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Comparative Morphological and Palynological Studies on Some Species Of Sida L (Malvaceae) in Nigeria

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Morphological and Palynological studies of some species of *Sida* in Nigeria

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A comparative morphological and palynological study was conducted on eight *Sida* species in Nigeria to identify diagnostic characters for their accurate identification and classification. Qualitative and quantitative vegetative, floral, and pollen characters were evaluated using standard taxonomic procedures. Pollen grains were acetolysed and examined under a light microscope, while hierarchical cluster analysis was employed to assess species relationships based on morphological and palynological characters.

Morphological observations showed that all species possessed simple leaves that varied in shape from linear-lanceolate, cordate, oval, and rhomboid to acute and acuminate, with leaf surfaces either pubescent or glabrous. Inflorescences were solitary and axillary or arranged in clusters, while petals were consistently five, connate, and varied in colour from white (*S. linifolia*) and pale orange (*S. urens*) to yellow in the remaining species. All species produced dehiscent fruits. Palynological analysis revealed that all pollen grains were large and oblate-spheroidal. The polar axis ranged from 70.00 ± 3.54 µm in *S. acuta* to 153.75 ± 12.37 µm in *S. pilosa*, whereas exine thickness varied from 9.75 ± 0.35 µm in *S. urens* to 15.00 ± 0.35 µm in *S. rhombifolia*. Pore number and pore diameter also varied considerably among the species. Cluster analysis grouped morphologically similar taxa, with *S. pilosa,S. urens*, *S. alba,S. corymbosa*, and *S. acuta,S. rhombifolia* showing close affinities, while *S. linifolia* formed a distinct cluster. Therefore morphological and pollen morphological data provide diagnostic information for differentiating *Sida linifolia, Sida pilosa, Sida urens, Sida acuta, Sida alba, Sida cordifoli, Sida corymbosa, Sida rhombifolia.*
Keywords*:Sida,* morphology; palynology; pollen morphology; hierarchical cluster analysis.

INTRODUCTION

The genus *Sida* L. belongs to the family Malvaceae, commonly known as the mallow family. Malvaceae is one of the largest families of flowering plants, comprising approximately 82 genera and about 1,500 species that are widely distributed

throughout the tropical and subtropical regions of the world (Shaheen, 2000). Members of the family are predominantly herbs, shrubs, and small trees, with the greatest diversity occurring in tropical regions (Duke & Dobley, 1995). The family is believed to have evolved from woody members of the order Malvales and exhibits remarkable diversity in floral ecology and reproductive strategies (Gottsberger, 1972). The genus *Sida* was established and validated by Linnaeus in *Species Plantarum* (1753). It is one of the largest and taxonomically most complex genera within the family Malvaceae. Although more than 1,000 names have been published under the genus, current taxonomic estimates recognize approximately 150–250 valid species distributed throughout the tropical and subtropical regions of both hemispheres (Paul & Nayar, 1988; Fryxell, 1997). However, some authorities recognize fewer than 100 species, reflecting the persistent taxonomic uncertainties surrounding the genus (Markey, 2011). Historically, *Sida* has been regarded as a "wastebasket taxon" because numerous species that could not be confidently assigned to other genera were placed within it. Consequently, many species have undergone repeated reclassification, and the circumscription of the genus remains unresolved.

Species of *Sida* are cosmopolitan in distribution and are commonly found flowering during the rainy season (Agwu *et al.*, 2015). Members of the genus are predominantly annual or perennial herbs, although they may occur as shrubs or, less commonly, small woody trees in tropical regions (Anami & Jespin, 2017). They occupy a wide range of habitats, including open woodlands, riverbanks, pastures, plantations, cultivated fields, gardens, roadsides, and waste areas (Rajapuriyadharahini & Weerasena, 2020). Common vernacular names associated with *Sida* species include broom grass, broom weed, cheese weed, common fan petals, clock plant, common wireweed, morning mallow, southern *Sida*, and spiny-headed *Sida* . Some species, such as *Sida rhombifolia*, also serve as important nectar and host plants for butterflies and moths, highlighting their ecological significance.The classification of Malvaceae has undergone several revisions over time. Hutchinson (1967) recognized five tribes within the family: Malopeae, Malveae, Hibisceae, Abutileae, and Ureneae. Within this framework, the tribe Malveae was further divided into the subtribes Corynabutilinae and Malvinae, while Abutileae was divided into Abutilinae and Sidinae (Tate *et a*l., 2005). These classifications were primarily based on reproductive characters, including the number and position of carpels, ovules per

carpel, fruit type, and the relationship between stylar branches and carpels. Such morphological features continue to play an important role in the taxonomy and systematics of the family. The genus *Sida* possesses considerable ecological, medicinal, and economic importance, making it a subject of sustained interest among botanists, taxonomists, horticulturists, and agricultural scientists. Despite its significance, the taxonomy of the genus remains problematic because of extensive morphological variation, overlapping diagnostic characters, and the lack of comprehensive systematic studies in many regions.

In Nigeria, although several species of *Sida* have been reported, comprehensive comparative studies integrating both morphological and palynological evidence remain limited. Basic taxonomic documentation of Nigerian *Sida* species is still inadequate, making accurate species identification and the understanding of their evolutionary relationships challenging. Morphological and pollen characters have long been recognized as valuable taxonomic tools for resolving species boundaries and elucidating phylogenetic relationships within Malvaceae. Therefore, the present study was undertaken to evaluate the qualitative and quantitative morphological characters, together with pollen morphological characteristics, of selected Nigerian species of *Sida*. The study aims to improve the identification and delimitation of the taxa and to provide additional evidence for assessing the phylogenetic relationships among members of the genus occurring in Nigeria.

MATERIALS AND METHODS

Sample collection

Field collections of species of *Sida* were made from two states including Oyo and Plateau in Nigeria covering forest and savanna ecological zones. Field notes were taken for characters such as the colour of the petal, sepal, stamen, carpel; fruit and colour of the leaf which might not be available after the specimens had been processed. Flower buds and floral specimens were preserved in 50% ethanol. Plant identification and authentication were done at the University of Ibadan Herbarium (UIH), Nigeria, where voucher specimens were also deposited for future reference.

Macro-Morphology

Vegetative floral macro-morphological characters were examined in eighty six specimens studied. Qualitative and quantitative characters were assessed. Quantitative characters include leaf length, leaf width, petiole length, leaf blade length, style length, pedicel length, number of seed per hole, flower bud length, petal length, filament length, inflorescence length, using meter rule and thread (twine). Qualitative characters was studied on leaf shape, leaf margin, leaf surface, leaf texture, apex, base, sepal shape, sepal colour, sepal apes, petal shape, petal apex. style apex, fruit shape, petal colour, stigma type of inflorescence, inflorescence attachment and inflorescence position.

Preparation of pollen grains

Flower buds were preserved in 50% ethanol from field collections. Pollen preparation method was (Faegri and Iversen,1989). The pollen grains samples were each poured into appropriately labelled 50 ml plastic centrifuge tubes. They were crushed to powdery form using glass rods, Acetolysis mixture was prepared and poured into each tube. The tubes were stirred on the vortex mixer. They were heated in a water bath for about 10 minutes, brought down and cooled. They were centrifuged at 4000 revolutions per minute (rpm) for 10 minutes and the supernatant decanted into a special bottle labelled "Acetolysis Waste", Copious amount of distilled water was added to each tube, mised on the mixer, centrifuged and decanted. (This is first rinsing). The content of each tube was then sieved using a 120 micron sieve mesh. (The water for the sieving served as second rinsing after acetolysis). It was centrifuged and decanted.50% glycerol was added to the residue in the tube (to mop up water remaining in the tube). It was mixed, centrifuged and decanted. Supernatant was decanted off finally and tubes inverted over filter paper and left over night. 100% glycerol was added to the final residue in the tubes and shaken, which was then poured into the storage bottle, covered with a cover slip and sealed with nail vanish. The slides were observed under light microscope at 40x and 100x magnifications. Photographs were taken using Olympus CH_30 with mounted with KRUSS DE 1.3 digital camera.

Data analysis

Both qualitative and quantitative , morphological and pollen data obtained from this study were subjected to descriptive and multivariate statistical analyses. The mean values of all the quantitative data of *Sida* were calculated with the range (minimum-maximum) and standard deviation. The data matrices were analysed using paleontogical statistics software package for educational and data analysis software, version 3.0 (PAST) program. Cluster analysis was carried out to remove (highly correlated) variables from the data file.

RESULTS

Vegetative morphology

The eight *Sida* species examined exhibited herbaceous or shrubby habits, with annual or perennial life forms. All taxa possessed simple, alternately arranged leaves but differed markedly in their vegetative morphological characters (Tables 2). Leaf shape varied from linear-lanceolate and lanceolate to cordate, ovate, and rhomboid. Leaf surfaces were either glabrous or pubescent, with pubescence recorded in *Sida urens*, *S. pilosa*, *S. cordifolia*, *S. corymbosa*, and *S. acuta*. Leaf apices ranged from acute to acuminate and obtuse, while leaf margins were entire, crenate, dentate, or doubly dentate. Variation was also observed in leaf base morphology, which ranged from obtuse and truncate to cordate and broadly cordate .

Quantitative vegetative characters also differed among the taxa (Table 1). *Sida alba* produced the largest leaves, with a mean leaf size of 7.08 × 15.00 cm, whereas *S. rhombifolia* had the smallest leaves, measuring 4.35 × 1.39 cm on average. Petiole length showed considerable interspecific variation, ranging from 0.10 cm in *S. acuta* to 2.71 cm in *S. cordifolia*.

Floral morphology

The inflorescences were consistently axillary in all species, occurring either as solitary flowers or in clusters (Table 3). Pedicel length ranged from 0.30 cm in *S. cordifolia* to 1.10 cm in *S. corymbosa*. Floral structure was generally uniform across the taxa. Each flower possessed five connate petals that varied in shape from

obcordate and obovate to obliquely obovate (Table 5). Petal colour showed limited variation among the species: *S. linifolia* had white petals, *S. urens* had pale orange petals, whereas the remaining species produced yellow petals. Petal length ranged from 0.50 cm in *S. pilosa* and *S. urens* to 0.90 cm in *S. alba* and *S. corymbosa* (Table 3).

Sepals were consistently five in number but differed in morphology, being campanulate, cup-shaped, or broadly lanceolate (Table 4). Sepal length ranged from 0.50 cm in *S. alba* to 0.80 cm in *S. rhombifolia* (Table 5).

Fruit morphology

Fruit morphology exhibited relatively little variation among the species. All taxa produced dehiscent schizocarpic fruits that varied in shape from globose and subglobose to circular (Table 4). Each mericarp contained a single seed, a feature that was constant across all the taxa examined.

Table 1 :Quantitative leaf macro-characters of some *Sida* L. in Nigeria.

Taxa	Leaf length (cm)	Leaf width (cm)	Petiole (cm)	Leaf blade (cm)
Sida linifolia	3.5-12.2 7.23± 2.61	0.1-0.9 0.66± 0.27	0.2-0.9 0.56± 0.26	3.0-11.9 2.67± 2.53
Sida pilosa	3.0-11.0 6.67±2.45	1.0-3.6 2.61±0.81	1.0-4.1 2.12±0.83	3.0-7.5 4.71±1.25
Sida urens	4.0 – 7.9 5.91±1.32	0.7– 2.6 2.23±2.27	0.2– 2.4 1.66±0.52	2.0– 5.8 4.59±3.86
Sida acuta	3.0 -7.0 5.12±1.34	0.5 -4.1 1.71±0.92	0.1 -2.9 0.45±0.47	3.0 -7.6 5.31±1.61
Sida alba	3.2-11.6 7.08±2.15	11.0-3.2 2.15±0.77	0.2-3.8 1.55±0.88	3.0-11 5.88±1.98
Sida cordifolia	3.6-14.5 9.59±8.29	1.3-4.7 2.71±1.34	0.9-4.9 2.71±1.34	2.8-10.6 5.60±2.66
Sida corymbosa	3.0-13.2 6.98±2.34	0.6-4.9 2.18±1.05	0.2-1.6 0.58±0.29	3.0-12.3 6.74±2.29
Sida Rhombifolia	2.0-8.1 4.35±1.65	0.3-2.2 1.39±2.18	0.1-0.7 0.45±0.20	1.5-7.1 3.89±1.54

Measurements: Range

Mean±SD

Table 2:Qualitative vegetative characters of some *Sida* L. in Nigeria.

Taxa	Leaf Shape	Leaf margin	Leaf apex	Leaf base	Leaf texture	Leaf arrangement	Leaf surface
Sida linifolia	Linear to Lanceolate	Entire	Acute	Obtuse	Glabrous	Alternate	Glabrous
Sida pilosa	Cordate	Doubly dentate	Acuminate	Broadly cordate	pubescent	Alternate	Pubescent
Sida urens	Cordate	Dentate	Acuminate	Cordate	Pubescent	Alternate	Pubescent
Sida acuta	Lanceolate	Crenate	Acute	Obtuse	Pubescent	Alternate	Pubescent
Sida alba	Oval	Finely dentate	Obtuse	Rounded	Glabrous	Alternate	Glabrous
Sida cordifolia	Oval, cordate	Dentate	Obtuse, Truncate	Rounded	Pubescent	Alternate	Pubescent
Sida corymbosa	Lanceolate	Crenate	Acute	Obtuse	Pubescent	Alternate	Pubescent
Sida rhombifolia	Rhomboid, Oval,Lanceolate	Regularly dentate	obtuse	Truncate	Glabrous	Alternate	Glabrous

Table 3:Qualitative floral characters of some *Sida L.* in Nigeria

Taxa	Sepal shape	Sepal color	Petal shape	Petal color
Sida linifolia	Cup-shaped	Dark green	Obovate	White
Sida pilosa	Campanulate	Pale green	Obovate	Cream yellow
Sidsa urens	Campanulate	Dark green	Symmetrical obcordate	Pale orange
Sida acuta	Campanulate	Green	Connate	Light yellow
Sida alba	Broadly lanceolate	Green	Rounded	White to pale yellow
Sida cordifolia	Campanulate	Green	Obliquely obovate	Dark yellow
Sida corymbosa	Campanulate	Green	Connate	Light yellow,
Sida rhombifolia	Campanulate	Green	Asymmetrically obcordate	Yellow

Table 4:Qualitative and quantitative characters of fruit and inflorescence of some *Sida* L. in Nigeria

Taxa	Fruit shape	Dehiscence	Inflorescence type	Seed shape	Seed color	Number of seed per segment
Sida linifolia	Globose or disc-shaped	Dehiscent	Axillary	Wedge-shape	Brown	1
Sida pilosa	Globose	Dehiscent	Axillary solitary cluster	Wedge-shape	Brownish black	1
Sidsa urens	Globose	Dehiscent	Axillary	Trigonous	Brown	1
Sida acuta	Globose	Dehiscent	Axillary, solitary, cluster	Wedge-shape	Reddish brown	1
Sida alba	Globose	Dehiscent	Solitary, cluster	Wedge-shape	Brown	1
Sida cordifolia	Circular	Dehiscent	Axillary, solitary	Kidney –shape	Dark brown	1
Sida corymbosa	Globose	Dehiscent	Axillary,	Wedge-shape	Brown	1
Sida rhombifolia	Subglobose	Dehiscent	Axillary, solitary	Kidney-shape	Brown	1

Table 5:Quantitative floral characters of *Sida* L. in Nigeria

Taxa	Sepal length (mm)	Petal length (mm)	Pedicel length (mm)	No of sepal	No of petal
Sida linifolia	5.5-6	4-5	4-12	5	5
Sida pilosa	5.4-6	6	10-12	5	5
Sida urens	5-7	9	12	5	5
Sida acuta	8	10	2-8	5	5
Sida alba	6	5-6	5-6	5	5
Sida cordifolia	7	7-8	2-4	5	5
Sida corymbosa	5-7	10	10-12	5	5
Sida rhombifolia	10.5	4-8	4-8	5	5

Pollen Morphology

Table 6 shows that all eight *Sida* species examined possess large, oblate-spheroidal pollen grains, indicating uniformity in pollen shape across the genus. However, significant variation was observed in the quantitative pollen characters. The polar axis ranged from 70.00 ± 3.54 µm in *Sida acuta* to 153.75 ± 12.37 µm in *Sida pilosa*, while exine thickness varied from 9.75 ± 0.35 µm in *S. urens* to 15.25 ± 0.35 µm in *S. rhombifolia*. Spine length was greatest in *S. cordifolia* and least in *S. acuta*. Pore size also differed among the species, with *S. alba* having the largest pores and *S. rhombifolia* the smallest. The highest pore number was recorded in *S. cordifolia* (>12), whereas *S. pilosa* and *S. urens* had the fewest (>5). Overall, while pollen shape remained constant, quantitative pollen characters showed considerable variation and provide useful diagnostic features for distinguishing the *Sida* species studied.

Table 6:Qualitative and quantitative pollen morphological characters of some *Sida* L. in Nigeria

Species	Polar axis	Pollen shape	Equitorial diameter	Pollen size	Exine	Spine	Pore size
Sida linifolia	82.5-85 83.75±1.77	Oblate spheroidal	82.5-85 83.75±1.77	Large	10-11.2 10.75±1.06	5-5.5 5.25±0.35	2.7-3.0 2.85±0.21
Sida pilosa	145-162.5 153.75±12.37	Oblate spheroidal	145-162.5 153.75±12.37	Large	13.7-14.5 14.1± 0.57	5-5.5 5.52±0.35	6.25-6.7 6.48±0.32
Sida urens	95-102.5 98.75±5.30	Oblate spheroidal	95-102.5 98.75±5.30	Large	9.5-10 9.75±0.35	5-5.25 5.125 ±0.17	6.2-7 6.6±0.57
Sida acuta	67.5-72.5 70±3.54	Oblate spheroidal	67.5-72.5 70±3.54	Large	10-10.5 10.±0.35	1.5-2.5 2±.017	5-5.25 5.13±0.18
Sida alba	87.5-90 188.75±1.77	Oblate spheroidal	87.5-90 188.7±1.77	Large	12.512.75 12.±0.18	5-5.5 5.25±0.35	6.7-7.5 7.1±0.57
Sida cordifolia	95-100 97.5±3.53	Oblate spheroidal	95-100 97.5±3.53	Large	14.5-15 14.±0.35	7.25-7.50 7.38±0.18	5-5.25 5.13±0.18
Sida corymbosa	90-90.5 90.25±0.354	Oblate spheroidal	90-90.5 90.2±0.354	Large	10-12.5 11.±1.77	5-7.5 6.25±1.77	6.25-7.5 6.88±0.88
Sida rhombifolia	105-122.5 108.75±5.30	Oblate spheroidal	105-11.5 58.25±66.11	Large	15-15.5 15.±0.35	5-6.25 5.63±0.88	5-5.5 5.1±0.14

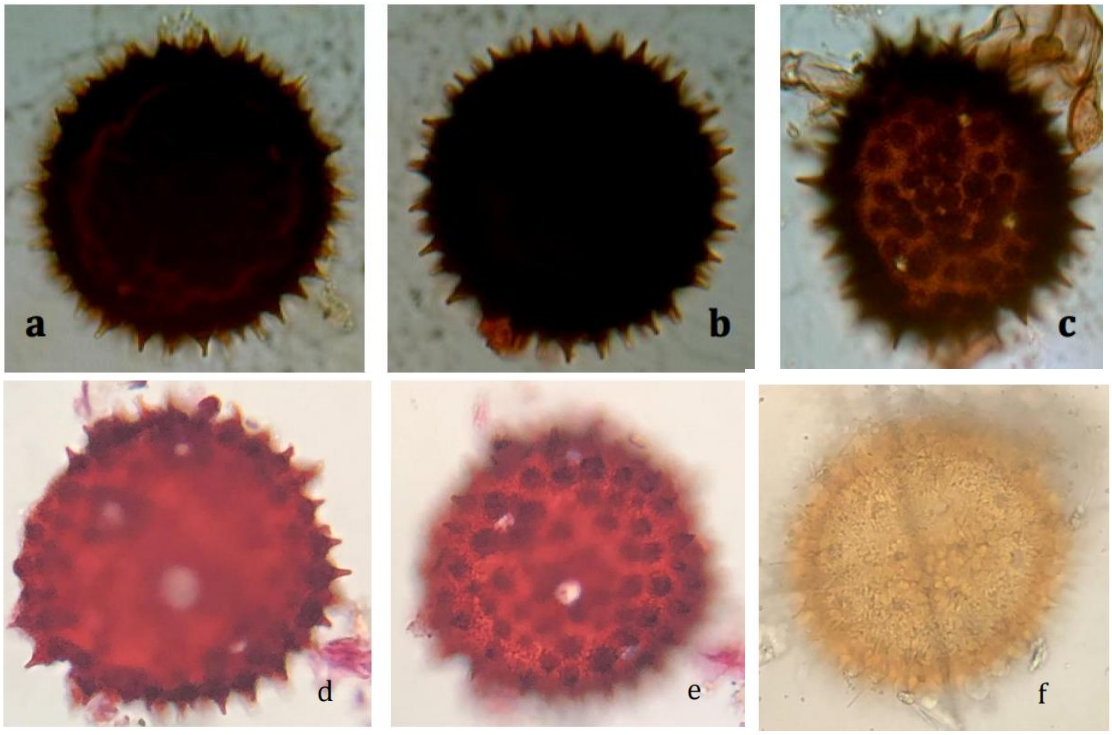


Figure 1: Photomicrographs of pollen grains of genus *Sida* in Nigeria.

a. *Sida acuta* showing spines and shape.
b. *Sida alba* showing spines and shape.
c. *Sida cordifolia* showing spines and ora .
d. *Sida corymbosa* showing well displayed spines .
e. *Sida corymbosa* showing pores surrounded by 4 spines.
f . *Sida linifolia* showing numerous pores.

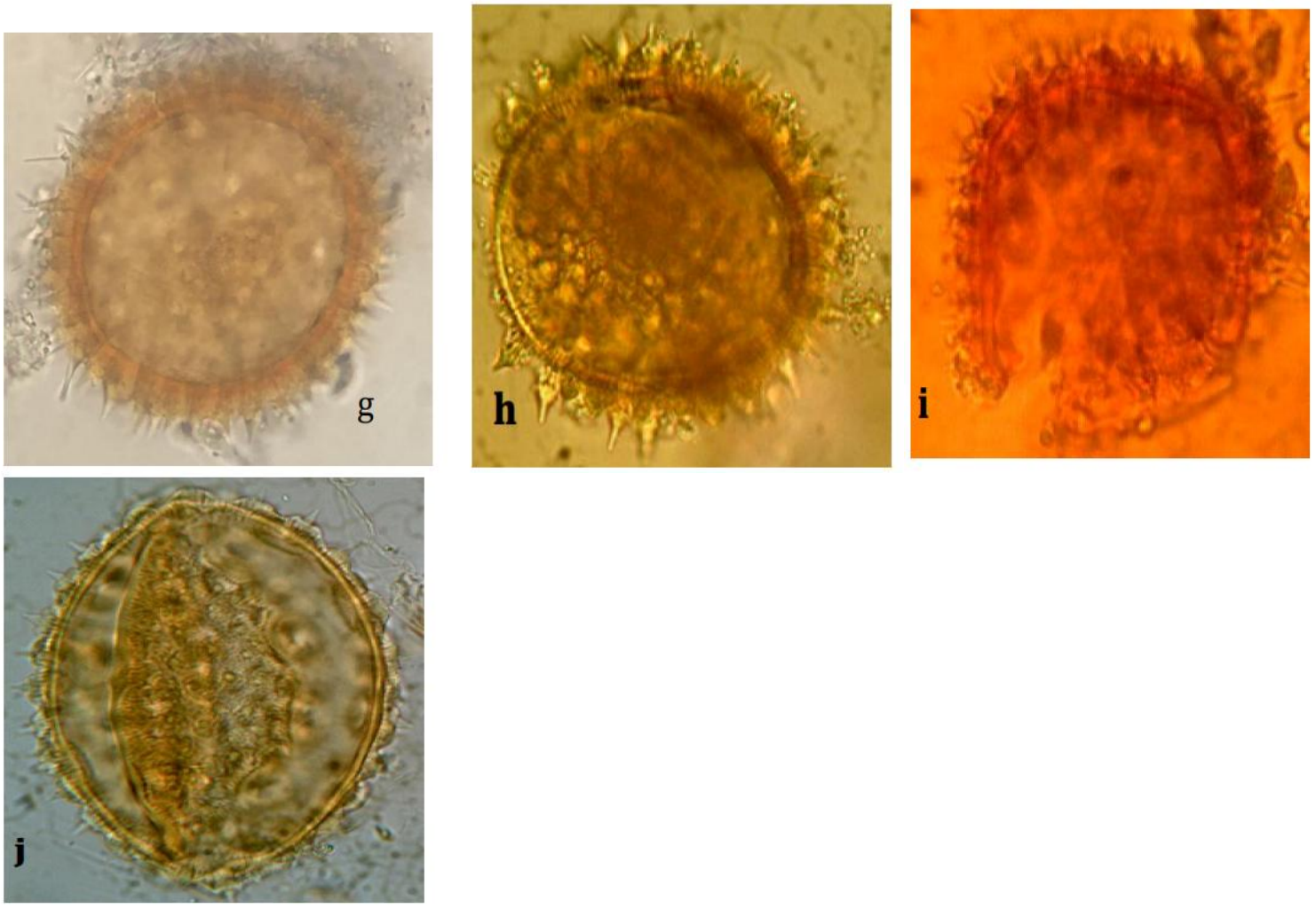


Figure 1 Cont :Photomicrographs of pollen grains of genus *Sida* in Nigeria.
g.*Sida linifolia* shows spines and exine.
h. *Sida rhombifolia* showing long supretectal spine.
i. *Sida urens* showing exine stratification and spines.
j. *Sida pilosa* showing spines and possibly pseudocolpi.

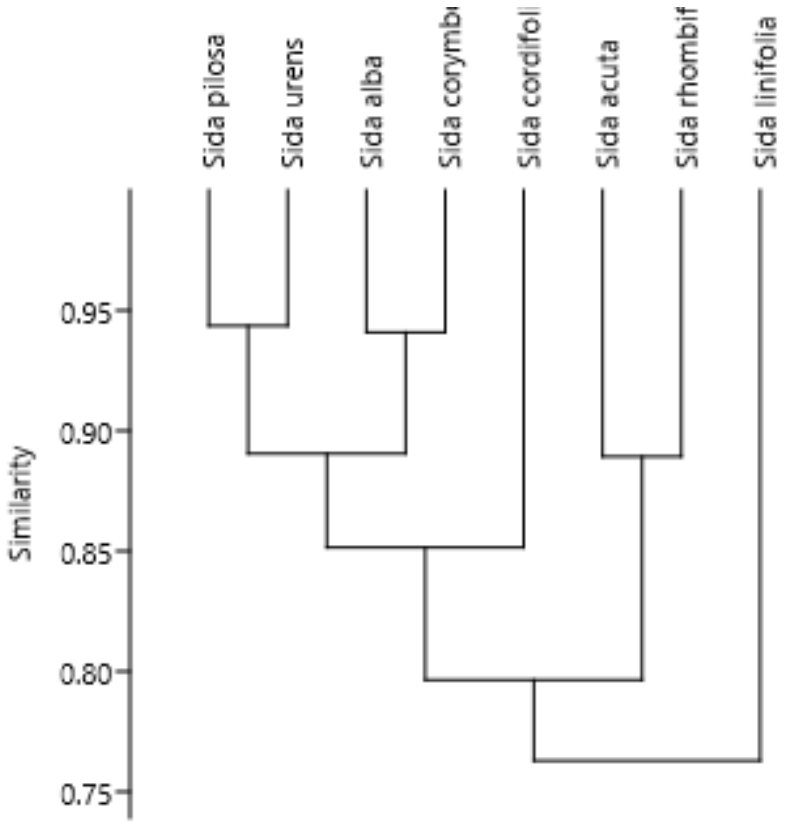


Figure 2: Dendogram showing relationships among selected *Sida* species based on morphological characters.

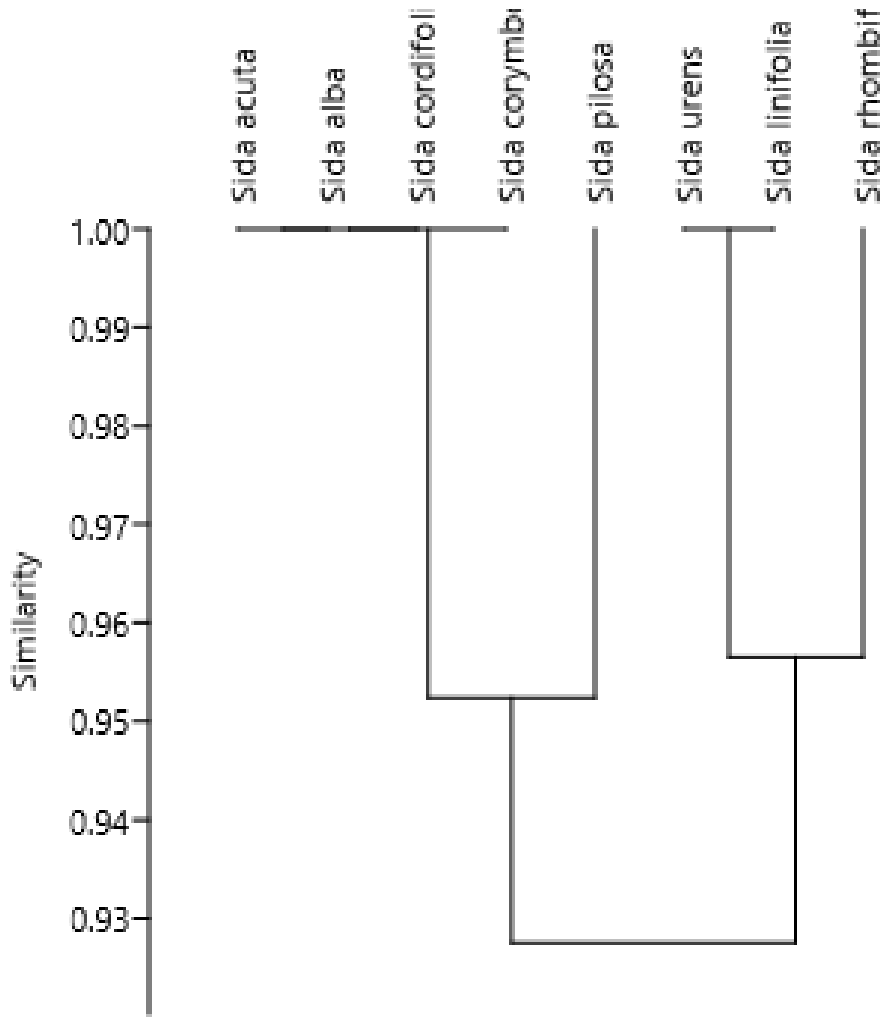


Figure 3:Dendogram showing relationships among selected *Sida* species based on Pollen characters.

Discussion

The present study revealed considerable morphological and palynological variation among the eight *Sida* species investigated in Nigeria. The observed differences in leaf dimensions, leaf shape, margin, apex, base, floral characters, fruit and seed morphology demonstrate the value of a combination of characters in species delimitation. This agrees with the taxonomic treatment of Nigerian *Sida* by Ugborogho (1981), in which combinations of vegetative and reproductive characters were used to distinguish species.

Leaf characters were particularly useful for separating the taxa. *Sida cordifolia* had the largest mean leaf length, whereas *S. rhombifolia* had the smallest. Qualitative differences were also pronounced: *S. linifolia* was characterized by linear-lanceolate, entire and glabrous leaves, *S. pilosa* and *S. urens* by cordate and pubescent leaves, and *S. acuta* and *S. corymbosa* by lanceolate leaves. Differences in pubescence were also taxonomically informative. Previous anatomical studies of Nigerian *Sida* have demonstrated variation in foliar characters and trichomes and confirmed their usefulness in distinguishing species (Olatunji & Bakare, 1993).

Floral, fruit and seed characters provided additional evidence for species delimitation. Although all taxa possessed five sepals and five petals, variation occurred in sepal and petal shape, colour and dimensions, as well as fruit and seed morphology. The predominance of axillary flowers and dehiscent fruits is consistent with the general reproductive characteristics of *Sida*. These relatively stable generic features, together with variable quantitative and qualitative characters, provide a useful basis for species identification.

The morphological cluster analysis supported these observations. *Sida pilosa* and *S. urens* showed close affinity, as did *S. alba* and *S. corymbosa*, while *S. acuta* and *S. rhombifolia* also formed a distinct close pair. These relationships correspond broadly with similarities in leaf and reproductive characters. In contrast, *S. linifolia* was the most morphologically distinct taxon, consistent with its unique combination of linear-lanceolate, glabrous leaves and entire margins. The clustering should, however, be interpreted as phenetic similarity rather than direct evidence of evolutionary relationship.

Pollen morphology provided additional characters for species discrimination. All eight taxa possessed oblate-spheroidal, spinose pollen grains with numerous pores, indicating strong palynological affinity within the genus. Similar pollen characteristics have been reported for *Sida* and other Malvaceae, including pantoporate and echinate pollen in *S. acuta* and *S. rhombifolia* from Nigeria. El Naggar (2004) also demonstrated that pollen shape, size, aperture characteristics and exine sculpture are taxonomically valuable in Malvaceae.

Despite the general similarity in pollen type, considerable variation occurred in pollen size, spine dimensions, pore size and pore number. *Sida pilosa* produced the largest pollen grains, whereas *S. acuta* and *S. linifolia* had comparatively smaller grains. *Sida linifolia* also possessed relatively short spines compared with several other taxa. Such quantitative differences are potentially useful for separating species with similar vegetative morphology. Studies of *Sida* pollen have similarly demonstrated that pollen size, aperture number, pore size, exine ornamentation and spine characters are useful in species delimitation. Spine variation is particularly significant in Malvaceae because differences in spine size and morphology may occur between species within the same genus.

The pollen cluster analysis revealed two major groups. The first comprised *S. acuta, S. alba, S. cordifolia* and *S. corymbosa*, whereas the second comprised *S. pilosa, S. urens, S. linifolia* and *S. rhombifolia*. Within the latter group, *S. pilosa–S. urens* and *S. linifolia–S. rhombifolia* showed particularly close associations. The two major groups joined at approximately 0.93 similarity, indicating high overall palynological similarity but measurable differences in quantitative pollen characters. A comparable use of hierarchical cluster analysis successfully separated *Sida* species based on pollen characters in a previous study.

The morphological and palynological dendrograms did not produce identical groupings, demonstrating that the two character systems provide complementary taxonomic information. Morphological characters were more effective in recognizing some species-level differences, whereas pollen characters provided relatively conserved generic features together with useful quantitative differences. Consequently, the combined use of external morphology and palynology provides stronger taxonomic evidence than either dataset alone. Pollen terminology and character

interpretation should follow standardized palynological criteria such as those established by Punt et al. (2007).

Overall, the results demonstrate that the eight *Sida* taxa can be effectively differentiated using combinations of vegetative, floral, fruit, seed and pollen characters. Leaf shape, margin, apex, base and indumentum were particularly useful morphological characters, while pollen size, spine length, pore size and pore number provided important supplementary palynological characters. The findings therefore support the application of numerical taxonomy and palynology as complementary approaches to *Sida* systematics in Nigeria. However, the dendrograms indicate similarity rather than evolutionary history; anatomical and molecular evidence would be valuable for further testing the relationships suggested by the present study.

Conclusion

The study established significant morphological and palynological variation among the eight *Sida* species investigated in Nigeria. Morphological characters, particularly leaf shape, margin, apex, base, effectively differentiated the taxa, while floral, fruit and seed characters provided additional diagnostic evidence. Pollen morphology revealed a generally conserved oblate-spheroidal and spinose pollen type but showed interspecific variation in pollen size, spine dimensions, pore size and pore number.

The morphological and palynological cluster analyses demonstrated both close affinities and distinct morphological profiles among the species. *Sida linifolia* was particularly distinct in the morphological analysis, while the pollen analysis separated the taxa into two major groups. These findings confirm that an integrated assessment of morphological and palynological characters provides useful taxonomic evidence for the identification and delimitation of *Sida* species in Nigeria. Further integration of anatomical and molecular data is recommended to validate the relationships revealed by the present study.

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