

## SURVEY OF ORNAMENTAL FERNS, THEIR MORPHOLOGY AND USES FOR ENVIRONMENTAL PROTECTION, IMPROVEMENT AND MANAGEMENT.

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### ABSTRACT

A survey of ornamental ferns with potentials for environmental protection, improvement and management was conducted at Obafemi Awolowo University, Ile-Ife, Nigeria and villages around it between 2008-2012. The collections were characterized morphologically. This was with a view to creating awareness of the importance of ornamental ferns for environmental management and economic values. Ferns were collected from humid forest, rainforest and re-growth forest vegetation zones, open bare land, around homes, offices and road sides. All the ferns collected were raised at the Department of Botany, OAU, Ile-Ife. Morphological, reproductive and growth parameters were observed, documented for their ornamental values and for their relevance in environmental protection, improvement and management. The result showed that there were a lot of variations in the shape and type of apex, frond length and diameters; leaflet texture, size and shapes in all the ferns studied. There were little variations in the structures of rhizome except in *Phymatodes scholopendria* with long-creeping, climbing, succulent rhizome. The only leaflet with petiole was found in *Adiantum veneris-capillus*. They have shoot and root biomass which are directly involved in checking wind and soil erosion by covering and holding soils together. These ornamental ferns were found to have much value for landscaping and aesthetic purposes but they were found in few villages with little or no attention. There is very little awareness of their use for ornamental purposes, environmental protection, improvement and management in this region.

**Keywords:** Environmental Management, Morphological Studies, Ornamental Ferns.

### INTRODUCTION

Ornamental plants are plants that are grown for decorative purposes in gardens and landscape design projects such as house plants for their beautiful flowers. They are grown for the display of aesthetic features like flowers, leaves, scent, overall foliage texture and fruit; the purpose of which is for the enjoyment of gardeners, visitors and the public. The beauty of offices of corporate organisations like banks, industries, schools, shopping complexes and religious buildings are enhanced by the ornamental plants such as ferns, flowers of different varieties, shrubs and trees planted within their surroundings. This has, therefore, made the demand for ornamental plants to be on the increase (Website 1).

Ferns are widely distributed throughout the world especially in the tropics and in Nigeria (Oloyede and Odu, 2011). Ferns and fern allies belong to the order Filicales. They are homosporous leptosporangiate pteridophytes, seedless (cryptogamic), flowerless, vascular plants found mostly in the humid areas. They require water to grow, survive and at least during sexual reproduction for male gamete to swim to the non-motile female gamete (Sporne, 1975). They can be

perennial, annual, terrestrials, aquatics or epiphytes (growing on the tree trunks, walls, dead wood or rock crevices). Their stems are called rhizomes; fronds are made up of leaflets arranged oppositely or alternately on the rachis. Sori containing numerous tiny spores are found on the abaxial surface of the leaflets. In ferns, the leaflets are referred to as pinnae with or without petiole while fronds petioles are called stipes. Growth pattern is described in terms of frond position as erect, open, drooping or bushy. A lot of ferns have medicinal values for treating various diseases (Powell, 1976; Camus *et al.*, 1991; Christensen, 1997). Majority of them are edible, some are used for feeding domestic animals (Babayemi *et al.*, 2006) because they are nutritious plants with low levels of oxalate and cyanide (Biplab and Subir, 2007; Oloyede *et al.*, 2008; Oloyede *et al.*, 2010). In New Zealand, one is highly impressed by ornamental ferns which are found on the national emblem, bank notes and coins (Patrick and John, 2000). The business of setting up ornamental gardens has become quite relevant in today's business environments. Some natural

factors causing environmental degradation include drought, fire (Baiyewu *et al.*, 2005), clearing of land, erosion from heavy rainfall and

winds. The continuous environmental degradation could be attributed to increase in population size, ignorance and mismanagement of plant resources. Environmental problems such as deforestation, desertification and decline of soil fertility due to overcropping, overgrazing and urbanization are direct effects of human activities.

Ornamental plants add beauty to the stadia for spot activities such as football, table tennis, lawn tennis and athletics (Ugberugbhe, 1997). They have wide spectrum of uses in environmental management; the most obvious among them are landscape, aesthetic, control of wind and water erosion, they also serve as sources of income to the people. Ornamental plants also provide attractive environments for human enjoyment. Few places in Nigeria where ornamental plants have been used for environmental improvement are Lucky Fibres and Cheveron in Lagos and International Institute for Tropical Agriculture (IITA) Ibadan.

Ferns are neglected, less cultivated, underutilized, unrecognized plants and there is lack of awareness of the importance of ferns as ornamental plants and for environmental management in Nigeria. This work was therefore designed to provide detailed information on the position and morphology of ferns and prospects of using ornamental ferns for environmental protection, improvement and management in Nigeria.

#### MATERIALS AND METHODS

Fern species were collected from different vegetation zones within the estate of the Obafemi Awolowo University, Ile-Ife which is made up of rainforest, re-growth, derived savanna and swampy vegetations. Possible ornamental ferns of all the families and genera available in this region were collected using cutlass and hoe from 2008 to 2012. Identification was done using IFE herbarium specimens and available Floras (Alston,

1959; Agnew, 1974). For further studies, each of the eight fern species was planted in pots at the Department of Botany, OAU, Ile-Ife. Morphological features that can disappear in transit e.g. stipe's colour, hairiness, texture; growth forms such as erect, tall, open, bushy and drooping were recorded on the field. Vegetative characters such as rhizome; crozier; ramenta; frond fertility; leaflet shape, type, petiole and arrangement; apex type and shape were recorded. Quantitative measurements were done using metric rule for frond length and diameter, leaflet length and breadth as shoot biomass while root biomass was also studied so as to ascertain their ability to hold soil against erosion. Reproductive structures such as spores, sporangia, arrangement of sori on the leaflets, presence or absence of indusia and points of attachment of sori on the leaflets were also recorded.

#### RESULTS

A total of eight species of ornamental ferns were collected for this study (Table 1). Ornamental ferns were found to be very few on this campus and scanty among the ornamental plants in few places within the campus. All the fern species collected for this study are terrestrials except *Phymatodes scolopendria* which is epiphytic. The measurements of some morphological attributes are shown in Table 2. The vegetative and reproductive features observed and recorded in each of the eight fern species studied are as follows:

##### 1. *Adiantum capillus-veneris* (Plate 1a)

It is a terrestrial, perennial, deciduous, medium-sized, herbaceous plant growing well on the soil in the semi-forest or derived savanna. Its fronds are erect, tall, solid without nodes, polished brown towards the top but become black at the middle and towards the lower parts. The fronds possess dichotomous branches and compound unipinnate leaves. The fronds are fertile with scattered, small sized, elongated sori arrangements on the abaxial

**Table 1: List of Families, Genera and Species of Ferns Studied.**

S/No	Families	S/No.	Genera	S/No.	Species
1	ADIANTACEAE	1	<i>Adiantum</i>	1	<i>Adiantum capillus-verneris</i>
		2	<i>Pteris</i>	2	<i>Pteris ensiformis</i>
				3	<i>Pteris acanthoneura</i>
				4	<i>Pteris vittata</i>
2	NEPHROLEPIDACEAE	3	<i>Nephrolepis</i>	5	<i>Nephrolepis exalta</i>
				6	<i>Nephrolepis exaltata</i>
				7	<i>Nephrolepis furcans</i>
3	POLYPODACEAE	4	<i>Phymatodes</i>	8	<i>Phymatodes scolopendria</i>

**Table 2: Quantitative Data of Morphological Parts of Fern Species Studied.**

S/No.	Species	MFL. (Cm) ± S.E	M FD. (Cm) ± S.E	MLL. (cm) ± S.E	MLB. (cm) ± S.E
1	<i>Adiantum capillus-veneris</i>	51.00 ± 2.92	1.40 ± 0.24	1.62 ± 0.14	1.60 ± 0.09
2	<i>Pteris acanthoneura</i>	66.00 ± 3.67	1.40 ± 0.24	10.80 ± 1.24	4.32 ± 0.29
3	<i>Pteris ensiformis</i>	50.00 ± 3.54	1.20 ± 0.20	6.50 ± 0.45	1.34 ± 0.12
4	<i>Pteris vittata</i>	34.00 ± 1.87	1.20 ± 0.20	8.60 ± 0.60	1.30 ± 0.15
5	<i>Nephrolepis exalta</i>	53.00 ± 3.00	1.30 ± 0.18	3.36 ± 0.21	0.72 ± 0.07
6	<i>Nephrolepis exaltata</i>	46.00 ± 1.87	1.20 ± 0.11	1.28 ± 0.58	0.52 ± 0.07
7	<i>Nephrolepis furcans</i>	74.40 ± 3.14	1.20 ± 0.11	6.80 ± 0.34	1.200 ± 0.11
8	<i>Phymatodes scolopendria</i>	4.20 ± 0.20	3.80 ± 0.20	41.00 ± 1.18	14.20 ± 0.66

MFL=Mean frond length, MFD=Mean frond diameter, MLL=Mean leaflet length, MLB=Mean leaflet breadth



(a)



(b)



(c)



(d)



(e)



(f)

#### Plate 1. Plant Forms and Habits

a: *Adiantum capillus-veneris* as ornamental plant at the Department of Botany, OAU, Ile-Ife.

b: *Pteris acanthoneura* growing in wet forest at Reforestation Nurssery, Botany Department, OAU, Ile-Ife.

c: *P. ensiformis* growing as ornamental plant at the Department of Botany, OAU, Ile-Ife.

d: *P. vittata* growing as ornamental plant at the Department of Botany, OAU, Ile-Ife.

e: *Nephrolepis exalta* as ornamental plant at the Department of Botany, OAU, Ile-Ife.

f: *N. exaltata* as ornamental plant at the Department of Botany, OAU, Ile-Ife.



surface. Indusia present, cover the sori but there is no ramenta. Leaflets are leathery, hard in texture, entire (smooth) margins, with polished brown petioles and obtuse (round) apex. The fronds are drooping at maturity while the leaflets form canopy that covers the soil. It has fibrous root system, closely arranged together, very close to the soil surface and able to hold soil particles together. Propagation is through the rhizome and the spores.

#### 2. *Pteris acanthoneura* (Plate 1b).

It is a terrestrial, perennial, medium-sized, evergreen, herbaceous plant that grows on the soil in moist forest, derived savanna, re-growth or secondary forest. Its fronds are erect, tall (able to check wind erosion), polished brown stipes (petioles) and compound unipinnate leaves. Leaflets are coarse, hard, deeply serrated margins, acute/acuminate apex with sori on the abaxial surfaces. Indusia present, cover the sori while ramenta covers the base of the frond. The shape of the apex, the forked base and margins of the leaflets are added advantages to its beauty. The size and arrangements of the leaflets form a good cover over the soil surface while the fibrous root arrangements form good system for holding soil particles together (Plate 1b). Propagation is by the rhizome and the spores.

#### 3. *Pteris ensiformis* Burm, FL. (Plate 1c).

It is called silver lace fern or slender brake fern. It is a terrestrial, perennial, medium sized, shade-loving, herbaceous plant with glabrous crozier, erect rhizome and glabrous polished brown stipes. It grows on the soil and pots. The fronds are erect, fertile, moderately tall, drooping but become bushy at maturity. The leaflets are coarse, hard, leathery, forked, serrated margins, silver lace, linear to linear lanceolate pinnules, greenish with middle or central white colour and acute/acuminate apex. There are elongated sori arrangements on the abaxial surface of the pinnules. Indusia present, cover the sori but there is no ramenta. The shoot biomass covers the soil from excessive heat of the sun. The fibrous root system with light biomass is able to hold soil particles together. It grows on the soil with minimal moisture in re-growth forest. Propagation is by the spores and from the rhizomes.

#### 4. *Pteris vittata* Linn. (Plate 1d).

It is a native of China, so it is commonly called Chinese ladder brake fern for the step ladder-like appearance of its fronds. It is a terrestrial,

perennial, evergreen, short, herbaceous plant with rosette (open) growth morphotype. Rhizome, crozier and stipes are heavily hairy; ramenta present at the lower end of the fronds. Rhizome is erect, fronds are erect, spreading or open, drooping with hairy rachis, leaf is compound unipinnate while leaflets are linear with the longest at the tip of the frond. Leaflet margin is entire (smooth) with acuminate apex and hairy mid-rib (coasta). Sori are elongated on the abaxial surface pinnae. Indusia present, cover the sori, ramenta present as white hairs towards the base of the fronds. Shoot biomass covers the soil while root biomass holds the soil firmly. It grows on the soil and dead wood in wet forest while propagation is by the spores and rhizomes.

#### 5. *Nephrolepis exalta* (Plate 1e).

Its common names are Boston fern and Boston sword fern. It is a terrestrial, perennial, short, evergreen, herbaceous fern with curled leaflets. Rhizome is glabrous, erect with long creeping stolons; stipe is polished shining black without ramenta and indusium. Fronds are sterile, short, erect and bushy with bipinnate leaves. There are curled leaflets capable of covering the top soil. It grows well on the soil in the wet forest, re-growth forest, derived savanna vegetations and inside the pot. The fibrous root system with heavy biomass is able to hold more soil particles together for prevention of soil erosion. Propagation is from the tips of the stolons and rhizomes.

#### 6. *Nephrolepis exaltata* (Plate 1f).

Its common name is rabbit's foot fern. It is a terrestrial, perennial, medium-sized, deciduous, herbaceous fern, grows on the soil and inside the pot. Rhizome is short and is sub-erect. Fronds are erect, sterile, drooping and bushy at maturity. Leaf is either compound unipinnate or bipinnate or both on the same plant. The unipinnate leaf has linear leaflet with acute apex and flat, glabrous lamina. Some of these leaflets may become bipinnate at maturity. The leaflets of bipinnate leaf are short, curled and finely toothed with short acute apices. Stipe is polished brown without ramenta and indusium. Its root biomass is good in holding soil particles together while the leaflets of the drooping fronds provide effective covering of the top soil. Propagation is very rapid through the stolons and rhizomes.

#### 7. *Nephrolepis furcans* (Plates 2a & b).

It is called lemon button fern because its leaflets are lemon color. It is a terrestrial, perennial, medium sized, herbaceous fern; it grows well on

the soil in re-growth forest and inside the pots at homes and offices. Rhizomes and croziers are erect and glabrous while ramenta are found at the lower part of the fronds. Their fronds are strong, tall, erect, drooping and become bushy at maturity. Leaf is compound unipinnate, leaflets are broad, glabrous, evergreen, lemon to light green color

leaflets with entire margins and suitable as plant cover; apex is emarginate i.e dichotomously branched into two forming either acute or acuminate or both on the two apices (Plate 2c). Stipes are polished brown and reniform indusium present. Sori are found on the abaxial surface of the leaflets (Plate 2d).



(a)



(b)



(c)



(d)

Plate 2. Plant Forms and Habits.

a & b. *Nephrolepis furcans* as ornamental plants at Botany Department, OAU, Ile-Ife.

c: A pinna (leaflet) of *N. furcans* showing emarginate, acute & acuminate apices.

d. *N. furcans* showing beautifully arranged sori on the abaxial surface of a pinna.



There is fibrous root system with long, compact roots forming heavy biomass capable of holding soils together. The heavy shoot biomass of drooping fronds provides effective covering of the soil particles. Propagation is by the spores, rhizomes and tips of the stolons.

8. *Phymatodes scolopendria* (Bunm. F.) Ching. (Plates 3b & c).

It is called golden rod fern or wart fern. It is epiphytic, perennial, climber; medium-sized herbaceous fern growing on the palm tree or wood in wet shaded forest or secondary forest naturally but become terrestrial as a cultivated potted plant. It was collected from the top of a palm tree at the research farm at OAU, Ile-Ife. Rhizome is green but becomes dark brown at maturity, long-creeping, subterranean, fleshy to succulent, covered with scattered numerous brownish peltate or clathrate scales. Fronds are deeply pinnatifid, glabrous and fertile with simple biforked shining leaves. Leaflets are scattered on the long rhizomes, margin is forked, entire; lamina is ovate, apex is

acute to acuminate. Sori are large, brown, round, oval or elliptic, sunken inside the lamina in four rows and on the veins on the abaxial surface of the leaflets near the apex; sporangium present but has no stalk. Indusium present while brownish ramenta are found at the base of the fronds. Stipe is polished brown and is as long as half of the frond in length; propagation is through the spores and from the rhizomes.

## DISCUSSION

In ferns, variations in the vegetative features are good diagnostic characters for separating and delimiting species. The differences in the sori arrangements, sizes, locations, presence or absence of stalk on the sporangia in ferns have taxonomic values (Oloyede and Odu, 2011). Being perennial, they are able to build heavy shoot biomass that are good for aesthetic, medicinal and food values and have potentials for environmental improvement and protection. The height



(a)



(b)



(c)

Plate 3. Plant forms and habits.

a: *Phymatodes scolopendria* showing beautifully arranged sori on the abaxial surface of pinnule.

b: *Phymatodes scolopendria* as an ornamental plant.

c: *Phymatodes scolopendria* growing on the palm tree (porophyte) as an epiphyte at research farm, OAU, Ile-Ife.

of the fronds, the shape of the crowns and the canopies of these ferns have attractive potentials and are capable of checking wind erosion and dust from our environments. They are cover crops/plants protecting the ground and top soils from overheating by the sun thereby preventing soil microorganisms from death or migration to some other conducive environments. As terrestrial plants, they can be planted directly on the soils or inside the pots in our houses, beside the roads, lawns and gardens for decorations and aesthetic values just as reported by Patrick and John (2000) that in New Zealand, ornamental ferns are the abundant features of every habitat. The presence of ramenta; hairs; hard, leathery leaflet texture prevent attacks by the herbivores (Moon and Pal, 1949) thereby creating long life and ability to produce more, heavy shoot biomass over the years. The root biomass that is able to hold more soils together also prevents soil erosion, percolation and leaching as part of the environmental improvement, protection and management.

*Phymatodes scolopendria*, an epiphyte with forked leaflets and neatly arranged brownish sori on the abaxial surface (Plates 3a) brings beauty to the host tree and the environment when planted around homes. The brownish coloration of the fronds and young leaflets of *Adiantum capillus-veneris* with round apex and polished stipe adds beauty to the environment. Even, its dried fronds are good for decorations at homes and offices. *Pteris ensiformis* is called silver lace fern for the lovely lace-like textures of its fronds (Nelson, 2000); the central white coloration surrounded with green/greenish blue edges on its leaflets also brings beauty to its/our environments. The rosette (open) growth form of *Pteris vittata*, the step ladder-like appearance of its fronds, the arrangement of the sori; the covering of the rhizome, crozier, rachis and stipes with whitish colored long hairs add more beauty to the environment. Its hyperremediation of arsenic is an added advantage to the improvement of arsenic contaminated soil and water in our environments (Bondada and Ma, 2003). The finely toothed, curled, glabrous leaflets of both *Nephrolepis exalta* and *N. exaltata* always add glamour to the beauty of the environments around offices and homes. In *Nephrolepis furcans*, the leaflets are lemon to light green color, glabrous, broad and bushy giving effective covering to the soil and for aesthetic values. The

most fascinating features of *N. furcans* are the beautifully arranged sori on the abaxial surface of its pinnae (Plate 2d), dichotomously branched apex to form emarginate (being forked) which further branched dichotomously forming acute, acuminate or both (Oloyede and Odu, 2011).

*Adiantum capillus-veneris* have obtuse (round) apex, its leaflets are round in shape with petioles which are rare among homosporous ferns. *P. vittata* have linear leaflets with acute to acuminate apex, the terminal leaflet is usually the longest among the leaflets while the stems (rhizomes) are erect, sub-erect and hairy. The terrestrial ferns that have roots in wet soils have direct access to more nutrients; enhance proper growth and healthy fronds causing high reproductive ability (Oloyede *et al.*, 2011). The only epiphytic fern encountered in this study, *Phymatodes scolopendria* is a climber, found on *Elaeis guineensis* also proves to be good for ornamental purposes. The size, oval shaped, shining, brownish, well arranged sori on the pinnae are sure evidence of its ornamental potentials. The brownish, succulent, fleshy rhizomes with scattered short hairs add more to its aesthetic values. It has long, creeping succulent, subterranean rhizome usually covers by the substrata for preservation during the dry season.

The result showed that variations in the qualitative aspects of the vegetative features, reproductive characters and habitat preferences are of diagnostic importance such that high relevance and more emphasis can be placed on them for fern taxonomic evaluation. These ferns are good for both indoor and outdoor purposes to beautify homes and offices; for landscaping, aesthetic values and for environmental protection and management. All the ferns collected for this study are perennial plants. They have ability for continuous production of spores, croziers, fernlets (young fern plants) from their stolons and accumulate biomass throughout the year with the availability of moisture and adequate supply of nutrients. The advantage of this as ornamental plants is that they can be retained in the environments for years producing fronds for various economic importance such as medicinal, research, food, for sale for landscaping, as ornamental plants and environmental beautification purposes. The findings in this work are similar to that of (Allen, 1999) who reported that ferns are usually used for food, medicinal,

economic, decorative and environmental purposes in the United State, Europe, New Zealand, Japan, Africa and the Philippines.

## CONCLUSION.

Ferns are mostly located in the wild and in few cities in Nigeria. There is need for massive collection and cultivation of ferns for their ornamental, aesthetic and landscaping; environmental protection, food and medicinal values. Therefore, mass cultivation and campaign for the awareness of the use of ferns as ornamental plants is hereby advocated.

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