	1.33±0.11	2.76±6.68	1.65±0.18	1.77±0.18	1.17±0.16	1.38±0.70	1.89±0.80
Pod width (cm)	0.41±0.10	0.18±0.70	0.39±0.80	0.26±0.80	0.39±0.80	0.24±0.60	0.26±0.60	0.34±0.50

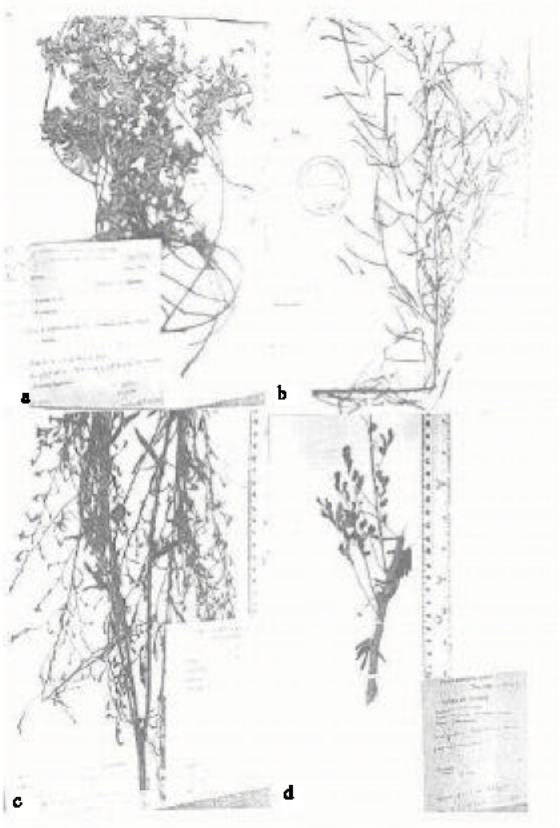

Fig. 2 (a-d): Morphology of *Indigofera* species *(a) I. senegalensis*. Annual herb *(b)I. stenophylla*. Annual herb*(c)I.teminalis*. A semi woody under shrub.*(d)I. tinctoria*. A soft woody shrub

I. stenophylla Fig. 2b and *I. prieureana* Fig. 1c, which share a common habit and stem type, they equally possess the same smooth bark, thick and hairy leaf texture, opposite leaf arrangement and compound leaf type, that separates them from the other taxa Table 2. The floral symmetry seperates this species into two distinct types *I. terminalis*, *I. stenophylla*, *I. prieureana*, *I. tinctoria* and *I. hirsuta* shows actinomorphic while *I. paniculata*, *I. pulchra* and *I. senegalensis* show zygomorphic arrangement. The flower arrangement reveal a near sessile arrangement in *I. terminalis*, *I. stenophylla*, *I. prieureana*, *I. pulchra* and *I. hirsuta*, alternate in *I. paniculata* and *I. senegalensis*, while *I. tinctoria* is opposite Table 3. The flower type varies from simple raceme in *I. hirsuta* to axillary raceme in *I. stenophylla*, *I. prieureana*, *I. tinctoria* and *I. senegalensis* while it is terminal panicle in *I. paniculata* and *I. terminalis*. This various symetry types noticed the species could be used in further seperation of thiese taxa.

The floral morphological attributes of the eight species of *Indigofera* as documented here, further show the interspecific relationship between *I. stenophylla* Fig. 2b and *I. prieureana* Fig. 1c, shown in Table 3. Conclusively, the variation in the morphological (vegetative and floral) characters show an interspecific affinity between *I. stenophylla* and *I. prieureana*, that could be used taxonomically in the delimitation of these taxa.

DICUSSION

The results of the morphological features of the *Indigofera* species studied showed some specific characteristics that can be used for taxonomic decision, for example. The distinct variation in the habit in the

species constitutes an important distinguishing feature. *I. hirsuta*, *I. prieureana*, *I. senegalensis* and *I. stenphylla* Fig. 1a, c, 2a and b are herbs while *I. paniculata*, *I. pulchra*, *I. terminalis* and *I. tinctoria* Fig 1b, d, 2c and d are all shrubs, hence the eight species studied could therefore be separated into two groups based on their habit. This observation is in line with earlier works of[10,13,18] who used comparative mophorlogy of different species in establishing relationship among the taxa.

The variations in stem type, colour and nature of bark clearly delineates *I. prieureana* and *I. stenophylla* from the other species. This is important since Okwulehie and Okoli[10] in Tiliaceae and Nwachukwu[16] in Euphorbiaceae have distinguished and separated some species using variations in their morphology though not in the genus *Indigofera*. Other workers have vividly emphasized the taxonomic importance of morphological features in making reliable taxonomic conclusions[17,19,20,21]. The leaf arrangement showed alternate in *I. paniculata* and *I. tinctoria* Fig. 1b and 2d while it is opposite in the other six taxa Fig. 1a, c, d and 2a, b and c. This observation is similar to the one recently made by Edeoga[13] in some *Dissotis* sp. Furthermore the shape and apex showed that majority of the species are oblong/obovate Figs 1a, c, d, 2a and d and mucronate Fig. 1a, c and d and 2a, c and d, respectively. This is in line with the works of Okeke[10,16-18] who used morphological features in determining taxonomic relationships among taxa. The floral features of the taxa further confirm the interspecific relationship between *I. prieureana* and *I. stenophylla* in their flower type, symmetry, arrangement, calyx colour, shape, corolla and fruit shape and seed number per pod Table 3. These distinguishing morphological features observed in these investigations are of systematic value because they are reasonably constant in *I. prieureana* and *I. stenophylla* Table 2 and 3 and hence distinguish these two taxa from the other six taxa. The purpose of this investigation is to show that application of morphological features has proven to be of immense assistance in interpreting problems related to plant classification. Thus the necessity of including the results from the vegetative and floral morphology with data derived from other botanical disciplines remains vital when formulating conclusions on the systematic of the *Indigofera* sp.

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