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TAXONOMIC EVALUATION OF HOMOSPOROUS LEPTOSPORANGIATE FERNS (PTERIDOPHYTES) IN SOUTHWESTERN NIGERIA

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ABSTRACT

Taxonomical studies of leptosporangiate ferns collected from Southwestern Nigeria were carried out for taxonomic re-evaluation, additional diagnostic features and for establishing the missing gaps in the taxonomy of fern species in this region. The habitats from where these ferns were collected include humid areas, waterlogged, road sides and rock crevices. Features investigated were rhizomes, croziers, fronds, ramenta, stipe's colour; leaf type: shape, hairiness, margins, length and breadth; apex shape and type; leaflet shape and margins, indusia, spores, sporangia and sori arrangements. These features were used to construct artificial taxonomic key for the thirteen families of ferns collected. The quantitative data obtained were coded for statistical analysis using Principal Component Analysis. Different growth forms and growth duration were also recorded. The results of the scatter diagram shows how closely or distantly related these fern species are to one another. The dendogram showed two main clusters, two sub-clusters and four minor sub-clusters. An artificial taxonomic key produced was found valuable for the identification of the thirteen families of ferns studied. Most of these ferns are perennials accumulating biomass while few are annuls. The ferns had different growth forms such as spreading, tangle and climbing. The agreement of the results of dendogram and scatter diagram showed that ferns form natural groupings with their close or distant relationships. The possession of tubers, rhizomes, gemmae and numerous spores by a fern species is an adaptation for effective distribution and dispersal.

INTRODUCTION

Homosporous leptosporangiate ferns belong to the Order Filicales, Class Pteropsida, Division Pteridophyta (Sporne, 1975) and widely distributed throughout the world especially in the tropics. Pteridophytes require water at least during sexual reproduction for their motile male gametes to swim to non-motile female gametes (Sporne, 1975). Pteropsida is the largest group of pteridophytes containing more than 10,000 species of ferns (Schooley, 1997) having very wide range

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of forms, structures and uses. Pteridophyte refers to vascular (tracheophyte) cryptogamic plants with independent gametophytes, known since Silurian or some 380 million years ago (Kartesz, 1994). Land plants are grouped into Bryophyta and Tracheophyta (Kenrick, 2000) but pteridophytes generally differ from bryophytes and seed plants in having both gametophytes and sporophytes as independent plants at maturity (Smith, 1955). In Nigeria, fern species occur abundantly in the high rainfall belt of the South (Odu and Opapeju, 1986). Pteropsida comprises woody tree ferns, walking, spreading, tangle and climbing ferns such as *Lygodium microphyllum* and filmy ferns with leaves just one cell thick and herbaceous ferns, the aquatic ones may be floating or rooted in water (Schooley, 1997). Pteridophytes occur and are most abundant in moist, montane and re-growth forest and habitats like road sides, streams and bare land where most species are shade-loving and epiphytic (Agnew, 1974).

A lot of ferns are edible e.g. *Ceraptoteris cornuta* serves as vegetables in North America (Camus *et al.*, 1991) with high nutrient value (Oloyede *et al.*, 2010). *Nephrolepis baserrata* (Sw). Schott was used as fodder to feed African dwarf goats due to its availability even during drought (Babayemi *et al.*, 2006) due to high nutrient value and low anti-nutrient contents (Oloyede *et al.*, 2008). *Asplenium* is used as laxative to treat chest infections while *Adiantum capillus-veneris* is used to cure ailments such as rickets, Asthma, snake bites, diseases of spleen, liver, breasts, kidneys, rickets, smallpox, centipede bites, cough and leprosy in West Africa (Camus *et al.*, 1991). In New Zealand, ferns are abundant features of every habitat and featured on their currency notes and national emblem (Patrick and John, 2000). Water ferns as weeds on the rivers may obstruct waterways making fishing difficult (Oloyede, 2008). In Florida State, climbing fern (*Lygodium mycrophyllum*) spreads rapidly becoming the State's worst invasive weed, producing numerous leaflets which spread fire during bush burning (American Research Service, 2004). There is little or scanty work on the taxonomy of ferns in Nigeria. Thus, this study would contribute to the elucidation of the missing gaps in the morphological and taxonomic relationships of the pteridophytes. This work is therefore designed to provide taxonomic re-evaluation of the group leptosporangiate ferns from Southwestern Nigeria.

MATERIALS AND METHODS

Study sites, Collection and Identification of samples

The vegetation zones mapped out for the collection of ferns are the humid forests, swamps, rain forest, derived savanna, re-growth forest, road sides and mountainous ecological locations in Southwestern Nigeria. Collection of fern families and genera available in this vegetation was done. This region is spread through Osun, Oyo, Ogun, Ondo, Ekiti and Lagos States between Latitudes 6° and 10° N and Longitudes 2° and 6° E (Fig. 1 and Table 1). Each accession was identified using IFE herbarium specimens and available Floras (Alston 1959; Agnew 1974).

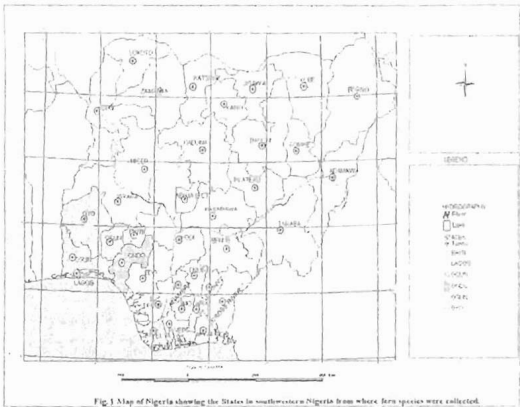

Fig.1. Map of Nigeria showing the States in Southwestern Nigeria where the fern species were collected

Statistical analysis

The qualitative characters such as stipe's colour, rhizome, ramenta, frond fertility, leaf, leaflet, hairiness and growth forms e.g. erect, tall, climbing, open, bushy and drooping were recorded and used to construct taxonomic key. Measurement of quantitative characters such as leaflet (length

and breath) cm, frond height (cm) and diameter (mm) were carried out using a meter rule. At least five leaflets were measured from five fronds per accession; this is because some fern plants have less than six fronds. The data obtained were recorded and coded for statistical analysis using Principal Component Analysis (PCA). This was done to find out whether differences or variations among them will be significant enough for their usage for taxonomic analysis of these ferns. The program used for the PCA is (SPSS) principal factoring of Kim (1970) package 12 and Past.exe. Dendogram and scatter diagram were drawn from the PCA using Var covariance.

This is to ascertain whether the relationships among them can aid fern classification and identification. The reproductive features such as spores, sporangia, arrangement of sori on the leaflets, presence or absence of indusia and position of sori on the leaflets were noted. The results were also used to construct artificial taxonomic key to ascertain the closely and distantly related species.

RESULTS

The results showed that ferns are terrestrials, aquatics, epiphytics, require moisture to survive

Table 1. List of families, genera and species of ferns studied

S/No	Families	S/No	*Genera*	S/No	Species
	Adiantaceae	1	*Adiantum*		*Adiantum capillus-verneris*
		2.	*Doryopteris*		*Doryopteris nicklesii*
		3	*Palleae*	3.	*Pelleae doniana*
				4.	*Pelleae rotundifolia*
		4	*Pityrogramma*	5.	*Pityrogramma calomelanos*
		5	*Pteris*	6.	*Pteris acanthoneura*
				7.	*Pteris artrovirens*
				8.	*Pteris burtonii*
				9.	*Pteris ensiformis*
				10.	*Pteris mildbraedii*
				11.	*Pteris vittata*
2	Aspidiaceae	6	*Tectaria*	12.	*Tectaria gemmifera*
3	Aspleniaceae	7	*Asplenium*	13.	*Asplenium barteri*
				14.	*Asplenium formosum*
				15.	*Asplenium nidus*
				16.	*Asplenium scolopendrium*
				17.	*Asplenium trichomanes*
				18.	*Asplenium unilateriale*
4	Nephrolepidaceae	8.	*Nephrolepis*	19.	*Nephrolepis biserrata*
				20.	*Nephrolepis cordifolia*
				21.	*Nephrolepis duffii*
				22.	*Nephrolepis exalta*
				23.	*Nephrolepis exaltata*
				24.	*Nephrolepis furcans*
				25.	*Nephrolepis undulata*
5	Denntaediaceae	9	*Pteridium*	26.	*Pteridium aquilinum*
6	Gleicheniaceae	10	*Gleichenia*	27.	*Gleichenia linearis*
7	Lomariopsidaceae	11	*Bolbitis*	28.	*Bolbitis gemmifera*
8	Parkiaraceae	12	*Ceratopteris*	29	*Ceratopteris cornuta*
9	Polypodaceae	13	*Microgramma*	30	*Microgramma oweriensis*
		14	*Phymatodes*	31	*Phymatodes scolopendria*
		15	*Platycerium*	32	*Platycerium angolense*
				33	*Platycerium stemaria*
10	Pteridaceae	16	*Coniogramme*	34	*Coniogramme pilosa*
11	Schizaeceae	17	*Lygodium*	35	*Lygodium japonicum*
				36	*Lygodium microphyllum*
12	Thylepteridaceae	18	*Cyclosorus*	37	*Cylosorus afer*
				38	*Cyclosorus striatus*
13	Vittariaceae	19	*Vittaria*	39	*Vittaria guiniensis*

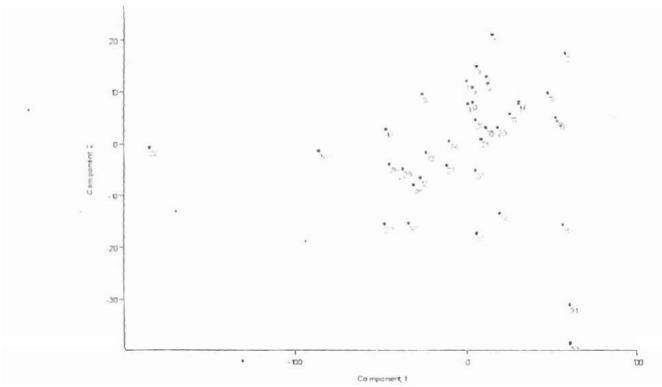

Fig 2. PCA Scatter Diagram using Var covariance

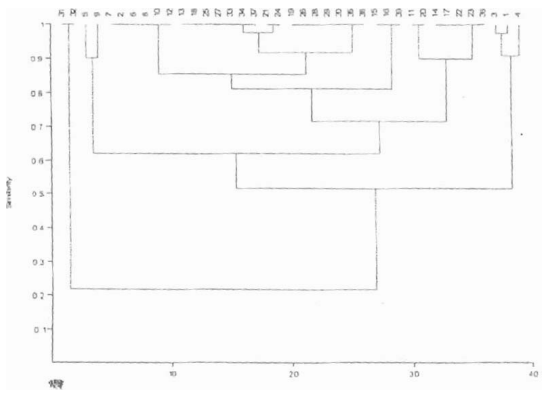

Fig. 3. Dendogram showing the relationship of fern species

and well distributed in dry and wet forests, regrowth and derived savanna ecological zones in Southwestern Nigeria. They grow well on road sides (*Nephrolepis biserrata*); fallowland (*Pityrogramm),* wet forest; waterfalls and springs e.g *Tectaria,* river banks, rock crevices and bare land. Majority of the terrestrial and aquatic ferns are taller, bushy and having heavier biomass than epiphytic ones. Table 1 shows the list of all the ferns species collected and used for this study.

Statistical analysis

The quantitative characters in Table 2 were used for the statistical analysis using PCA showed that there is significant difference in the parameters measured among the 39 fern species collected and studied. This shows that these fern species are different from one another based on these parameters: fronds length and diameter, leaflets length and breadth. The result of scatter diagram agreed with that of dendogram. Scatter diagram (Fig. 2) showed that the closer the species are, the more closely related they are to one another. (*Phymathodes scolopendria* and *Platycerium angolense)* are more closely related (both are epiphytes, lack leaflets, have broad compound leaves and bigger biomass) but are distantly related to *Lygodium microphyllum*, *Adiantum capillus-veneris and Doryopteris nicklesii*, which are very far away from them. The vegetative characters play very important role in the taxonomy of these fern species. Figure 3 shows the dendogram (obtained from Table 2) with two main clusters and two sub-clusters. This showed that all these 39 fern species can be grouped into two main clusters. The first main cluster comprises *Phymatodes scolopendria and Platycerium angolense* (Polypodiaceae), both are epiphytes with hairy rhizomes. They cluster to the highest level, showing that they are more closely related to one another than to other species. The second major cluster was further sub-divided into 2 sub-clusters. The first sub-cluster comprises *Palleae doniana, Adiantum capillus-veneris* and *Palleae rotundifolia (*Adiantaceae) which means that they are related in some parameters. The second sub-cluster comprises the remaining 34 fern species.

Different growth forms encountered

Climbing ferns: *Phymatodes scolopendria, Microgramma oweriensis* and *Vittaria guinensis, Lygodium microphyllum* and *L. japonicum* have stems modified for climbing tall trees and grow to indefinite height covering the whole tree trunk. Most of these species have erect fronds which become open or bushy and drooping at maturity as in *Nephrolepis exalta, N. exaltata, N. furcans, N. biserrata, N. cordifolia* and *Pelleae rotundifolia.* Tangle fern as in *Gleichenia linearis* is a network of leaf arrangement in which the leaves inter-woven with one another to form canopies. Some are erect and tall e.g. *Pteridium aquilinum* and *Tectaria gemmifera.* Those that become bushy at maturity and form colonies are *Nephrolepis exalta,*

Table 2. Quantitative Data of Morphological parts of fern species studied

S/No	SPECIES	Mean Frond Length(cm) ± S.E, N =5	Mean Frond Diameter(mm) ± S.E, N=5	Mean Leaf Length(cm) ± S.E, N=5	Mean Leaf Breadth (cm) ± S.E, N =5
1	*Adiantum capillus-veneris*	51.00 ± 2.92	1.40 ± 0.24	1.62 ± 0.14	1.60 ± 0.09
2	*Doryopteris nicklesii*	7.80 ± 0.66	1.20 ± 0.20	3.20 ± 0.58	1.74 ± 0.13
3	*Pelleae doniana*	60.40 ± 1.63	3.00 ± 0.00	9.60 ± 0.75	3.10 ± 0.40
4	*Pelleae rotundifolia*	54.60 ± 4.47	1.40 ± 0.24	0.74 ± 0.04	0.62 ± 0.08
5	*Pityrogramma calomelanos*	92.40 ± 3.06	6.60 ± 0.24	17.80 ± 1.02	4.28 ± 0.44
6	*Pteris acanthoneura*	66.00 ± 3.67	1.40 ± 0.24	10.80 ± 1.24	4.32 ± 0.29
7	*Pteris artrovirens*	62.00 ± 2.55	3.60 ± 0.24	11.20 ± 1.85	3.92 ± 0.33
8	*Pteris burtonii*	50.00 ± 3.54	1.20 ± 0.20	6.50 ± 0.45	1.34 ± 0.12
9	*Pteris ensiformis*	60.60 ± 2.87	3.60 ± 0.24	12.20 ± 1.02	2.80 ± 0.12
10	*Pteris mildbraedii*	63.80 ± 1.77	2.20 ± 0.20	11.60 ± 0.75	3.52 ± 0.22
11	*Pteris vittata*	34.00 ± 1.87	1.20 ± 0.20	8.60 ± 0.60	1.30 ± 0.15
12	*Tectaria gemmifera*	93.20 ± 1.85	3.80 ± 0.12	35.40 ± 2.04	7.40 ± 0.75
13	*Asplenium barteri*	17.20 ± 1.16	1.18 ± 0.11	1.90 ± 0.09	1.38 ± 0.16
14	*Asplenium formosum*	34.40 ± 1.72	1.30 ± 0.15	4.14 ± 0.07	0.58 ± 0.04
15	*Asplenium nidus*	12.60 ± 1.17	2.62 ± 0.42	6.36 ± 0.18	3.50 ± 0.22
16	*Asplenium scolopendrium*	11.00 ± 1.14	1.22 ± 0.17	6.60 ± 0.81	1.72 ± 0.12
17	*Asplenium trichomanes*	34.00 ± 1.87	1.16 ± 0.12	1.17 ± 0.10	2.08 ± 0.05
18	*Asplenium unilateriale*	53.40 ± 4.53	1.20 ± 0.14	8.80 ± 1.02	2.18 ± 0.23
19	*Nephrolepis biserraia*	112.00 ± 8.00	3.26 ± 0.31	12.20 ± 0.80	2.10 ± 0.08
20	*Nephrolepis cordifolia*	59.20 ± 2.42	1.26 ± 0.10	3.80 ± 0.34	0.50 ± 0.03
21	*Nephrolepis dufii*	56.00 ± 1.87	2.16 ± 0.12	8.80 ± 0.73	2.16 ± 0.12
22	*Nephrolepis exalta*	53.00 ± 3.00	1.30 ± 0.18	3.36 ± 0.21	0.72 ± 0.07
23	*Nephrolepis exaltata*	46.00 ± 1.87	1.20 ± 0.11	1.28 ± 0.58	0.52 ± 0.07
24	*Nephrolepis furcans*	74.40 ± 3.14	1.20 ± 0.11	6.80 ± 0.34	1.200 ± 0.11
25	*Nephrolepis undulate*	88.00 ± 3.74	1.12 ± 0.08	10.00 ± 0.71	2.12 ± 0.06
26	*Pteridium aquilinum*	59.00 ± 10.77	4.20 ± 0.58	12.00 ± 0.84	4.16 ± 0.08
27	*Gleichenia linearis*	76.00 ± 4.85	2.24 ± 0.13	10.60 ± 0.87	2.36 ± 0.15
28	*Bolbitis gemmifera*	101.60 ± 3.31	3.26 ± 0.31	12.20 ± 0.80	2.10 ± 0.08
29	*Ceratopteris cornuta*	109.00 ± 9.27	4.92 ± 0.41	6.80 ± 0.34	2.72 ± 0.27
30	*Microgramma oweriensis*	150.00 ± 16.12	2.28 ± 0.12	4.42 ± 0.24	1.76 ± 0.20
31	*Phymatodes scolopendria*	4.20 ± 0.20	3.80 ± 0.20	41.00 ± 1.18	14.20 ± 0.66
32	*Platycerium angolense*	4.20 ± 0.37	3.64 ± 0.21	54.00 ± 2.92	5.20 ± 0.80
33	*Platycerium stemaria*	58.00 ± 3.39	2.26 ± 0.16	19.00 ± 1.95	12.40 ± 1.17
34	*Coniogramme pilosa*	44.00 ± 1.70	2.12 ± 0.24	11.60 ± 0.75	4.00 ± 0.55
35	*Lygodium japonicum*	248.00 ± 13.90	1.36 ± 0.15	3.94 ± 0.31	1.16 ± 0.12
36	*Lygodium microphyllum*	94.00 ± 1.87	1.28 ± 0.12	2.90 ± 0.12	0.98 ± 0.13
37	*Cylosorus afer*	111.00 ± 11.00	3.80 ± 0.12	15.80 ± 1.91	4.38 ± 0.16
38	*Cyclosorus striatus*	97.00 ± 6.63	3.20 ± 0.25	13.40 ± 0.51	2.78 ± 0.10
39	*Vittaria guiniensis*	6.00 ± 0.00	2.38 ± 0.19	5.80 ± 0.49	3.00 ± 0.32

N. exaltata and *Cyclosorous afer. Ceratopteris cornuta* has succulent fronds while those with rosettes, having fronds that are well spreads forming open morphotype are *Pteris vittata and Asplenium barterii.* The three groups of epiphytes encountered are climbers with long creeping, hairy, rhizome e. g. *Vittaria guinensis, Microgramma oweriensis* and *Phymatodes scolopendria.* The second group comprises non-climbers with short, erect rhizomes e. g. *Platycerium angolense* and *P. stemaria.* The third group is non-climber *Nephrolepis undulata* with short, erect to sub-erect, tuberous, perennial rhizomes with few fronds, small-sized leaflets which grows as pendent plant, forming colonies on the host plant (phorophyte). The major reproductive features encountered include sori which are made up of aggregation of five or more sporangia which contain the spores. The sori are found on the abaxial surfaces of the leaflets. Indusium is a structure that covers the sorus when present.

Table 3. An artificial Taxonomic key to the families of homosporous leptosposangiate ferns in Southwestern Nigeria

1a	Leaf venation reticulate											
	2a.	Rhizome short										
		3a.	**Sporan**gia long-stalked; leaf broad, apex obtuse, emarginate ----------									Polypodiaceae
		3b.	Sporangia short-stalked; leaf apex acute to acuminate ----------									Parkiaraceae
	2b.	Rhizome long										
		4a.	Leaf dimorphic, unipinnate, ovate, linear, gemmae present----------									Vitteraceae
		4b.	Leaf monomorphic, linear-lanceolate, gammae absent ----------									Thelypteridaceae
			5a.	sporangia long-stalked								
				6a.	Leaf unipinnate to bipinnate, gemmae absent----------							Nephrolepidaceae
				6b.	Leaf unipinnate only, gemmae present----------							Asplenaceae
			5b.	sporangia short-stalked								
				7a.	Leaf compound, sori arranged on the margin----------							Aspidiaceae
				7b.	Leaf simple, sori arranged on the veins----------							Lomariopsidaceae
					8a.	Leaf compound, sori arranged on the midrib----------						Adiantaceae
					8b.	Leaf compound, sori arranged on the vein----------						Pteridaceae
1b.	leaf venation free					9a.	Indusium present, reniform, leaf tripinnate ----------					Dennstaedtiaceae
						9b.	Idusuim absent					
							10a.	Stem erect, leaf tripinnate, tangle----------				Gleicheniaceae
							10b.	Stem modified for climbing, leaf unipinnate----------				Schizaceae

DISCUSSION

Variations in the quantitative and qualitative aspects of the vegetative characters are very high and have taxonomic value for the identification of these ferns. In most cases these variations overlap as in Illoh and Olorode (1991). There is little or no significance variation in hairs, scales and ramenta. All the plant species used in this work are homosporous leptosporangiatè ferns (Alston 1959, Agnew, 1974; Sporne, 1975). The differences in the sori arrangements, shapes, quantities and presence or absence of stalk on the sporangia in some ferns are of taxonomic values and are useful in separating large numbers of ferns.

Most of the variations seen are due to their habitat preferences and water requirements (Babayemi *et al.*, 2006). The result from this study shows that the epiphytic ferns are not as tall, bushy and strong in strength as the terrestrial ones in the humid and aquatic areas. This is because they have limited access to water and nutrients. Whereas the terrestrial fern such as *Pteridium aquilinum* is tree-like while *Tectaria germifera*, *Gleichinia linearis* and *Nephrolepis biserrata* are giant ferns encountered in this study. The aquatic ferns like the genus *Cyclosorus* form giant very tall fronds since it has free access to water and adequate supply of nutrients. Through PCA, all these plants were grouped together based on the taxonomic relationships they share in common or they have differently. The dendogram reveals that the *Nephrolepis* species are closely related because of the characters (such as venation patterns, sori arrangements, presence of indusia, sporangia long stalked, stipes reddish brown and compound unipinnate leaves) that they have in common. In the second sub-cluster which is contained in the remaining 34 species, four minor sub-clusters would be highlighted. The first minor sub-cluster comprises *N. duffii* and *N. furcans* which are related in some

parameters like tufted fronds and unipinnate leaflets. The second minor sub-cluster is made up of *Asplenium formosum, A. trichomanes, N. exalta, N. exaltata* and *Microgramma owerensis*. They are also closely related (expect *Microgramma owerensis* which is an epiphyte) due to some characters they share in common e.g. *A. formosum and A. trichomanes belong to the same genus and family (Adiantaceae) with* shinning leaves. *N. exalta* has both unipinnate, fertile leaflets and bipinnate leaf type with sterile, curled leaflets on the same plant, *N. exaltata* has only bipinnate sterile, curled leaf while *N. duffi* has unipinnate with sterile, curled leaflets. *N. furcans* has peculiar morphological characters that further separated it from the others. It has lemon and near-white colours on the same plant, thus it is called lemon or albino fern. The leaflet is simple and broad with emarginate apex having been deeply cut dichotomously. Each of these two apices has acute to acuminate apex either separately or together. At times one of the acute or acuminate apices may further cut dichotomously again. Each of these apices still forms acute to acuminate type. *N. undulata* also has peculiar, distinguishable attribute in the possession of tuber on its rhizome. This tuber is a good survival attribute that can tolerate long drought and bush burning. It is also a good means of propagation as new fern plants sprout out from it from onset of rainfall.

The third minor sub-cluster comprises *Pteris artrovirens, P. acanthoneura, P. burtonii* and *P. ensiformis*. They have common characters like serrated leaf margins, elongated sori arrangements, glabrous crozier, polished stipes, short, erect rhizome and hard leaflet texture. The fourth minor sub-cluster comprises *Asplenium nidus, A. scolopendria* and *Vittaria guinensis* with slightly succulent fronds having simple leaves, the first two belongs to the same genus and the same family (Aspleniaceae). There are some rare, special or uncommon distinguishing characters in some fern accessions collected for this study. In the genus *Nephrolepis* for example, propagation is mainly through the spores but new offspring's sprout easily and readily from the tubers when present e.g. *N. undulata* and from the tips of the stolons. This enhances their spreading, distribution, survival, preservation and formation of colonies. Leaflets in *Asplenium trichomanes* and *Adiantum capillus-veneris* have petioles which is very uncommon among ferns. Viviparous activity recorded in *Ceratopteris cornuta, Asplenium barterii, A. trichomanes, Tectaria gemmifera* and *Bolbitis gemmifera* is the ability to produce young ones alive from the parent plants instead of going through the spores and prothalli. This is not common in other 34 ferns species even not among Gymnosperms and heterosporous pteridophytes. This has a lot of advantages in that the gemmae are produced on the leaves at anytime of the year once there is enough moisture to sustain them. They produce fernlets which drop on the soil as young fern plants. *Ceratopteris cornuta* also has ability to live successfully producing fibrous roots in water and on moist or wet land. This is referred to as amphibian mode of life. Variations in the quantitative aspects of the vegetative features are of diagnostic importance such that high relevance and emphasis can be placed on them for fern taxonomic evaluation.

The vegetative, reproductive and habitat features of these ferns are also useful in proposing the taxonomic key (Table 3) for the thirteen families observed in this work as in (Alston 1959; Agnew 1974; Kato and Price 1990) for ferns and (Singh 1968; Olorode 1984) for flowering plants. The significance of some valuable vegetative characters, growth forms, growth duration and habitat preferences are as follows. Long-creeping rhizome contains more fronds, more leaflets and subsequently more sori (if fertile). Fronds were widely spaced and create room for rapid growth and development since it reduces competition for both sunlight and soil nutrients. Thus, the healthier, bigger and longer the rhizome is, the more the number of fronds it can accommodate and thus, more sori can be produced on the leaflets. Habitat is an important character because when the habitat is favourable, the frond length is correspondly long, strong and viable. *Nephrolepis undulata*, a non-climber epiphyte, is the only one with rhizomatous tuber encountered in this study. The aerial biomass (frond) is annual while the underground biomass (the tuber) is perennial. It is able to survive annual bush burning and long drought with this tuber which is covered by the substratum. New fronds sprout out from this tuber

with onset of raining season. Leaf and leaflet size and texture are other valuable vegetative features. The hard leaflets textures of majority of these ferns such as *Cyclosorus* and *Pteris* species protect them from destructive herbivores (Hendrix, 1980).

Sorus is a valuable reproductive feature in the life of a fern being the aggregation of sporangia containing and preventing spores from loose attachment to the leaves or leaflets and from being blown off by the prevailing winds before maturity. The dispersal of numerous mature, viable spores help in the distribution of these ferns even beyond their ecological localities. Indusium, when present tends to protect the sori from mechanical injury, herbivores attack and destructive winds. Hairiness, scales and ramenta are some of the valuable vegetative characters of ferns observed in this study. Hairs are found on the leaves, leaflets, fronds, croziers and rhizomes. Ramenta are restricted to the lower part of the stipes just above the rhizome. Scales are found mainly on the rhizomes. Some of these structures have conspicuous colours such as brown, dark brown, red or black that tends to reduce herbivores attack on these ferns, thus, ferns become less attractive for herbivores to exploit (Hendrix, 1980).

Ferns have various modifications of their fronds for specific growth habit and for adaptation to their ecological environments. This study showed that some of these ferns have succulent rhizomes (stems), fronds, leaves and leaflets e.g. *Ceratopteris cornuta* and *Vittaria guinensis*. One major importance of this is the ability to store water for use during adverse ecological conditions. Results showed that two wet terrestrial ferns (*Lygodium microphyllum* and *L. japonicum*) have long, indeterminate growth with stems modified for climbing tall trees. They produce numerous leaflets covering the entire phorophytes (ARS, 2004). Three epiphytic climbers encountered in this study are *Phymatodes scolopendria, Microgramma oweriensis* and *Vittaria guinensis* and with ability to climb tall trees, attack by the herbivores is reduced. The perennial ones grow years to years accumulating biomass unless physically removed while very few are annuals. Due to their rapid growth, they are able to colonize bare land easily, reaching maturity within very short periods. The result also showed that habitat has major effects on the spreading, growth and development, distribution as well as reproductive potentials of ferns. Out of the 39 fern species collected and studied in this work, about 83% are wet terrestrials and aquatics while about 17% are epiphytes. This is similar to (Sporne, 1975) that the survival of fern depends largely on the availability of water. 27 species of ferns investigated are potential ornamental plants but 13 of them are still in the wild yet to be utilized as horticultural plants in Southwestern Nigeria. Thus, collection (Adebooye and Opabode, 2004), identification, cultivation for economic purposes, food value, elemental composition, research studies and to bring them to lime light for further studies is essential.

The findings in this work showed that ferns can tolerate wide ecological conditions in as much as moisture is available to sustain the gametophytes which lack cuticle, can easily lose water and dehydrated. There is therefore a need for constant supply of water to maintain this fragile stage in the life of a fern. The possession of rhizomes of various type, tubers, gemmae, numerous light spores and indusia to protect the spores by a fern species is a survival strategies and an adaptation for effective distribution and dispersal. This study is an attempt to improve the interest in the study of pteridophytes in Southwestern Nigeria. The results of scatter diagram and dendogram showed usefulness of quantitative analysis in species differentiation of ferns studied. Vegetative and reproductive characters are also taxonomically important in separating fern species. Therefore, grouping of fern species should be done with a combination of vegetative and reproductive characters to produce a reliable taxonomic estimation.

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