OBAFEMI AWOLOWO UNIVERSITY

PHENOTYPIC PLASTICITY OF MORPHO-ANATOMICAL CHARACTERS OF SELECTED PLANT SPECIES IN ADAPTATION TO RIPARIAN AND UPLAND ECOSYSTEMS.

BY

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CERTIFICATION

This is to certify that the research study was carried out by OLADIPO EBENEZER ADELEYE, SCP12/13/H/0509, as part of the requirement for the award of Master of Science degree in Botany of the Obafemi Awolowo University, Ile-Ife.

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DEDICATION

To **JEHOVAH**, the GOD ALMIGHTY, my wonderful parent and siblings.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
cm	Centimetre
cm^2	Squared centimetre
µm	Micrometre
μm^2	Square micrometre
g	Gram
ECL	Epidermal cell length
ECW	Epidermal cell width
SS	Stomata size
UEP	Upper epidermis
PP	Palisade parenchyma
SP	Spongy parenchyma
LEP	Lower epidermis
C	Collenchyma thickness
E	Epidermal thickness
P	Parenchyma thickness
PH	Phloem thickness
XY	Xylem thickness
PT	Pith diameter
S.E	Standard error
TR	Trichome

ABSTRACT

The study evaluated the foliar morphological and anatomical responses of fifteen plant species (four trees, seven shrubs and four herbs) having three different habits to two different ecosystems within Obafemi Awolowo University, Ile-Ife. The tree species studied were: *Celtis zenkeri* Engl.; *Funtumia elastica* (Preuss) Stapf.; *Holarrhena floribunda* (G. Don) T. Durand. and Schinz.; *Rauvolfia vomitoria* Afzel. The shrub species were: *Alchornea cordifolia* Mull. Arg.; *Chromolaena odorata* (L.) King and H.E. Robbins.; *Cnestis ferruginea* Vahl ex DC.; *Hedranthera barteri* (Hook. F.) Pichon.; *Icacina trichantha* Oliv.; *Rothmannia longiflora* Salisb.; *Sphenocentrum jollyanum* Pierre. The herbs were: *Asystasia gangetica* (L.) T. Anderson.; *Emilia coccinea* (Sims.) G. Don.; *Guyonia ciliata* Hook F. and *Synedrella nodiflora* (L.) J. Gaertner. This was with a view to providing explanation for the underlining mechanism behind these responses.

Exomorphological assessment was carried out on petiole length and leaf area using visual assessments. Anatomical evaluation was conducted on the leaf, petiole and epidermis following standard established protocols and using light microscopy. The epidermal features focused on stomata frequency and size, epidermal cell number, length and width, trichome frequency as well as their length and width. Other characters of leaf tissues investigated include; thickness of the cuticle, epidermis, spongy and palisade mesophyll, while petiole anatomical characters considered were thickness of the epidermis, collenchyma, parenchyma, phloem, and xylem cells along with pith diameter and trichome length.

The result revealed that most plant species showed significant ($p<0.05$) reduction in leaf area and petiole length from riparian to upland ecosystem. However, *Rauvolfia vomitoria,*

Chromolaena odorata, Rothmannia longiflora, Guyonia ciliata and *Synedrella nodiflora* showed some level of numerical decrease in petiole length but not significantly different ($p<0.05$) from riparian to upland ecozones. Foliar anatomical data revealed that stomata and trichome frequency, epidermal cell size significantly increased ($p<0.05$) from riparian to upland ecosystem for most of the species while number of epidermal cell, trichome and stomata size reduced significantly ($p<0.05$). In addition, significant increase ($p<0.05$) from the riparian to upland ecosystems occurs in cuticle thickness, epidermal cell, palisade and spongy mesophyll cells except for the lower cuticle. However, tissues of the petiole reduced significantly ($p<0.05$) from riparian to upland ecosystem except parenchyma cells.

The study concluded that *Funtumia elastica, Cnestis ferruginea* and *Synedrella nodifora* were the most adapted to the two ecozones among all the species studied in trees, shrubs and herbs respectively. This study further established the usefulness of anatomical studies in explaining the mechanism underlining the observed morphological responses of plants to varying ecosystems specifically in riparian and upland ecosystems.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Ecosystem

Ecosystem consists of all plants, animals and microorganisms (biotic factors) in an area functioning together with all the non-living physical (abiotic) factors of the environment (Christopherson, 1997). It is the entire assemblage of organisms living together in a certain space with their environment, this include an ecosystem called "riparian". The term riparian is derived from the Latin word "*riparius*" which means stream bank. It was initially used in the United States in the early 1800's as a legal term (Klett, 2002). Riparian ecosystem is one of the biosphere's most complex ecological systems but also one of the most important for maintaining the vitality of landscape and its rivers (Naiman and DeCamps, 1997). Riparian sites are systems with a high water table because of proximity to an aquatic site or subsurface water and have distinct vegetation and soil characteristics (Poff *et al.,* 2011). These sites are not only unique because they have high species diversity and densities as well as high productivity. They also allow for continuous interactions to occur between riparian, aquatic, and upland terrestrial sites through exchanges of energy, nutrients, and species (Johnson and McCormick, 1978). Riparian systems can also be defined as the interface between aquatic and terrestrial sites that occur along rivers and creeks (Johansen and Phinn, 2006). Riparian zones can extend to the limit of river margin when flooded, and its vegetation plays an important role in the ecological balance of river sites (Muller, 1997).

1.1.1 Riparian Ecosystem

Riparian forests are among the most biologically diverse portions of the terrestrial landscape and they provide numerous benefits to stream and terrestrial habitat (Salo and Cundy, 1987; Naiman *et al.,* 1993; Nilsson *et al.,* 1994; Pollock *et al.,* 1998). Among these important benefits are regulation of input within the stream network of large wood, fine organic material, nutrients, sediment, water and thermal energy (Chan *et al.,* 2004). Riparian communities typically consist of one or more deciduous tree species with an assorted understorey of shrubs and herbs (Holland and Keil, 1995). The transition between riparian habitats and adjacent non-riparian habitats often is abrupt, especially in montane areas where the topography is steep (Grenfell, 1988). Riparian communities are most often recognized as ribbons of green vegetation along a permanent supply of water or a stream as it flows through agricultural fields and down through ravines and valleys to eventually join a major river system (Naiman *et al*., 1993). Riparian forest sites occupy a transition zone which is distinguished from the upland areas by a difference in topography, soils and hydrologic regime. This zone stretches from the waters' edge up through the adjoining floodplain (Smith and Hellmund, 1993).

1.1.2 Upland Ecosystem

Upland forests consist of vegetation types commonly thought of as prototypical forests, which excludes wetland forests types such as swamps (NRI, 2007). Uplands often comprise more than 99% of the watershed's area, with the floodplain and stream channel making up the rest (BCMF, 2002). Uplands are associated with lowlands through the flow of water, either overland or through the soil. Vegetation slows the flow of water in the uplands so that it infiltrates the soil. Upland forest also contains a diverse assemblage composed of various subgroups based on height and strata (BCMF, 2002). Riparian and adjacent upland sites often contrast conspicuously in physical condition, disturbance regime and vegetation pattern (Brinson, 1990; Naiman *et al.,* 1993, Wajirou *et al.,* 2002). In riparian forests, the soil is usually mesic or wet, and a fluvial floodplain is formed by debris of coarse textures with or without organic soil, while the upland has deep organic soil which is slightly dry or moderately moist (Wajirou *et al.,* 2002).The natural disturbance regimes in both sites are also different; multiple natural disturbance regimes, such as flooding, debris torrents, channel migration and landslides as well as tree-falls occur in riparian areas, while only tree-falls take place in uplands (Gregory *et al.,* 1991; Naiman *et al.,* 1993, Wajirou *et al.,* 2002) and as a result, plants in these sites adapt to these varying natural disturbance regimes.

1.2 Plasticity of Forms and Organs

Plasticity of forms and organs is one of the ways by which plants show adaptation to heterogeneous or changes in environments. Plant morphological plasticity therefore enables a plant to change its growth pattern as it encounters different stresses (Guo *et al.,* 2007). It has been noted over the years that anatomical and morphological characters may serve as reliable indicators in the study and understanding genetic relationships, physiological processes and ecological adaptations of living organisms (Fahn, 1964; Hlwatika and Bhat, 2002). Individual plants can respond to the environment in two ways: in the short-term they can respond via morphological, physiological and biochemical changes (Bradshaw, 1965), while in the long-term, plant populations respond by changing their genetic composition (Hlwatika and Bhat, 2002). Phenotypic plasticity is defined as the ability of an organism to express different phenotypes with respect to different environments (Agrawal, 2001; Garland and Kelly, 2006). It may take the form of a flexible behaviour that changes over a few seconds or a developmental switch that permanently affects the adult form.

It is important to note that among the organs of the plant that shows a high level of plasticity of forms and structures is the leaf. This is because the leaf structural features which determined the plasticity of forms are associated with the amount of sunlight exposure (Abrams and Kubiske, 1990), or the water available in the habitat (Fahn and Cutler, 1992).According to Passioura (1976), the control of leaf area and morphology is the most powerful means by which a mesophytic plant can influence its fate when subjected to long-term water stress in the field.