UNIVERSITY OF LAGOS, NIGERIA
Inaugural Lecture Series 2018

TOPIC:

THE ENIGMATIC KINGDOM OF PLANTS: THEIR POWER TO STIMULATE, INTOXICATE AND ALTER CONSCIOUSNESS; THEIR POWER TO MAIM, KILL AND CURE

By

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An Inaugural Lecture Delivered at the University of Lagos
J.F. Ade. Ajayi Auditorium on Wednesday 10th October 2018

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ISSN: 1119-4456

Published by

University of Lagos Press and Bookshop Ltd
Works and Physical Planning Complex
P.O. Box 132
University of Lagos
Akoka, Yaba
Lagos, Nigeria
E-mail: press@unilag.edu.ng

DEDICATION

This inaugural lecture is dedicated to the memories of my late Parents, Pa. Isaiah Giwa Adelodun & Chief (Mrs.) Emilia Eminlola OLOWOKUDEJO, with profound gratitude.

PROTOCOL

The Vice-Chancellor,
Deputy Vice-Chancellor (Management Services),
Deputy Vice-Chancellor (Academic and Research),
Deputy Vice-Chancellor (Development Services),
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Other Principal Officers of the University,
Your Lordships (Temporal and Spiritual),
Your Royal Majesties and Highnesses,
Distinguished Academic and Professional Colleagues,
Non-academic Colleagues (Administrative and Technical),
Dear Students (Past and Present),
Members of the Press (Print and Electronic Media),
Distinguished Ladies and Gentlemen.

1.0 PREAMBLE

To God Almighty be the honour and the glory for making today a reality. I had the privilege of receiving a good education and the fortune of an excellent exposure to the best of university culture and traditions, both home and abroad. I secured admission to study Botany at the University of Lagos in August 1972, as a 21-year-old Higher School Certificate graduate of Victory College, Ikare-Akoko, Ondo State. The admission letter was delivered through the Post Office Box of my local church in Ikere, Ekiti State, from where I boarded a bus to Lagos to resume studies as a fresher at the University of Lagos, on the 26th of September 1972. I embarked on that fateful journey to Lagos with trepidation because of the horrible reputation of Lagos then, as a city of criminals and fraudsters. I obtained the Bus route numbers of the four Municipal Buses that plied Ojota to Yaba and the two buses that were dedicated to Yaba – University of Lagos axis. The journey was seamless and the experience was life changing. The rest, as it is commonly said, is history!

2.0 STRUCTURE OF THE LECTURE

This Inaugural Lecture is divided into four major segments. The first section shall shed more light on the subject of Botany, its origin, and some of its subdisciplines including recent advances and current trends. The power, wonders, mysteries, myths, and relevance of plants in human affairs will be presented in the second section. The third segment will highlight some of my research contributions within the general framework of my multidisciplinary training in Plant Taxonomy, Biosystematics, Biodiversity, Conservation, and the Environment. The fourth and last section will draw attention to the fragile and precarious state of the environment and how humans are killing the atmosphere, the land, and the oceans; depleting biodiversity and reducing the earth's capacity to sustain life. The lecture will be concluded by outlining some general and specific recommendations which have both local and global implications.

Mr. Vice-Chancellor Sir, the title of the lecture reflects the overwhelming influence and incredible dominance of plants over all other forms of living and nonliving entities and the environment. I am taking the audience on a tour to the world of plants, and letting all of us see how plants moulded our bodies, faculties, perceptions, and tastes. Either directly, or as the base of a pyramid of consumption; the roots, stems, fruits, and flowers of plants sustain the whole of the animal kingdom. The backdrop to our evolution, they attended the vital needs of all our ancestors – marine, amphibian, and primates – as they indispensably supply ours till today. **Therefore, in the end, or rather in the beginning, we are all plants.**

3.0 THE SUBJECT OF BOTANY – Definition, Origin & History

Botany, also called Plant Science(s), Plant Biology, or Phytology is the science of plant life and a branch of biology. The term "botany" comes from three Ancient Greek words: *botanikos* (**botanical**), *botane* (**plant or herb**), and *boskein* (**to feed**), and the French word *botanique* (**botanical**). Botany had its origin from the Stone Age people who tried to modify their surroundings and feed themselves. At first, the interest in plants was mostly practical and centred around how plants might provide food, fibres, fuel, and medicine. Eventually, an intellectual interest arose. Individuals became curious about how plants reproduced and how they were put together. This inquisitiveness led to plant study becoming one of the oldest branches of science, which broadly defined is simply **"a search for knowledge of the natural world"** (Stern, 2011). Since plant life is so fundamental to human survival, people have been studying plant life from the beginning of recorded time. When people were looking to trees, bushes, and grasses for food, they began to notice where and when these food items would show up. They made the connection between water and plant life, and noticed how soil types controlled the growth of plants.

Theophrastus, a Greek philosopher who lived roughly 2300 years ago, is called by many the father of botanical science. His writings on plant classification, patterns of growth, natural locations, and practical applications are considered by many, to be the most important writings on the subject to reach us from ancient times. It was in his days that **people of science and thought** began to realise the empirical (careful observation) and logical approach that can be taken in the pursuit of scientific knowledge. Much of his writing contained detailed instructions on how to cultivate and use a wide variety of plants, making his botanical science very practical. In A.D. 60, a Greek physician, **Dioscorides** wrote a general medical manual, called ***De Materia Medica.***, which became the medical guidebook in general practice for over 1500 years. Most of the medicines described in that work are botanical in nature and helped maintain the knowledge and use of non-food plants.

Near the beginning of the Renaissance, Theophrastus' writings were rediscovered and circulated, generating a new interest in the scientific study of plants themselves. Beginning from the 17th century, many scientists in the field of botany began to make remarkable discoveries in the history of the study of plants. As can be deduced, Botany originated in prehistory as **herbalism** with the efforts of early humans to identify – and later cultivate edible, medicinal, and poisonous plants, making it one of the oldest branches of science. Medieval physic gardens, often attached to monasteries, contained plants of medical importance. They were forerunners of the first botanical gardens attached to universities, founded from 1504 onwards. One of the earliest was the Padua Botanical Garden – the world's oldest academic botanical garden founded in 1545 and still in its original location in northeastern part of Italy. These gardens facilitated the academic study of plants. Efforts to catalogue and describe their collections were the beginnings of plant taxonomy and in 1753, it led to the binomial system of Carl Linnaeus that remains in use to this day.

3.1 Botany Today

Modern Botany is a fascinating blend of tradition and innovation. In recent times, it has expanded from its traditional base of plant morphology, anatomy, physiology, classification, and distribution, through the application of the most modern experimental techniques such as: scanning and transmission electron microscopy, computer technology, sophisticated analytical procedures, and revolutionary diagnostic techniques, in which short DNA sequences can be used for species identification. These processes involve DNA amplification, Agarose gel electrophoresis, Polymerase Chain Reaction amplification, Cycle Sequencing, Automated sequencing, editing, and alignment of DNA sequences and generation of DNA barcodes. Awareness of the fundamental importance of plants in our environment has increased rapidly with the realisation that they represent the only truly renewable energy source. Already, plants are being used, not only directly as food, raw materials, and drugs, but increasingly as novel sources of fuel and of chemicals for industry. This has led to the development of new subjects such as genetic engineering and biotechnology, which depend on the studies of plant genetics, physiology, and biochemistry for their success. In addition, the resurgence of interest in medicinal

plants, which constitutes an important part of health care system in developing countries, has generated widespread involvement of communities and government in the study, for the efficient utilisation and conservation of these plants. Moreover, biodiversity is fast becoming the key indicator of a healthy planet and healthy society.

Furthermore, fundamental botanical research underpins many aspects of agricultural and industrial development such as plant breeding, plant protection, and fertiliser practices. At the same time, research in ecology, taxonomy, and biosystematics is helping us understand how to manage existing plant resources wisely, both for leisure activities and for agriculture, forestry and genetic conservation, all for the benefit of mankind.

3.2 Branches of Botany

Over time, as the spirit of enquiry festers and technology grows, there has been a conscious diversification of plant study. These have given rise to several distinct subdisciplines of Botany including: Anatomy, Physiology, Taxonomy/ Systematics, Biosystematics, Molecular Systematics, Morphology, Cytology, Genetics/Cytogenetics, Plant Geography/Biogeography, Ecology, Economic Botany, Ethnobotany, Phytochemistry, Embryology, Algology, Bryology, Mycology/Pathology, Palynology, and Palaeobotany, among others.

3.3 The Kingdom Concept

It was natural when classification schemes were first developed, that all living organisms would be placed according to the highest category of **Kingdom**, in either the **Plant Kingdom** or the **Animal Kingdom**. While this distinction still works well for the more complex plants and animals, it breaks down for some of the so-called **simpler** organisms, e.g. *euglenoids,* slime moulds, bacteria and others. In various attempts to overcome these problems, biologists have proposed three –, four –, five – and six – kingdom arrangements, as shown in Tables 1&2 below. However, for the purpose of this lecture the old traditional two-kingdom scheme is adopted for clarity, ease of communication, and understanding. The hypothetical derivations and relationships among kingdoms and the major groups of organisms are illustrated in Figure 1.

Table 1: Five Classifications of Organisms into Kingdoms

TWO KINGDOMS (Traditional)	THREE KINGDOMS (Hogg and Haeckel)	FOUR KINGDOMS (Copeland)	FIVE KINGDOMS (Whittaker)	SIX KINGDOMS (Woeseetal.)	FEATURES
		Monera Bacteria	Monera Bacteria	Archaea Archaebacteria	Cells prokaryotic; Lack muramic acid
	Protoctista	Protoctista	Protista	Bacteria	Cells prokaryotic: have muramic acid
	Bacteria	Algae	Algae	True bacteria	
	Algae Slime molds	Slime molds Flagellate fungi	Slime molds Flagellate fungi	Protista Algae	Cells eukaryotic
	Flagellate fungi	True fungi	Protozoa	Slime molds	
	True fungi Protozoa Sponges	Protozoa Sponges	Sponges	Water molds Protozoa Sponges	
			Fungi	Fungi	Absorb food in solution
			True fungi	True fungi	
Plantae	Plantae	Plantae	Plantae	Plantae	Produce food via Photosynthesis
Bacteria Algae	Bryophytes Vascular plants	Bryophytes Vascular plants	Bryophytes Vascular plants	Bryophytes Vascular plants	
Slime molds Flagellate fungi True fungi Bryophytes Vascular plants					
Animalia Protozoa	Animalia Multicellular animals	Animalia Multicellular animals	Animalia Multicellular animals	Animalia Multicellular animals	Ingest food
Sponges Multicellular animals					

Source: Bidlack & Jansky, 2011

Table 2: Classification of Organisms into Six Kingdoms

Domain Archaea
- **Kingdom Archaea**
  - Phylum Archaebacteria (methane, salt, and sulfolobus bacteria)

Domain Bacteria
- **Kingdom Bacteria**
  - Phylum Eubacteria
  - Class Eubacteriae (unpigmented, purple, and green sulfurbacteria
  - Class Cyanobacteriae (cyanobacteria)
  - Class Chloroxybacteriae (chloroxybacteria)

Domain Eukarya
- **Kingdom Protista**
  - Phylum Chlorophyta (green algae)
  - Phylum Chromophyta (yellow-green, golden-brown, and brown algae)
  - Phylum Rhodophyta (red algae)
  - Phylum Euglenophyta (euglenoids)
  - Phylum Dinophyta (dinoflagellates
  - Phylum Cryptophyta (cryptomonads)
  - Phylum Prymnesiophyta (haptophytes)
  - Phylum Charophyta (stoneworts)
  - Phylum Myxomycota (plasmodial slime molds)
  - Phylum Dictyosteliomycota (cellular slime molds)
  - Phylum Oomycota (water molds)
  - (Phylum Protozoa – protozoans)
  - (Phylum Porifera – sponges)
- **Kingdom Fungi**
  - Phylum Chytridiomycota (chytrids)
  - Phylum Zygomycota (coenocytic fungi)
  - Phylum Ascomycota (sac fungi)
  - (Lichens)
  - Phylum Basidiomycota (club fungi)
  - Phylum Deuteromycota (imperfect fungi)
- **Kingdom Plantae**
  - Phylum Hepaticophyta (liverworts)
  - Phylum Anthocerotophyta (hornworts)
  - Phylum Psilotophyta (whisk ferns)
  - Phylum Bryophyta (mosses)
  - Phylum Lycophyta (club mosses)
  - Phylum Equisetophyta (hosetails)
  - Phylum Polypodiophyta (ferns)
  - Phylum Pinophyta (conifers)
  - Phylum Ginkgophyta *(Ginkgo)*
  - Phylum Cycadophyta (cycads)
  - Phylum Gnetophyta (*Gnetum, Ephedra, Welwitschia*)
  - Phylum Magnoliophyta (flowering plants)
    - Class Magnoliopsida (dicots)
    - Class Liliopsida (monocots)

  Division Tracheophyta of earlier classifications
- **Kingdom Animalia (multicellular animals)**

Source: ***Bidlack & Jansky, 2011***

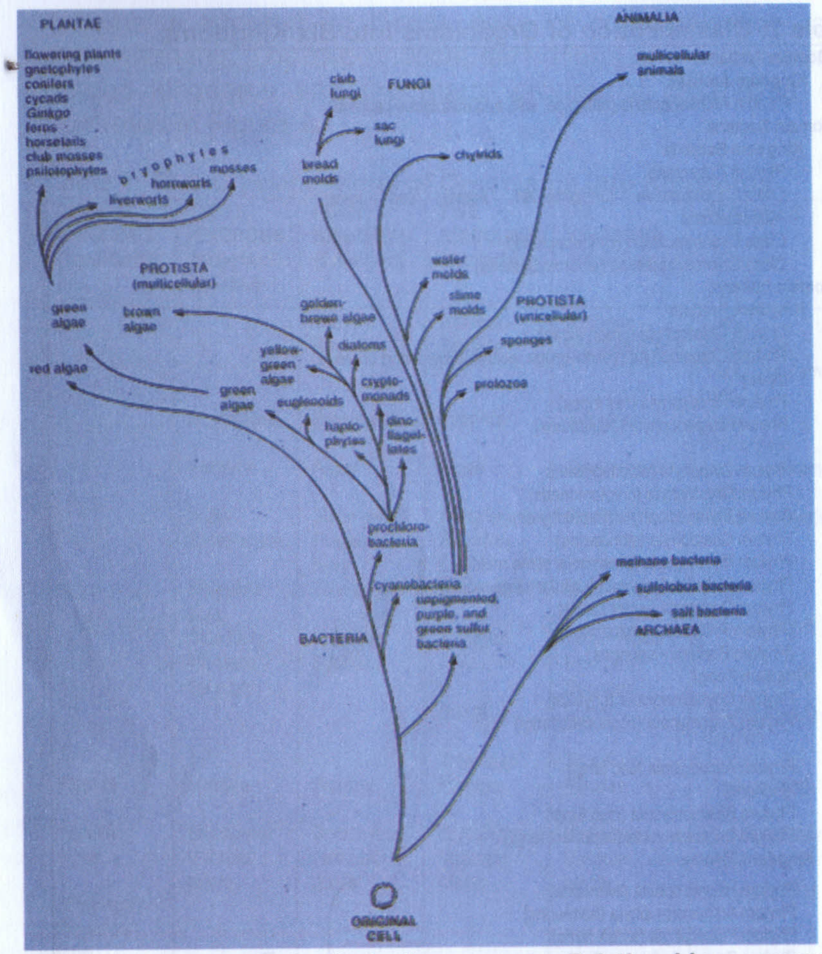


Figure 1: Hypothetical Derivations and Relationships among kingdoms and the Major Groups of Organisms
Source: ***Bidlack & Jansky, 2011***

4.0 THE POWER OF PLANTS

Millions of years ago, it was the rise of plant life that boosted the stock of oxygen in the atmosphere from a trace gas to the one-fifth proportion that fostered the outburst of animal life. Without the green mantle for our planet, supplied by over 300,000 plant species, animal life as we know it (including *Homo sapiens*) would never have evolved. Some biologists believe that the demise of one plant species may eventually

lead to the extinction of up to 30 animal species, as the consequences reverberate up the food chains. Plants convert sunlight into the stored chemical energy on which all animal life depend on for food (and humans for fuel too). The enormous diversity of plants offers adaptations to every conceivable environment, from desert to tundra, the tropics having the richest speciation. We depend on this green wealth at every turn – from indirect benefits for soil and climate to direct supplies to our tables, factories, and hospitals.

Plants are the foundation of all existence, of humans and animals, of society and civilisation. In order to nourish, cure, delight, and inspire us, they battle constantly with the elements. Plants have launched men on the most momentous voyages of discovery, across oceans and continents, and through the inner empires of the mind. Plants create most of our reality and many of our dreams. They are the source of our nourishment and health, pleasures and ecstasies; they sustain religions, cultures, and civilisations. In the end, they can kill and return us to the soil on which they themselves feed. A standard distinction between plants and animals is that the former is static, while the latter is freely mobile. Yet, animals and people are free to roam only within the limits plants allow them, and plants themselves are seldom motionless. They cannot afford to be. Every change in their environment affects them acutely. All parts of a plant constantly respond to each other and to the conditions around them – to light, warmth, moisture, air pressure, touch, temperatures, the position of the sun, and the direction of the wind. Rooted to the spot, they present a picture of rest which is belied by their internal mechanics. Science is still baffled by the series of incredibly complex adjustments that enable a sunflower (*Helianthus annuus*) to faithfully keep its face to the sun, traversing a broad ellipse throughout the hours of light. Nor can botanists fully understand the protective upheavals in, say, a coltsfoot, when sudden rain threatens to swamp the cosmetic gadgetry of scent and colour. This warding off of rain is one of the hiccups of plant life – responses to particular and unpredictable change (Lehan, 1977). Beneath such actions lies the more regular programming, the series of responses to the elemental cycles of night and day, and the succeeding seasons of each year. In the tropics, we talk of dry and wet/rainy seasons, while in temperate regions it is either spring, summer, autumn/fall, or winter. Plants are fully aware of all these seasons. Within every seed of a fruit, sometimes within every cell of a leaf, sits the blueprint for the species' survival. The bare stems of a tree in winter; the buds, shoots and flowers of spring; the denser foliage of summer; and the fruitfulness of autumn; form a predestined pattern within the gene. Every plant knows what is generally required of it. And there is more than these outward and visible signs of growth. Beneath the skeletal profiles of winter, there is unceasing activity within the earth. Along with routine maintenance goes the construction of the leaves and shoots which must break ground, with unerring timing, when the year's worst privations are over. The shoots emerge primed with a vast store of knowledge – about how tall to grow, at what point to branch, when to develop leaf, what forms to assume in each of these particulars, down to the last vein on the leaf and last bristle on its perimeter (Lehan, 1977).

4.1 Photosynthesis

This is the most important process on earth for life as we know it. Life on earth depends on it to provide oxygen and absorb carbon (IV) oxide. It is also the foundation through which carbon enters the web of life, directly or indirectly providing food and shelter for most living organisms. By means of plants, the rays of the sun are transformed into flesh. Alone of all life–forms, plants can not only catch sunlight but – by a unique alchemy – compound it with terrestrial ingredients to make the basic food and substance of all living things. Oil and coal today provide about 90% of the energy needed to power trains, trucks, ships, aeroplanes, factories, computers, communication systems, and a multitude of electrically energised appliances. The energy within that oil and coal was originally captured from the sun by plants (including algae) growing millions of years ago and then transformed into fossil fuels by geological forces. However, the energy needs of

transportation, industry, and homes seem insignificant, when compared with the combined energy requirements of all living organisms. **Every living cell requires energy just to remain alive,** and more energy is needed for the cell to reproduce, grow or do physical work as part of an organism. In addition, oxygen is vital to nearly all life in processes that release stored energy.

Photosynthesis, at least indirectly, is not only the principal means of keeping all forms of humanity functioning, but also the sole means of sustaining life at any level – except for a few bacteria that derive their energy from sulphur salts and other inorganic compounds. This unique manufacturing process of green plants furnishes raw material, energy, and oxygen. In photosynthesis, energy from the sun is harnessed, and with the aid of chlorophyll, it is transformed from light energy to biochemical energy in the bonds between the atoms of a sugar molecule. Oxygen is given off as a by-product of the process. It has been estimated that all of the world's green organisms (including those in the oceans) together produce between 100 billions and 200 billion metric tons (between 110 billion and 220 billion tons) of sugar each year (Stein, 2011). To visualise that much sugar, consider that it is enough to make about 300 quadrillion sugar cubes (one quadrillion is 1,000,000,000,000,000). Much of the sugar produced by plants is converted to wood, fibres (such as cotton and linen), and other structural materials. The first products of photosynthesis may also be converted to disaccharides, such as sucrose; polysaccharides, such as starch; and other storage forms of carbohydrates. The digestive activities of living organisms break down the carbohydrates to smaller molecules. Sugars produced by photosynthesis are also involved in the synthesis of amino acids for proteins and a host of other cell constituents. In fact, photosynthesis produces more than 94% of the dry weight of green organisms, with the remainder coming from the soil or dissolved matter.

The capacity of plants to meet our energy needs may well determine the ultimate size of human populations. In some heavily populated parts of the world, the food supply already is falling short of providing enough energy to sustain life, and starvation is widespread. Meanwhile, in the Western world, significant numbers of persons consume too much food and are spending a lot of money on weight reduction. We will, however, eventually approach a point at which human populations, in general, will need to stabilise else, those in the most affluent areas could exceed the capacity of the plants to sustain them. A great deal of photosynthesis occurs in organisms living in the oceans. It is estimated that between 40% and 50% of the oxygen in the atmosphere originates in oceans and lakes.

4.2 Additional Metabolic Pathways

While photosynthesis and respiration are the main processes through which plants grow, develop, reproduce, and survive, there are many other additional processes that contribute toward these activities. Most of these use intermediate steps, but they could not function without photosynthesis and respiration. Some of the essential compounds produced from additional pathways include sugars, phosphates and nucleotides, nucleic acids, amino acids, proteins, chlorophylls, cytochromes, carotenoids, fatty acids, oils, and waxes.

Metabolic processes not required for normal growth and development are generally referred to as *secondary metabolism.* Although not essential, many of the products from secondary metabolism enable plants to survive and persist under special conditions. These products provide the plant with unique colours, aromas, poisons, and other compounds that may attract or deter other organisms or give them a competitive edge in nature. Humans have exploited many secondary compounds from plants for medicinal, culinary or other purposes. It has been estimated that from 50,000 to 100,000 such compounds exist in plants, with only a few thousands of these thus far having been identified. Secondary metabolic products may be derived from a modification of amino acids and related compounds to produce alkaloids, or through specialised conversions such as the

shikimic acid pathway (phenolics) and *mevalonic acid pathway* (terpenoids). Examples of these compounds are shown in Table 3. Lignin, which is a component of secondary cell walls, is, for example, synthesised through the shikimic acid pathway. Because it is hard to digest and is toxic to some predators, it protects plants from herbivorous animals.

Table 3: Examples of Plant Secondary Compounds

Compound	Example Source	Human Use
ALKALOIDS		
Codeine	Opium poppy	Narcotic pain reliever, cough suppressant
Nicotine	Tobacco	Narcotic; stimulant
Quinine	Quinine tree	Used to treat malaria
PHENOLICS		
Lignin	Woody plants	Used for hardwood furniture and baseball bats
Salicin	Willow tree	Aspirin precursor
Tetrahydrocannabinol	Marijuana	Treatment for glaucoma; nausea suppressant
TERPENOIDS		
Camphor	Camphor tree	Component of medicinal oils and disinfectants
Menthol	Mints and eucalyptus tree	Strong aroma; used in cough medicines
Rubber	Rubber tree	Rubber tyres , rubber bands, and other commercial products

Wherever there is greenery, photosynthesis is working to make oxygen, release energy, and create living matter from the raw material of sunlight, water, and carbon dioxide. **Without photosynthesis, there would be an empty world, an empty sky, and a sun that does nothing other than warm the rocks and reflects off the seas.**

4.3 Dependence of Human and Animal on Plants

Humans and animals depend on green organisms to produce the oxygen in the air that we breathe and to remove the carbon dioxide we give off. Plant life constitutes more than 98% of the total *biomass* (collective dry weight of living organisms) of the earth. Plants and other green organisms have the exclusive capacity to produce oxygen, while converting the sun's energy into forms vital to the existence of both plant and animal life. At the same time, plants remove the large amounts of carbon dioxide given off by all living organisms as they respire. In other words, virtually all living organisms are totally dependent on green organisms for their existence. If some major disease were to kill all or most of the green organisms on land, in the oceans, and lakes, all the animals in these habitats would starve to death. Even if some alternative sources of energy were available, animal life **would suffocate within 11 years** – the time estimated for all the earth's oxygen to be completely used up if it were not replaced.

Plants are also the source of products that are so much a part of human society that we largely take them for granted. We know, of course, that rice, corn, potatoes, and other vegetables are plants; but all foods, including: meat, fish, poultry, eggs, cheese, and milk, to mention just a few, owe their existence to plants. Condiments such as spices, and luxuries such as perfumes, are produced by plants. So also are dyes, adhesives, digestible surgical stitching fibre, food stabilisers, beverages and emulsifiers. Our houses are constructed with lumber from trees, which also furnish the cellulose for paper, cardboard, and synthetic fibres. Some of our clothing, camping equipment, beddings, draperies, and other textile goods, are made from fibers of many different plant families. Coal is fossilised plant material, and oil probably came from microscopic green organisms or animals that were either directly or indirectly plant consumers. All medicines and drugs at one time came from plants, fungi, or bacteria, and many important ones including most of the antibiotics, still do. Microscopic organisms play a vital role in recycling both plant

and animal wastes, and aid in the building of healthy soils. Others are responsible for human diseases and allergies. Potatoes, grains, and other sources of carbohydrates are currently used in the manufacture of alcohols, some of which are being blended with gasoline ("gasohol"), and such uses probably will increase in the future.

Although, there are approximately 250,000 species of flowering plants, only six species – **wheat, rice, corn, potato, sweet potato, and cassava** – provide **80%** of the calories consumed by humans worldwide. An additional eight plants – sugar cane, sugar beet, bean, soybean, barley, sorghum, coconut, and banana – complete the list of major crops grown for human consumption.

Table 4: Six Major Crops Consumed by Humans Worldwide

S/N	Common Name	Botanical Name	Family
1.	Wheat	*Triticum aestivum L.*	Poaceae
2.	Rice	*Oryza sativa L.*	Poaceae
3.	Corn	*Zea mays L.*	Poaceae
4.	Potato	*Solanum tuberosum L.*	Solanaceae
5.	Sweet potato	*Ipomoea batatas (L.) Poir*	Convolvulaceae
6.	Cassava	*Manihot esculenta Crantz*	Euphorbiaceae

Table 5: Additional Eight Plants Grown for Human Consumption

S/N	Common Name	Botanical Name	Family
1.	Sugarcane	*Saccharum officinarum L.*	Poaceae
2.	Wild beet	*Beta vulgaris L.*	Chenopodiaceae
3.	Bean	*Phaseolus vulgaris L.*	Fabaceae
4.	Soybean	*Glycine max (L.) Merr.*	Fabaceae
5.	Barley	*Hordeum vulgare L.*	Poaceae
6.	Sorghum	*Sorghum bicolor (L.) Moench*	Poaceae
7.	Coconut	*Cocos nucifera L.*	Arecaceae
8.	Banana	*Musa acuminata Colla*	Musaceae

In the **two million years that we have inhabited this earth**, we have cultivated plants for only the most recent **10,000 years**, or less than 1% of our history. However, in that time, we have dramatically changed the plant landscape and our own lives. Hunter-gatherer societies have given way to agricultural societies and the development of cities and civilisation. Such concentrations of people are vulnerable to catastrophes such as drought and famine. Domesticated plants depend on us for their survival, but we have also become dependent on them for our survival. We domesticate plants by altering them genetically to meet our needs. A domesticated plant is one whose reproductive success depends on human intervention. This is an ongoing evolutionary process, and plants are found in a continuum from purely wild to fully domesticated. Our current crop plants continue to evolve as a result of our breeding efforts. It is amazing that, although humans have eaten thousands of types of plants in the past, we currently rely on only a handful to supply almost all our nutritional needs.

5.0 POWER TO STIMULATE, INTOXICATE, DEPRESS AND ALTER CONSCIOUSNESS

Tea and coffee stimulate the mind, trespassing – however softly – on that inner part of man which is seen as his private inalienable core. What some people prohibit, however, most others enjoy as a mild fillip in the day's routine, drinking – without obvious decline – some hundred thousand cups of one or the other beverage in a lifetime. Certainly, these and other plant based drinks have a hold on us, a hold which has had its effect on history. Some plant stimulants burnish the emotion, giving joy, merriment, wonder, and nostalgia a greater intensity. Some appear to quicken the wits, or sharpen desire, or enhance sensual pleasure. Some bring drowsy forgetfulness, sleep, and visions. Certain plants that are involved in this scenario are the hallucinogens plants with constituents which change human perception into a faculty that seems quite remote from normal observation. When we eat a plant or drink an infusion made from it, we are taking in substances which have a chemical effect on, among other things – the physical complexities of our brains. Some of these chemicals have not been isolated, and the means whereby they act on the brain are seldom thoroughly understood. It seems that the process is often the negative one of suppressing some neural reactions, so that others are highlighted in a way which can affect the subject's emotional states. Intoxication by alcohol is an example.

Hallucinogens may be subject to the same rules but their effects are usually more interesting and dramatic than those of other drugs, and more ambitious claims have been made on their behalf. The spiritual and theological aspects of religions may well have been born out of the powers of these plants. The magic mushrooms of Mexico, the soma of ancient India, and the *Amanita muscaria* which was, some claim, were crucial to the religions which went before and perhaps gave rise to some aspects of Christianity–all these were not only aids to worship but, in themselves, objects of worship (Lehane, 1977). Intensive research into these plants over the last four decades, and into their use among primitive people, has stressed that many rituals, lore, and behaviour are still influenced, in a way which earlier observers failed to notice, by insights and visions vouch-safed by consumption of the plants. And it was indicated that much religion, ritual, and lore in advanced societies stems from similar consumption – with its consequent insights and visions in the forgotten past.

Indeed, there is no area of the inhabited world in which plants have not made it possible to alter the state of human consciousness to such an extent that people feel they have actually departed from the tiresome realities of the workaday world. The various plant species involved in changing the state of consciousness are called "Psychoactive" plants, which act on the central nervous system. They are divided into three broad categories:

- **Stimulants**, which excite and enhance psychomotor activity;
- **Hallucinogens,** which are capable of inducing a dreamlike state, as well as hallucinations; and
- **Depressants,** which reduce mental and physical performance.

A wide range of plant derivatives is involved in the production of these mind-altering drugs. Cocaine, coffee, and tea are well-known stimulants; peyate, certain mushrooms, morning glory seeds, and marijuana (hemp) are frequently used hallucinogens; while alcohol and tranquillisers are the best known examples of depressants. Nicotine obtained from smoking, chewing and sniffing tobacco may act as a depressant, but it serves usually as a stimulant.

5.1 Stimulants

Stimulants have long been enjoyed by man. They give him a sense of well-being and exhilaration, self-confidence and power, and they alleviate fatigue and drowsiness. However, the inevitable prices to be paid include: increased agitation, apprehension and anxiety, mild mania (flight of ideas), as well as increased tolerance and often dependency, which are direct results of using stimulants. Two of the most powerful natural stimulants are Coca (*Erythroxylum coca*) and Chat (*Catha edulis*). Coca is a native to the Andes area of South America and an extract of coca, well-known as cocaine. It has been available since the 19th Century, but then only for medicinal purposes and, to the few who could afford it, for pleasure. The other stimulant is chat, which is commonly used in eastern Ethiopia and neighbouring countries where it is known as "flower of paradise" (Lewis & Elvin-Lewis, 1977).

In addition, there are mild beverage stimulants containing caffeine, theobromine, theophylline, and other alkaloids (Table 6).

Table 6: Mildly Stimulating Beverages Containing Xanthine Alkaloids (Lewis & Elvin-Lewis, 1977)

Angiosperm family and species	Vernacular Name	Alkaloid	Remarks
AQUIFOLIACEAE			
Ilex paraguensis	Yerba mate	to 2% Caffeine	Leaves for Paraguay tea or mate in Central America, much cultivated in Northern Argentina to Southern Mato Grosso (Brazil)
I. amara, I. conocarpa, I. pseudobuxus, I. theezans		Caffeine	Species widely substituted in Mate
I. cassine, I. vomitoria	Dahoon holly, Cassina	Caffeine	Leaves sold for tea in Southern North America: especially popular during Civil War when the South was blockaded; long used by Creek and other Indians as beverage and for ceremonials
I. opaca	American Holly		Dried leaves substituted for tea in Eastern North America during Civil War; probably little or no caffeine
MELATOMATACEAE			
Miconiawilldenowii		0.2% Caffeine	Leaves for tea in Brazil
RUBIACEAE			
Coffee arabica	Arabian coffee	1-2% Caffeine	Seed roasted, the widely cultivated coffee in South and Central America, Eastern Africa: native to the highlands of Eastern Africa
C. excelsa, C. liberica,		Caffeine	Western Africa and cultivated, often grown in lower, more tropical elevations than C. arabica
C. maclaudii C. robusta C. stenophylia and others			
SAPINDACEAE			
Paulliniacupana	Guarana	2.5-5% Caffeine	In Brazil, a paste from pulverised seeds mixed with cassava is dried into bars and used as needed in beverage. It also contains 5% tannin; alcoholic drink prepared from seeds and cassava
P. yoco		2.8% Caffeine	Beverage in Colombia chiefly from bark
STERCULIACEAE			
Cola acuminate Cola nitida	Cola	+2.5% Caffeine	Cola nuts (seeds) infusion for stimulating tea in Western Africa and cultivated throughout tropics; seeds also chewed; popular chewing stick; ingredient of cola soft drink beverages (CocaCola, Pepsi-Cola)

Theobroma cacao	Cacao tree	(minute) caffeine: to 3% theobromine	Seeds long use as a beverage among Mexican Indians, native to tropical America, widely cultivated especially in Western Africa, source of powdered chocolate, cocoa
THEACEAE			
Camellia sinensis	Tea	1-4% Caffeine (small) theophylline	Of Asian origin and widely cultivated since ancient times for dry tea leaf
C. kissi		Caffeine and theophylline	Leaves for tea in the Himalayan region
Luryatheoides			Leaves for tea in Cuba

5.2 Hallucinogens

These are unique compounds. In nontoxic doses, they produce changes in perception, thought, and mood, without causing major disturbances of the autonomic nervous system. Psychic changes and abnormal states of consciousness induced by hallucinogens differ utterly from ordinary experiences. The user of hallucinogens forsakes the familiar world and, in full consciousness, embraces a quasidream world operating under other standards, strange dimensions, and in a different time. These drugs are a means of escaping from reality as it is commonly understood. Most hallucinogens are of plant origin. A few are found among animals; e.g. taraxein, a substance producing schizophrenia, is the only hallucinogen extracted from humans (Hoffer & Osmond, 1967). They do not occur at random throughout the plant kingdom, but rather are dispersed among two groups only – the fungi and, more commonly, the flowering plants, as shown in Table 7.

Hallucinogens are found in these well-known plant families, Loganiaceae, Rubiaceae, Apocynaceae, Acanthaceae, Solanaceae, and Convolvulaceae. Large members of these families are concentrated in the New World, in Mexico, and in northern South America, where the use of hallucinogens has

deep traditional roots among the indigenous populations. Just as plants having hallucinogens are not found at random and the number of taxa involved is limited, the compounds responsible for hallucinations are composed of very few chemical types. Most are nitrogen-containing compounds, thus, alkaloids. The alkaloids include the protoalkaloids or amino alkaloids, which lack nitrogen in their central structure though usually not in the side chains, and the more complex alkaloids, having nitrogen in their heterocyclic ring structure. The majority of the latter are indoles derived from tryptamines.

Table 7: Plants of Hallucinogenic Use

Plant Group and Species	Vernacular Name	Hallucinogenic Principle	Comments
FUNGI: ASCOMYCETES			
Clavicepitales			
Claviceps purpurea	Ergot	d-Lysergic acid amide	Visual hallucinations: St. Anthony's fire from other ergot alkaloids
FUNGI: BASIDIOMYCETES			
Lycoperdales			
Lycoperdon marginatum, L.	Puffballs	Unknown	Auditory hallucinations characterise intoxication as experienced by the Mixtecs (Oaxaca, Mexico)
Agaricales (Mushroom)			
Amanita muscaria	Fly agaric	Ibotenic acid, muscimol	Major hallucinogen of Burasia in times gone by
Conocybe cyanopus, C. siliginoides		Psilocybin, psilocin	Sacred mushrooms (Leonanactl) of Mexico
Gymnopilus spectabalis			
Panaceolus sphinotrinus, P. subbaltatus			
Psilocybe acutissima, P. aztecorum, P. baesystis			
P. caerulescens			
P. caerulescens			
P. cordispora			
P. fagicola			
P. hoogshagenii			
P. isauri			

P. mexicana			
Stropharia cubensis			
ANGIOSPERMS			
Annonales			
MYRISTICACEAE			
Mytistica fragrans	Nutmeg and mace	Nonnitrogenous	
		Phenylpropenes Aromatic fraction Possibly a synergism Between elemicin Myristicin, and safrole	
CANNABACEAE			
Cannabis sativa (+ C. indica, C. ruderalis	Hemp, marihuana, hashish, bhang	Nonnitrogenous di-benzopyrans: trahydrocannabinol	
			anxiety tin whites); stimulant and aphrodisiac
ACANTHACEAE			
Justicia pectoralis		N, N-Dimethyltryptamine	Pulverized leaves added to
var. stenophylla			Virola, hallucinogenic snuff in Colombia and adjacent Brazil
SOLANACEAE			
Atropa belladonna	Belladonna	Hyoscyamine, scopolamine and other alkaloids	Hallucinations sometimes occur largely because of Sco polamine: ingredient of magic brews of middle ages
Brunfelsia spp.		Alkaloid components not well characterized	Hallucinogenic drink from leaves and bark in tropical South America, may be added to ayahuasca (Banisteriopsis)
Cestrum laevigatum, C. parqui	Dama da noite	Unknown (contain saponins, gitogenin, and digitogenin, C. parqui the steroidal alkaloid solasonine	Reputedly sold in ports of southern Brazil as a substi-tute for marijuana
			Pulverized seeds in termen-

Datura spp.		Scopolamine and other tropane alkaloids	Ted drinks, or infusion of Leaves and twigs lead to intoxication and hallucination
Hyoscyamus niger, H. muticus	Henbane	Hyoscyamine, scopola-mine, and other alkaloids	Ingredients of magic and witches brews of earlier days producing visual hallucina-tions and flights of fancy
RUBIACEAE			
Mitragyna speciosa		Mitragynine, a harmine analog N,N-Dimethyltry-Ptamine	Intoxicants in southeast Asia, hallucinogenic in large doses
Psychotria cathargineneis, P. viridis			Added to ayahuasca to en-hance hallucinogenic beve-rage
CONVOLVULACE AE			
Argyreia nervosa	Wood rose	Ergoline alkaloids	Seeds contain 3mg of alka-loidal material per gram
Ipomoea violacea	Morning glory	D-Lysergic acid amide (ergine); other" ergot" alkaloids maybe active	Seeds – tlitlitzen- have long use in Mexico as hallucino-gen
Rivea corymbosa	Morning glory	As for Ipomoea	Seeds – ololiuqui –as halluci-nogen in Mexico

5.3 Depressants

A number of drugs that act to depress the central nervous system produce effects of euphoria and well-being, beginning with sedation (calming, tranquilising), followed by hypnosis (sleep), general anaesthesia, and coma, and ending with death from respiratory failure as the dose increases to higher levels. When controlled, all are enormously useful drugs in medicine and society, but all are subject to abuse. With depressant, drugs abuse may lead to addiction, a compulsion characterised by three features: a tendency to increase the dose because tolerance develops, the appearance of physiological changes when drug use is discontinued (i.e., withdrawal symptoms occur), and a strong desire to continue taking the drug (Ray, 1972). This addictive property of many depressants, which include **alcohol, barbiturates, tranquilisers and opium, and its derivatives morphine, heroin, and methadone,** is their great danger to mankind.

5.4 Alcohol

Alcohol in several forms – such as beer from cereals, wine from fruits and berries (Table 8), and mead from honey – was well known by the beginning of recorded history. Some authorities suggest that mead, possibly the oldest of alcoholic beverages, appeared during the Paleolithic Age (ca. 8000 BC), and unquestionably man has indulged in alcohol for religious, social, and medicinal purposes ever since (Lewis & Elvin – Lewis, 1977).

Medicinal use by the Egyptians is recorded among the papyri, which attest to the use of beer and wine as vehicles for other medicines, and as tranquilisers and soporifics. Once distillation had been developed by the Moslems, many of the distillates, such as brandy from wine and whisky from beer, were mixed with sweeteners and herbs for use by physicians to counter a variety of illnesses. Ethanol was the potent constituent in many such concoctions, causing recognisable physiological effects of relaxation and tranquillity, and its effective role in these and numerous patent medicines of today must not be discounted. Alcohol has numerous other uses: as a solvent to remove oils such as those from poison ivy, as an evaporator to cool the skin during fevers, as a disinfectant, as a pain reliever, as an appetite stimulator, and as a treatment for the common cold. Most alcoholic drinks or beverages are not consumed for medicinal purposes, however, but for pleasure and solace in this hectic world, where hundreds of millions drink liquor, beer, or wine; however several millions have become enslaved by alcohol.

Table 8: Some Plant Sources of Alcoholic Drinks (Beer, Wine, Spirits etc.)

Cereals

S/N	Common Name	Scientific Name
1.	Wheat	*Triticum aestivum*
2.	Rice	*Oryza sativa*
3.	Maize	*Zea mays*
4.	Guinea corn	*Sorghum bicolor*
5.	Barley	*Hordeum vulgare*
6.	Millet	*Pennisetum nigritatum*
7.	Rye	*Secale cereale (over 20,000 varieties)*
8.	Oats	*Avena sativa*

Fruits

S/N	Common Name	Scientific Name
1.	Oil palm	*Elaeis guineensis*
2.	Raphia palm	*Raphia farinifera*
3.	Kola nut (two cotyledons)	*Cola nitida*
4.	Kola nut (> two cotyledons)	*Cola acuminata*
5.	Plantain	*Musa paradisiaca*
6.	Banana	*Musa acuminata*
7.	Mango	*Mangifera indica*
8.	Grapes (table wine)	*Vitis vinifera*
9.	Grapefruit	*Citrus paradisi*

Alcoholic Beverages

The basis of all alcoholic beverages is fermentation, the chemical action of yeast (commonly known as *Saccharomyces cerevisiae)* acting on sugar in the presence of water. Yeast recombines the carbon, hydrogen, and oxygen of sugar and water into ethyl alcohol (ethanol, C_2H_5OH) and carbon dioxide. The source of sugar is mostly fruits, especially grapes, or malted barley (sprouted grain that when killed retains the enzymes necessary to convert the starch of grains and mashes to sugar). The appropriate yeasts, often widespread wherever the grapes or other plants grow, are selected for their tolerance to the alcohol they metabolise, which normally has an upper limit of about 15%. In order to obtain alcohol at concentrations higher than that produced by fermentation, alcohol is heated and vapours are collected and condensed into liquid again, in a process known as distillation. This increases the percentage of alcohol, because the distillate has a lower boiling point than water, and thus becomes more concentrated in the condensed liquid than in the original solution. When man mastered the process of distillation he increased to five the basic forms of alcoholic beverages available: table wines, fortified or dessert wines, beers, liqueurs, and distilled beverages (spirits) (Table 9).

Table 9: Examples of Plants Used as Carbohydrate Sources in Making Alcoholic Beverages for Domestic Use

Plant Group and Species	Locality	Remarks
RED ALGA *Rhodymenia palmata*	Kamchatka, Siberia	Natives use this seaweed as a base
FUNGUS *Fomesauberianus*	Tropics	Intoxicants, also cause fits and frenzy
ANGIOSPERMS ANACARDIACEAE *Sclerocarya caffra* *S. schwein furthii*	South Africa Tropical Africa	Fruit is used to prepare a beerlike beverage
APIACEAE *Heracleum sphondylium*	Eastern Europe	In Slavic countries boiled leaves and fruit are used to prepare Bartsch
ARECACEAE *Hyphaene crinata*	South Africa	Stem sap (this and other species of palm widely used)
ELAEAGNACEAE *Elaeagnus multiflora*	Japan	Fruit
FABACEAE *Hymenae acourbaril* *Prosopis nigra* *P. pubescens*	Brazil Argentina Southwestern United States and Mexico	Seed pulp Fruit Fruit used by Indians
RHAMNACEAE *Zizyphus abyssinica*	Malawi	Fruit for potent alcoholic beverages
SAPINDACEAE *Paullinia cupana*	Guarana, Brazil	Seeds mixed with cassava and water

Effects of Alcohol

When alcohol reaches the central nervous system, it slows or anesthetises brain activity. Though alcohol is a depressant, the initial feeling created is just the opposite, as the barriers of self-control are lifted and the drinker acts or speaks in ways that his well trained sober self normally forbids. After a number of drinks, the motor centres of the brain are affected, causing clumsiness and unsteadiness in movements. Other effects on those who overindulge include nausea, upset stomach, headaches, and hangover. Withdrawal from alcohol may involve tremors, seizures, visual or auditory hallucinations or both, delirium tremens (frenzied excitement with tremors), and blackouts.

5.5 Tranquilisers

Like alcohol and the barbiturates, tranquilisers depress the central nervous system, relieve tension and anxiety, and sometimes relax the skeletal muscles. The first tranquiliser was found in *Rauvolfia serpentina* (Apocynaceae), which proved to be an indole alkaloid reserpine. Whenever Mahatma Gandhi felt the need to induce a state of philosophic detachment, he sipped tea brewed from the leaves of the plant that grows wild in India and in most of the world's tropical lands. For centuries, the plant was widely used for its calming effect. Holy men chewed it while meditating. Native medicine men employed it to treat highly agitated mental patients. It was even used to soothe fretful babies. Today the drug is not much used in mental health therapy, but it remains an important drug employed in the relief of a major killer, high blood pressure.

5.6 Kava

For a very long time, the natives of the South Pacific islands used the rhizomes and roots of *Piper methysticum* (Piperaceae) or kava to make a beverage that relaxed body and mind, induced refreshing sleep, and eased the pain. The rootstocks are initially handled in two ways: (a) they are reduced to fragments and chewed to a soft mass with saliva, the liquid is mixed with cold water or coconut milk, and the foamy liquid is strained and consumed a few hours later; (b) they are grated and macerated in cold water or coconut milk, and the liquid is filtered before drinking. The kava prepared by chewing has a narcotic effect. It paralyses muscles, particularly the lower limbs; it increases the force, but decreases the rapidity of the hearts' action; and it at first stimulates, then depresses respiration. Unlike alcohol, the drug does not impair mental alertness. A small quantity gives rise to a euphoric state of short duration characterised by tranquillity and friendliness. Chewed kava is a cerebral depressant; the drug apparently steadies the pulse, does not raise body temperature, is diaphoretic, and counteracts obesity. The deep, dreamless sleep from kava is not followed by a hangover. However, the substance is addicting, and with continuous use, many natives, as well as patients using the extract dihydromethysticin, develop exfoliative dermatitis (Keller &Klohs, 1963). From the root of kava have been isolated methysticin, yangonin, dihydromethysticin, and dihydrokawain, mostly lactones and resins variously estimated at between 3 and 4% of the root (Lewis & Elvin – Lewis, 1977).

5.7 Opiates

Opium is a powerful drug derived from the poppy *Papaver somniferum*, native to the Middle East. If its capsule is cut between the time the petals drop and before the capsule matures – a period of about 10 days during the year–long growth of this annual – a milky sap emerges. When left in the open, the sap dries into the brown, gummy substance known as opium. Throughout history, opium has been a servant to man and many men have also been dependents and addicted servants of opium. Opium is possibly the oldest narcotic known, as early as 4000 BC. The Sumerians referred to it as the **joy plant**. The drug was used medicinally in ancient Greece and Rome, and Arabian traders introduced it into China. During the Middle Ages, a variety of opium preparations appeared in the form of a laudanum or tincture (opium in about 10% ethanol) to ease pain and to create general euphoria. Thus, the stage was set for the popularity of patent medicines containing opium in the 19th century.

In Europe, opium had by this time become widespread and popular. Notable writers, such as Thomas De Quincey, who was addicted by the age of 20 after initially using a laudanum to dull the pain of a toothache, wrote: "Opium gives and takes away. It defeats the steady habit of exertion; but it creates spasms of irregular exertion. It ruins the natural power of life; but it develops preternatural paroxysms of intermitting power" (***Confessions of an English Opium – Eater, 1821***). Several historical and significant events centred on opium occurred between China, Britain, India, and the United States of America, including the concession of Hong Kong Island to the British by the Chinese emperor.

Of the more than 25 alkaloids obtained from opium and its extracts, the most important are morphine (4 – 21%), codeine (0.8 – 2.5%), noscapine or narcotine (4 – 8%), papaverine(0.5 – 2.5%), and thebaine (0.5 – 2%). The most significant are: morphine and its salts, which are strongly analgesic, hypnotic, and narcotic. Heroin, formed by the acetylation of morphine, has similar but more pronounced action. Isolated in 1803, morphine came into general use as a painkiller in the 1830s.

6.0 POWER TO MAIM AND KILL

The vegetable kingdom offers an enormous range of poisons. These poisons may be present in the flower, seed, leaf, stem, or root. Their quantity varies according to the time of the year, the time of the day, the soil, and the weather. A dawn killer may be impotent by noon, and a poor soil can restrict the amount of poisonous glycosides or alkaloids present in the plant. Plant products or their derivatives are important to everyday life, whether in an urban or rural area in economically developed countries, or in the third world, because they directly affect our well-being. In these various environments are found hundreds of plants that are injurious if ingested, and are capable of causing any number of symptoms, including death.

Many houseplants are poisonous and children are attracted to the colourful parts of these otherwise harmless organisms in our midst. Few realise, for example, that apple seeds contain cyanide, which may be lethal in large doses; that the eating of green and sprouting parts of potatoes may cause severe poisoning and that common houseplants such as oleanders, caladiums, dieffenbachias and philodendrons must be avoided, for a person ingesting the leaves of oleander, or its sweet nectar, may develop severe vomiting, irregular heartbeat, and respiratory paralysis, followed by death. Hay fever and dermatitis result from an abnormality of our immune system known as allergy. The abundant grasses, trees, shrubs, weeds, and fungi in our environment produce pollen, spores, and other materials to which we become sensitised, so that on re-exposure they cause discomforting symptoms that may become life-threatening.

Certain plants have the disturbing quality of modifying our cells in other ways. Some give rise to mutations that may occur in our reproductive cells, permanently altering succeeding generations if these cells are utilised in reproduction. Others may affect our somatic or body cells in a way that causes congenital abnormalities, resulting in irreparable damage to the foetus. Even more insidious, some plants have the ability to induce cellular aberrations, especially in the peripheral blood, perhaps affecting the immune and clotting systems, and in some instances causing death. Plant proteins, typified by those found in the juice of the pokeweed, enter the body through simple cuts and abrasions to do their damage.

Plants have also developed an array of weapons, like thorns, stinging hairs, irritating leaf surfaces, and a lethal chemical arsenal (secondary metabolites), to ward off herbivores while remaining firmly rooted. Plants are also 'poisonous' to one another – a phenomenon known as allelopathy – essentially a form of chemical warfare between different species of plants. For instance, the walnut tree is not planted in gardens because a chemical known as juglone leaches from the roots and leaves and will inhibit the growth of many common garden

plants especially tomatoes. Some plants arm themselves with poisons or prickles as a deterrent and defence. Others live by killing and overtly lure their prey by means of bright colours and tantalising smells. These are the **plant carnivores**, and animal flesh is a necessary part of their diet. Their techniques range from mechanically operated springs and traps to a more passive enticement into a cup of poison. Their victims are mostly insects, which, once caught, are marinated in digestive acids and absorbed into the plant's channels. But there are cases where such a small fry is left struggling on its gummy foothold as bait for bigger victims such as frogs and lizards. There are hundreds of carnivorous plant species growing in warm and temperate parts of the world, mainly in bogland where the soil's nitrogen supply needs supplementing. These plants are armed with the glutinous mechanism of springs, tubes, and suckers, strangling their improvident prey. Examples include *Utricularia adpressa, Drosera aberrans, Drosophyllum lusitanicum, Nepenthes adnata, Philcoxia bahiensis, Roridula dentata, Triphyophyllum peltatam.*

6.1 Major Poisonous Principles Found among Plants

The major poisonous principles found among plants are organic compounds, such as **alkaloids, diterpenes, cardiac and cyanogenic glycosides, nitro-containing compounds, oxalates, resins and certain proteins and/or amino acids.** Some plants also accumulate inorganic elements, largely from the soil, and these too may have serious effects on animals and/or man.

Table 10: Major Types of Alkaloids Classified by Basic Ring Structure with Examples of Poisonous (and Other) Plants Containing Each (Lewis & Elvin-Lewis, 1977)

Alkaloid Type	Major Alkaloid	Plant: Family	Plant: Genus and Species	Plant: Vernacular Name
Alkaloids with heterocyclic nitrogen atoms				
Pyridine-piperidine	Coniine	APIACEAE	*Conium maculatum*	Poison hemlock
	Arecoline	ARECACEAE	*Areca catechu*	Betel nut palm
	Lobeline	CAMPANULACEAE	*Lobelia inflata*	Indian tobacco
	Piperine	PIPERACEAE	*Piper nigrum*	Pepper
	Isopelletierine	PUNICACEAE	*Punica granatum*	Pomegranate
	Nicotine	SOLANACEAE	*Nicotiana spp., Duboisia Hopwoodii*	Tobacco
Tropane	Egonine (cocaine)	ERYTHROXYLACEAE	*Erythroxylum coca*	Cocaine
	Atropine, hyoscyamine	SOLANACEAE	*Atropa belladonna*	Belladonna
	Scopolamine		*Datura stramonium*	Jimson weed
			Duboisia spp.	
			Hyoscyamus niger	Henbane
			Mandragora officinarum	Mandrake
	Tropine		*Withania somnifera*	
Isoquinoline	Berberine	BERBERIDACEAE	*Mahonja aquifolium*	Oregon grape
	Tubocurarine	MENISPERMACEAE	*Chondodendron tomentosum*	Curare component
	Morphine, codeine noscapine (narcotine), papaverine, thebaine	PAPAVERACEAE	*Papaver somniferum*	Opium poppy
	Berberine, sanguinarine		*Argemone mexicana*	Prickly poppy
	Berberine, sanguinarine, chelidonine		*Chelidonium majus*	Celandine
	Aporphine		*Corydalis caseana,*	Fitweed
			Dicentra spp.	Dutchman's breeches
	Sanguinarine		*Sanguinaria canadensis*	Bloodroot
	Hydrastine	RANUNCULACEAE	*Hydrastis canadensis*	Goldenseal
	Emetine	RUBIACEAE	*Cephaelis ipecacuanha*	Ipecac
Quinoline	Viridicatin	FUNGUS	*Penicillium viridicatum*	
	Acronycine	RUTACEAE	*Acronychiabau eri*	
	Quinine, quinidine	RUBIACEAE	*Cinchona and Remijiaspp*	
Indole	Ergonovine, ergotamine	FUNGUS	*Clavicepspurpu rea*	Ergot
	Psilocybin	FUNGUS	*Psilocybe spp.*	
	Vinblastine, vincristine	APOCYNACEAE	*Catharanthus roseus*	Periwinkle
	Reserpine		*Rauvolfia serpentina*	
	Physostigmine	FABACEAE	*Physostigma venenosum*	Calabar bean
	Gelsemine, sempervirine	LOGANIACEAE	*Gelsemium sempervirens*	Yellow jassamine
	Strychnine, brucine		*Strychnosnux-vomica*	Strychnine
Imidazole	Pilocarpine	RUTACEAE	*Pilocarpus jaborandi*	
Pyrrolizidine	Retrorsine	ASTERACEAE	*Senecio spp.*	Groundsel
		BORAGINACEAE	*Echium plantagineum*	Viper's bugloss
	Heliotrine, lasiocarpine		*Heliotropium europeaum*	Heliotrope
	Monocrotaline, retrorsine	FABACEAE	*Crotalaria spectabilis*	Rattlebox
Pyrrolizidine	Retrorsine	ASTERACEAE	*Senecio spp.*	Groundsel
	Heliotrine, lasiocarpine	BORAGINACEAE	*Echium plantagineum*	Viper's bugloss
			Heliotropium europaeum	Heliotrope
Quinolizidine	Sparteine	FABACEAE	*Cytisus scoparius*	Scotch broom
	Cytisine		*Laburnum anagyroides*	Golden-chain
	Lupinine		*Lupinus spp.*	Lupine

Steroid alkaloids	Cevadine	LILICEAE	***Schoenocaulon officinalis***	
	Ester alkaloisgermidine & germitrine, glycoalkaloid veratrosine		*Veratrum viride*	American hellebore
	Zygacine		*Zigadenus spp.*	Death camas
	Aconitine	RANUNCULACEAE	*Aconitum spp.*	Aconite
	Solanidine	SOLANACEAE	*Lycopersicon esculentum*	Tomato
	Solanidine		*Solanum spp.*	
Purine bases	Caffeine	AQUIFOLIACEAE	*Ilex paraguariensis*	Mate
	Caffeine	RUBIACEAE	*Coffea arabica*	Coffee
	Caffeine	SAPINDACEAE	*Paullinia cupana*	Guarana
	Caffeine	STERCULIACEAE	*Cola nitida*	Kola
	Caffeine	THEACEAE	*Camellia sinensis*	Tea
	Theobromine	STERCULIACEAE	*Theobroma cacao*	Chocolate
Alkaloids without Heterocyclic Nitrogen Atoms				
Alkaloids amines	Ephedrine	EPHEDRACEAE	*Ephedra sinica*	
	Mescaline	CACTACEAE	*Lophophora williamsii*	Peyote
	Cathine	CELASTRACEAE	*Catha edulis*	Chat

6.2 Cyanogenic Glycosides

The glycosides yielding **hydrocyanic acid** (HCN) as one product of hydrolysis are called cyanogenic. Probably the most widely distributed of these is amygdalin which is commonly found in the Rosaceae (rose family). **Amygdalin** is found in large quantities in seeds of **apples** and **pears** and in the stony **seeds, bark and leaves of apricots, bitter almonds, wild and domestic cherries, peaches, and plums**. In the hydrolysis of amygdalin, a two-step process (Fig. 2), two molecules of glucose are released, the first caused by the enzyme amygdalase, the second by prunase. Free hydrocyanic acid is the violently toxic end product of the hydrolysis.

The severity of poisoning from cyanide in plants depends on how much free HCN and/or cyanogenic glycoside exists in the plant. Hydrocyanic acid inhibits the action of the enzyme cytochrome oxidase, the terminal respiratory catalyst linking atmospheric oxygen with metabolic respiration. Therefore,

HCN poisoning is asphyxiation at the cellular level. As little as 0.06g has caused death in man, and the largest dose from which a person has been known to recover is 0.15g.

A wide range of plants possess cyanogenic glycosides capable of releasing HCN. Selected examples of such plants are presented in Table 11, which shows a predominance of genera classified in the Rosaceae. This presentation also illustrates the great number found in the allied Fabaceae (pea family), as well as in the totally unrelated Poaceae (grass family). Some of the common poisonous plants found in Nigeria are shown in Table 12 together with the poisonous part, common and vernacular names.

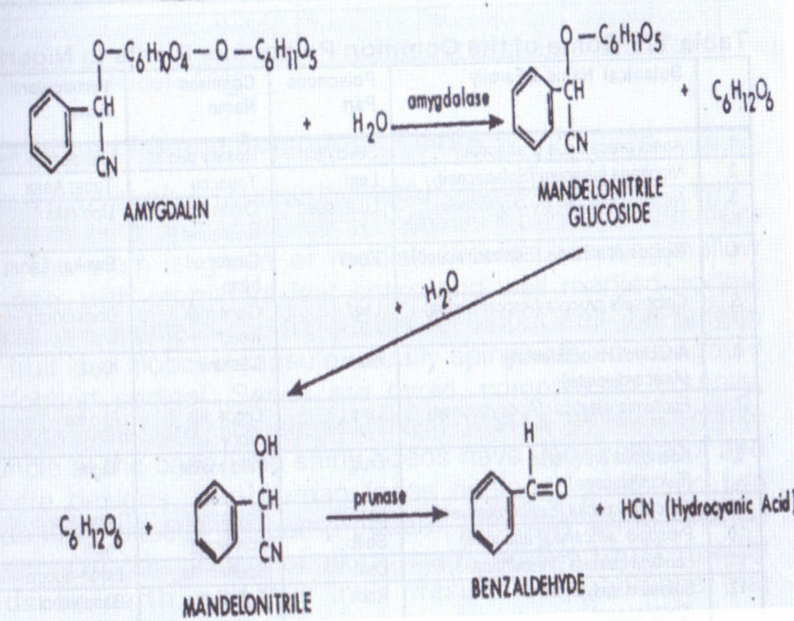


Figure 2: Hydrolysis of Amygdalin

Table 11: Some Important Toxic Plants Having Cyanogenic Glycosides Arranged Phylogenetically

Angiosperms: Dicotyledons
CHENOPODIACEAE. *Suckleya*
PASSIFLORACEAE. *Adenia, Passiflora*
EUPHORBIACEAE. *Manihot, Stillingia*
ROSACEAE. *Cercocarpus, Cotoneaster, Eriobotrya, Malus, Prunus, Pyrus, Rhodotypos*
FABACEAE. *Acacia, Cassia, Dolichos, Lotus, Phaseolus, Trifolium, Vicia*
SAXIFRAGACEAE. *Hydrangea*
MYRTACEAE. *Eucalyptus*
LINACEAE. *Linum*
OLACACEAE. *Ximenia*
CAPRIFOLIACEAE. *Sambucus*
BIGNONIACEAE. *Crescentia*
ASTERACEAE. *Ageratum, Bahia, Florestina*

Angiosperms: Monocotyledons
JUNCAGINACEAE. *Triglochin*
POACEAE. *Cynodon, Glyceria, Holcus, Panicum, Sorghum, Zea*

Table 12: Some of the Common Poisonous Plants in Nigeria

	Botanical Name & Family	Poisonous Part	Common Name	Vernacular Name
1.	*Abrus precatorius (Fabaceae)*	Seed, leaf	Rosary pea	Oju ologbo
2.	*Nicotiana tabacum (Solanaceae)*	Leaf	Tobacco	Taba; Aasa
3.	*Nerium oleander (Apocynaceae)*	Leaf, seed	Oleander; roselaurel	Upe elila
4.	*Ricinus communis (Euphorbiaceae)*	Seed	Castor oil bean	Eweka; Larun
5.	*Calotropis procera (Apocynaceae)*	Leaf	Giant milk weed	Bomubomu
6.	*Anacardium occidentale (Anacardiaceae)*	Seed	Cashew	Kaju
7.	*Funtumia elastica (Apocynaceae)*	Latex	Lagos silk rubber	Ako Ire
8.	*Adenopus breviflorus (Cucurbitaceae)*	Fruit	Wild melon	Itagiri
9.	*Jatropha curcas (Euphorbiaceae)*	Leaf	Physic nut	Lapalapa
10.	*Prosopis africana (Fabaceae)*	Seed	Iron wood	Ayan
11.	*Lantana camara (Verbenaceae)*	Leaf	Spanish flag	Ewon-agogo
12.	*Solanum dasyphyllum (Solanaceae)*	Root	Egg plant	Boboawodi
13.	*Bambusa vulgaris (Poaceae)*	Leaf	Bamboo	Opaarun
14.	*Antiaris toxicana (Moraceae)*	Sap/latex	Poison arrow	Igi oro
15.	*Argemone mexicana (Papaveraceae)*	Fruit, leaf	Prickly poppy	Mafowokan
16.	*Chrysophyllum albidum (Sapotaceae)*	Unripe fruit	Cherry	Agbalumo
17.	*Senna hirsuta (Fabaceae)*	Leaf	Hairy senna	Asunwon
18.	*Erythrophleum suaveolens (Fabaceae)*	All parts	Sasswood	Epo obo
19.	*Plumbago zeylanica (Plumbaginaceae)*	Root, leaf	Wild leadwort	Inabiri
20.	*Capsicum annum (Solanaceae)*	Root	Chilli/sweet pepper	Atarodo
21.	*Urtica dioica (Urticaceae)*	Leaf	Stinging nettle	Esinsin
22.	*Uraria picta(Fabaceae)*	Leaf	Dubra	Aluparada
23.	*Ceiba pentandra(Bombacaceae)*	Stem	Kapok tree	Egungun
24.	*Scleria depressa(Cyperaceae)*	Fruit	Sword grass	Labelabe
25.	*Croton penduliflorus(Euphorbiaceae)*	Seed, leaf	Turk's carp	Aworoso
26.	*Euphorbia unispina (Euphorbiaceae)*	Sap	Cactus	Oro adete
27.	*Cucumis melo (Cucurbitaceae)*	Fruit, sap	Musk melon	Baara-ekute
28.	*Entada gigas(Fabaceae)*	Leaf, fruit	Monkey ladder	Ewe aagba
29.	*Manihot utilissima (Euphorbiaceae)*	Tuber, leaf	Cassava	Ege pupa
30.	*Physostigma venenosum (Fabaceae)*	Bark,seed	Calabar bean	Epo obo
31.	*Cannabis sativa (Cannabaceae)*	Leaf	Marijuana, weed	Igbo; Ako-taba

Source: Olowokudejo 2010

Description of Some Poisonous Plants

Ricinus communis L.(Euphorbiaceae) Castor oil plant

An annual herb or a short – lived perennial about 1 – 8meters high. The stem is green or reddish brown becoming hollow with age, with prominent leaf scars and well marked nodes. Leaves are palmate 4 – 12 partite for about half the length. The fruit is a globose capsule usually spiny with an elongated 3 lobbed pedicel. Seeds are ovoid, compressed dorsally, shinning, pale grey to almost black with a yellowish-white caruncle at the base. The shiny seeds have very beautiful and intricate designs. Like human faces or finger prints, no two seeds have exactly the same pattern, and they exhibit infinite genetic variation. These seeds are **among the most deadly seeds on earth**, and it is their irresistible appearance that makes them so dangerous.

Figure 3: Castor Oil Plant (*Ricinus communis*): Foliage and Seeds

The seeds are poisonous to people, animals and insects. One of the main toxic proteins is "**ricin**" – a potent cytotoxin. One milligram of ricin can kill an adult; symptoms of human poisoning begin within a few hours of ingestion and these are: abdominal pain, vomiting, diarrhoea, sometimes bloody; and thereafter, - severe dehydration, a decrease in urine and low blood pressure and death.

Castor Seeds and the Assassination of a Journalist at a Bus Stop Near Waterloo Station in London
In 1978, the toxic protein (ricin) of the castor oil seed was used to assassinate Georgi Markov, a Bulgarian journalist who spoke out against the Bulgarian Government. He was stabbed with the point of an umbrella while waiting at a bus stop near Waterloo Station in London. The autopsy revealed a perforated metallic pellet that contained the ricin embedded in his leg.

Medicinal Uses of Castor Oil Plant
Ironically, this plant possesses a wide variety of medicinal uses: the oil from the seed is a well-known laxative that has been widely used for over 2,000 years! It is considered to be fast, safe and gentle, prompting a bowel movement in 3 – 5 hours for both the young and the aged. The seed is anthelmintic, cathartic, emollient, laxative, and purgative. It is rubbed on the temple to treat a headache and is also powered and applied to abscesses and various skin infections. The leaves are used as a poultice to relieve headaches and treat

boils. Castor seeds are pressed to extract castor oil which is used for medicinal and other commercial purposes. Ricin does not partition into the oil because it is water-soluble, therefore, castor oil does not contain ricin, provided that no cross-contamination occurred during its production.

In the United States, castor oil has been used by the military in aircraft lubricants, hydraulic fluids, and in the manufacture of explosives. It is now of importance in a wide variety of technical applications due to its unique content of ricinoleic acid. The oil is used, for instance, in the manufacture of some lubricants, plastics, surfactants, paints and dyes and in the preparation of imitation leather. Textile scientists have used sulphonated (or sulfated) castor oil in the dyeing and finishing of fabrics and leather. It has also been used in the synthesis of soaps, linoleum, printer's ink, nylon, varnishes, enamels, and electrical insulations. It is also found in many commercial skin care products. When it is used in the manufacture of soap, it forms a clean, light-coloured soap with a stable lather, which dries and hardens well. It is used for hair conditioners, treating conditions such as dry or brittle, damaged hair or hair loss (as a very thick oil with a slight but prominent odour and slightly sticky texture). It is also often used as an emollient and skin softener, and being free from smell, and has been recommended for medicinal use as a treatment of gastrointestinal problems, lacerations and other skin disorders such as psoriasis.

7.0 POWER TO CURE, NOURISH AND SUSTAIN

Plants that possess therapeutic properties or exert beneficial pharmacological effects on the human body are generally designated as medicinal plants. Medicinal plants naturally synthesise and accumulate secondary metabolites like **alkaloids, steroids, terpenes, flavonoids, saponins, glycosides, cyanogens, tannins, resins, lactones, quinines, volatile oils** etc. Medicinal plants have been used for the treatment of illnesses and diseases since the dawn of time. Ancient Chinese scriptures and Egyptian papyrus hieroglyphics described medicinal uses of plants. Indigenous cultures of Africa and Native Americans used herbs in their healing rituals, while others developed traditional medical systems (e.g. Ayurvedic and Traditional Chinese Medicine) in which herbal therapies were used. Researchers have found that people in different parts of the world tend to use the same or similar plants for treating the same illnesses.

Medicinal plants are of immense value for primary healthcare and income generation for a wide segment of the world's population, most especially in developing countries. World Health Organisation (WHO) consultative group defined a medicinal plant as 'any plant which, in one or more of its organs, contains substances that can be used for therapeutic purpose or which are precursors for the synthesis of useful drugs'. Sofowora (1982) elaborated on this definition to include the following:

(a) plants or plant parts used medicinally in galenical preparations (e.g. decoctions, infusions, etc);
(b) plants used for extraction of pure substances either for direct medicinal use or for the plant hemi – synthesis of medicinal compounds (e.g. hemi–synthesis of sex hormones from diosgenin);
(c) food, spice, and perfumery plants used medicinally;
(d) microscopic plants, e.g. fungi, actinomycetes, used for isolation of drugs, especially antibiotics;
(e) fibre plants, e.g. cotton, flax, jute, used for the preparation of surgical dressings.

The plant kingdom represents a vast emporium of untapped medical potentialities and this has led to a resurgence of interest in ethnomedicine, ethnobotany, and ethnopharmacology (Olowokudejo, 1987; Fadeyi et al., 1989; Olowokudejo, 1993, 2008). Nigeria's vast landscape, variable climate and rich geographical features endowed her with some of the most diverse plant groups in Africa. The wide variety of medicinal plants has been an important part of the health care system in Nigeria since the ancient time (Olowokudejo et al. 1993). The heavy reliance on plant medicine is attributed to their efficacy, relative accessibility, low prices, local availability, and general acceptance by local communities and the

inadequacy of health centres and doctors for health care needs, especially in rural areas (Olowokudejo & Bamgbowu, 1993).

7.1 Global Use and Value of Medicinal Plants

The World Health Organisation (WHO, 1978) estimated that 70-80% of the population in the developing countries depend on herbal traditional medicine as their primary health care (Olowokudejo, 1987; Olowokudejo & Pereira – Shetolu, 1988). Farnsworth &Soejartor (1991) and Srivastava (2001) have observed that the above applies to many people worldwide. With the realisation that it would be impossible to replace herbal medicine with western techniques in the foreseeable future, the WHO established a Division on Traditional Medicine and has been leading a revival of interest in medicinal plants. Ever since the global demand for herbal medicine is not only large but growing (Srivastava, 2000). The market for Ayurvedic medicines is estimated to be expanding at the rate of 20% annually in India (Subrat, 2002), while the quantity of medicinal plants obtained from just one province of China (Yunnan) has grown ten times in the last ten years (Pei Shengji, 2002). An example of increased pressure on collecting grounds is provided by the Gori Valley in the Indian Himalayas where the annual period of Medicinal and Aromatic Plants (MAP) harvesting has increased from two to five months (Uniyal et al., 2002). Contributory factors of the growth in demand for traditional medicine include the increasing human population and the glaring inadequate provision of Western (allopathic) medicine in developing countries as shown for some African countries in Table 13.

Table 13: Ratios of Doctors (Practicing Western Medicine) and Traditional Medical Practitioners (TMPs, Practicing Largely Plant-based Medicine) in East and Southern Africa (Marshall, 1998)

Country	Doctor: Patient	TMP: Patient
Ehiopia	1:33,000	-
Kenya	1:7142 (overall)	-
Malawi	1:833 (urban – Mathare)	1:987 (urban – Mathare)
	1:50,000	1:138
Mozambique	1:50,000	1:200
South Africa	1:1639 (overall)	-
	1:17,400 (home and areas)	1:700 – 1200 (Venda)
Swaziland	1:10,000	1:100
Tanzania	1:33,000	1:350 – 450 (Dar es Salaam)
Uganda	1:25,000	1:708

Herbal medicine is becoming ever more fashionable in richer countries, a market sector which has grown at 10-20% annually in Europe and North America over recent years (ten Kate & Laird, 1999). In addition, there are many related botanical products sold as health foods, food supplements, herbal teas, and for various other purposes related to health and personal care. The extent to which herbal preparations are prescribed within conventional medicine varies greatly between countries, for instance being much higher in Germany than in the UK or USA (Hamilton, 2003).

Plants have contributed hugely to western medicine, through the provision of ingredients for drugs or having played central roles in drug discovery (Bringmann et al., 1997). Some drugs, having botanical origins, are still extracted directly from plants, others are made through the transformation of chemicals found within them, while yet others are today synthesised from inorganic materials, but have their historical origins in research into the active compounds found in plants. There are undoubtedly many more secrets still hidden in the world of plants (Ayensu, 1978; Olowokudejo & Nyananyo, 1990; Olowokudejo & Pereira-Sheteolu, 1992; Mendelssohn & Balick, 1995).

7.2 The Value of Ethno Medicine

In terms of the number of species individually targeted, the use of plants as medicines represents by far the biggest human use of the natural world. Plants provide the predominant ingredients of medicines in most medical traditions. There is no reliable figure for the total number of medicinal plants on Earth, and numbers and percentages for countries and regions vary greatly (Schippmann et al., 2002). Estimates for the numbers of species used medicinally include: 35,000 – 70,000 or 53,000 worldwide (Farnsworth &Soejarto, 1991; Schippmann et al., 2002); 10,000 – 11,250 in China (He & Gu, 1997; Pei Shengji, 200; Xiao & Yong, 1998); 7500 in India (Shiva, 1996); 2237 in Mexico (Toledo, 1995); and 2572 traditionally by North American Indians (Moerman, 1998). The great majority of species of medicinal plants are used only in Folk Medicine. Traditional Medical Systems employ relatively few: 500-600 commonly in Traditional Chinese Medicine (but 6000 overall) (Pei Shengji, 2001); 1430 in Mongolian Medicine (Pei Shengji, 2002b); 1106-3600 in Tibetan Medicine (Pei Shengji, 2001; Pei Shengji, 2002b); 1250-1400 in Ayurveda (Dev, 1999); 342 in Unani; and 328 in Siddha (Shiva, 1996). Plants have always been a rich source of lead compounds, e.g. morphine, cocaine, digitalis and quinine, tubocurarine, nicotine and muscarine. Many of these lead compounds are useful drugs in themselves, e.g. morphine and quinine and others have provided the basis for the production of synthetic drugs (e.g. local anaesthetics developed from cocaine). There is recognition that plants are promising sources of new drugs. Over 120 pharmaceutical products currently in use are plant-derived and at least 75% of these were discovered by examining the use of these plants in traditional medicine. Table 14 shows a list of clinically useful drugs derived from the tropical rainforest (Ayoola, 2008).

Table 14: Some Clinically Useful Drugs from the Tropical Rainforest

Drug	Plant Source – Species & Family	Therapeutic Category
Ajmalicine	*Catharanthus roseus* (Apocynaceae)	Circulatory stimulant, Antihypertensive
Andrographolide	*Andrographis paniculata* (Acanthaceae)	Antibacterial
Arecoline	*Areca catechu*	Antihelminthic, Alzheimer's disease
Asiaticoside	*Centella asiatic* (Umbelliferae)	Vulnerary
Atropine	*Atropa belladonna* (Solanaceae)	Anticholinergic
Bromelain	*Annanas comosus* (Bromeliaceae)(Pineapple)	Anti-inflammatory
Camphor	*Cinnamonuun camphora* (Lauraceae – Camphor tree)	Rubefacient
Chrymopapian	*Carica papaya (Caricaceae)*	Proteolytic; Mucolytic
Cocaine	*Erythroxylum coca* (Erythroxylaceae-Coca)	Local anaesthetic
Curcumin	*Curcuma longa* L. (Zingiberaceae – Turmeric)	Choleretic, antioxidant
Deserpidine	*Rauwolfia tetraphylla* L. (Apocynaceae)	Antihypertensive, Tranquiliser
L-Dopa	*Mucuna deeringiana* (Leguminosae)	Antiparkinsonism
Emetine	*Cephaelis Ipecacuanha (Rubiaceae – Ipecae)*	Amoebicide, Emetic
Glaucarubin	*Simarouba glauca* (Simarcubaceae-Paradise tree)	Amoebicide
Glaziovine	*Ocotea glaziovii* Mez (Lauraceae-yellow cinnamon)	Antidepressant
Gossypol	*Gossypium spp.* (Malvaceae)	Male contraceptive
Hyocyamine	*Hyoscyamus niger* (Solanaceae)	Anticholinergic
Kawaina	*Piper methysticum.* (Piperaceae)	Tranquiliser
Moncrotaline	*Crotalaria spectabilis* (Leguminosae)	Antitumour agent (topical)
Morphine	*Papaver somniferum*	Analgesic
Neoandrographolide	*Andrographic paniculata* (Acanthaceae)	Dysentry
Nicotine	*Nicotiana tabacum* (Solanaceae)	Insecticide
Ouabain	*Strophanthus gratus* (Apocynaceae)	Cardiotonic
Papain	*Carica papaya* (Caricaeae-Papaya)	Proteolytic, Mucolytic
Physostigmine	*Physostigma venenosum* (Leguminosae)	Anticholinesterase
Picrotoxin	*Anamirta cocculuc* (Fish berry)	Analeptic
Pilocarpine	*Pilocarpus jaborandi* (Rutaceae) (Jaborandi)	Parasympathomimetic
Quinidine	*Cinchona ledgerian* (Rubiaceae – Yellow cinchona)	Antiarrhythmic
Quinine	*Cinchona legeriana* (Rubiaceae-Yellow cinchona)	Antimalarial, Antipyretic
Quisqualic acid	*Quisqualis indica.* (Combretaceae)	Antihelminthic
Rescinnami	*Rauwolfia serpentina* (Apocynaceae)	Tranquiliser
Reserpine	*Rauwolfia serpentina/vomitoria*	Tranquiliser

	(Apocynaceae)	
Roriferone	*Rorippa indica* (Cruciferae)	Antitussive
Rotenone	*Lonchocarpus nicou* (Leguminosae-Cube root)	Pesticide
Scopolamine	*Datura metel*(Solanaceae)	Travel sickness
Stevioside	*Stevia rebandiana* Hemsley (Compositeae)	Sweetner
Strychnine	*Strychnos nuz-vomica* (Loganiaceae)	CNS stimulant
Theobromine	*Theobroma cacao* (Cocoa, cacao)	Diuretic; Vasodilator
Tubocurarine	*Chondrodendron tomentosum* (Menispermaceae) Curare	Skeletal muscle
Vasicine (Peganine)	*Adhatoda vasica* (Acanthaceae)	Oxytocic
Vinblastine, Vincristine, Vinorelbine	*Catharanthus roseus* (Apocynaceae-Madagascan periwinkle)	Antitumour agents
Yohimbine	*Pausinystalia yohimba* (Rubiaceae)	Adrenergic blocker, aphrodisiac

Source: Ayoola, 2008

The number of plant species that provide ingredients for drugs used in Western Medicine is even fewer. It was calculated for an article published in 1991 that there were 121 drugs in current use in the USA derived from plants, with 95 species acting as sources (more than one drug is obtained from some species) (Farnsworth & Soejarto, 1991). Despite the small number of source species, drugs derived from plants are of immense importance in terms of number of patients treated. It is reported that ca. 25% of all prescriptions dispensed from community pharmacies in the USA between 1959 and 1973 contained one or more ingredients derived from higher plants (Farnsworth & Soejarto, 1991). A more recent study, of the top 150 proprietary drugs used in the USA in 1993, found that 57% of all prescriptions contained at least one major active compound currently or once derived from (or patterned after) compounds which are derived from plant diversity (Grifo & Resenthal, 1997).

Table 15: Number and Percentages of Medicinal Plant Species Recorded for Different Countries and Regions

The sizes of the floras (Column 3) are from Centres of Plant Diversity (WWF & IUCN, 1994 – 1997), except for the world estimate (bottom row) which is based on an estimate that

270,000 – 425,000 species of vascular plants are already known, with a further 10 – 20% to be discovered (Govaertis, 2001).

Country or Region	Number of Species of Medicinal Plants	Total Number of Native Species in Flora	% of Flora which is Medicinal	References to Figure in Column 2
China	11,146	27,100	41	(Pei Shengji, 2002a)
India	7,500	17,000	44	(Shiva, 1996)
Mexico	2,237	30,000	7	(Toledo, 1995)
North America	2,572	20,000	13	(Moerman, 1998)
World	52,885	297,000-510,000	10-18	(Schippmann et al., 2002)

The value of medicinal plants to human livelihoods is essentially infinite. They obviously make fundamental contributions to human health. Financially, the retail sales of pharmaceutical products were estimated at US$ 80 – 90 billion globally in 1997, with medicinal plants contributing very significantly (Sheldon, et al, 1997). A study of the 25 best-selling pharmaceutical drugs in 1997 found that 11 of them (42%) were either biological, natural products or entities derived from natural products, with a total value of US$ 17.5 billion (Laid & Kate, 2002). The total sales value of drugs (such as Taxol) derived from just one plant species (*Taxus baccata*) was US$2.3 billion in 2000 (Laid & ten Kate, 2002). The world market for herbal remedies in 1999 was calculated to be worth US$ 19.4 billion, with Europe in the lead (US$ 6.7 billion), followed by Asia (US$ 5.1 billion), North America (US$ 1.4 billion) (Land & Pierce, 2002).

Although virtually everyone on Earth benefits from medicinal plants, it is the financially poorest who are typically most closely dependent on medicinal plants – culturally and for their medicines and income (Olowokudejo, 1990, 1992, 2012). Only 15% of pharmaceutical drugs are consumed in developing countries (Toledo, 1995), and a large proportion of even this small percentage is taken by relatively more affluent people. The poor have little alternative to using herbal medicine,

which, anyway, they may prefer – at least for certain conditions (Marshall, 1998). Both rural and urban dwellers, in developing countries, rely on medicinal plants, many rural people still depending largely on plants collected from close to their homes, while town folks depend, for the most part, on dried plants transported in from rural areas.

Medicinal plants provide a significant source of income for rural people in developing countries, especially through the sale of wild-harvested material. The collectors are often herders, shepherds or other economically marginalised sections of the population, such as landless people and women. Between 50 – 100% of households in the northern part of Central Nepal and about 25 – 50% in the middle part of the same region are involved in collecting medicinal plants for sale, the materials being traded on to wholesale markets in Delhi (Olsen, 1997). The money received represents 15 – 30% of the total income of poorer household (Hamilton, 2003).

7.3 Plants Sustain National Economy and Provide Nourishment

Value of Forest Products (Wood)

There are several uses of the forest, but the use generating the largest direct economic revenue is the harvest of wood, i.e. timber logs for sawn wood and wood products, small dimensions for fuelwood and several other uses (World Bank, 1995). The forest wood products are (i) Sawnlogs (ii) Transmission poles (iii) Building poles (iv) Fuelwood (v) Bamboo (iv) Chewing sticks. These products are sold in bundles in various rural and urban markets. Value added to these products comes from (a) Splitting the fuelwood into small bundles, (b) Converting logs into the sawn wood, (c) Producing the chewing sticks from logs, (d) Substituting other building materials with poles, bamboo and raffia roofing. The forest production is a source of input to several economic sectors. Shortage of forest products can have severe economic impacts on traditional economies or when processing sectors lack a raw material and must use more expensive substitutes such as imported goods.

Some of the timber species which are well – known, used locally and also exported in reasonable quantities are listed in Table 16 with their trade names. Some of these species are found in some major timber markets in the country but are no longer as abundant as they were two decades ago. The well-known species are becoming scarce.

Table 16: Timber Species and Their Trade Names in Nigeria

Trade/Common Name	*Botanical Name*
Obeche	*Triplochiton scleroxylon*
Abura	*Mitragyna stipulosa*
Abura	*Mitragyna ciliata*
Apa	*Afzelia africana*
Apa	*Afzelia bipindensis*
Apa	*Afzelia pachyloba*
Mansonia	*Mansonia altissima*
Lagos mahogany	*Khaya ivorensis*
Benin mahogany	*Khaya grandifoliola*
Dry zone mahogany	*Khaya senegalensis*
African walnut	*Lovoa trichilioides*
Iroko	*Milicia excelsa*
Ceiba (Silk cotton)	*Ceiba pentandra*
Gedu	*Entandrophragma angolense*
Afara	*Terminalia superba*
Opebe	*Nauclea diderrichi*
Antiaris	*Antiaris africana*
Omu	*Entandrophragma candollei*
Utile	*Entandrophragma utile*
Ekki	*Lophira alata*
Ogea	*Daniella ogea*
Ebony	*Diospyros crassiflora*
Bombax	*Bombax buonopozense*
Omo	*Cordia platythyra*

Source: Olowokudejo, 2008

Non-Wood Forest Products

Non-wood forest products (NWFPs) play a crucial role in supporting community welfare as significant sources of edible product, fodder, fuel, fertiliser (mulch), fibres, medicines, gums and resins, oil and construction materials. Millions of people around the country living in rural areas in the vicinity of forests subsist on these products. They help to provide opportunities for additional employment and income. Activities related to the

collection and primary processing of NWFPs lend themselves suitable for equitable participation of women and indigenous people. While some of the NWFPs have entered a national and international trade, they tend to have a comparative advantage in supporting the development of rural and backward areas. At the national level, NWFP production and use, both in the informal and formal sectors, involve large numbers of people in harvesting, collecting, processing, marketing and in some cases even exporting. The informal nature of NWFP – transactions often result in the rural producers not receiving an equitable share of the benefits/profits, especially in situations where exploitative trade relationships exist.

NWFPs and Household Food Security

NWFPs are important in household food security because they supplement household agricultural production as shown in Table 17. The varied products are particularly important in reducing the shortage suffered during the period of scarcity of the agricultural cycle. They also help to even out seasonal fluctuations in the availability of food. NWFPs often contribute essential inputs for household nutrition. They are also valued as components of social and cultural identity. Riverine communities in the coastal regions, most especially the Niger Delta zone, derive the majority of their income from three NWFPs in the freshwater swamp forests zone. The products include (i) *Raphia* spp. (gin and larvae), (ii) *Calamus* spp. (Swamp cane), (iii) *Irvingiagabonensis* (Ogbono) (Powell, 1994). The importance of NWFPs is similarly high in villages around Cross River National Park (Infield in Drolet, 1991), Kainji Lake, Okomu and Gashaka – Gumpti National Parks.

Table 17: General Contributions of Forest Food to Human Nutrition

Type of Forest Food	Nutrients
Fruits and berries	Carbohydrates (fructose & Soluble sugars), vitamins (especially C), minerals (calcium, magnesium, potassium); some provide protein, fat or starch.
Nuts	Oils and carbohydrates
Young leaves, herbaceous plants	Vitamins (beta-carotene, C) calcium, iron
Gums and saps	Proteins and minerals

Source: Food and Nutrition Division, FAO (1994)

Apart from meeting the subsistence needs, the potential of NWFPs for poverty alleviation is particularly important. The weight of poverty falls heavily on certain groups among whom are tribal communities who depend on biodiversity products for employment and income derived through collection and processing of a range of NWFPs. Millions of rural workers process NWFPs at home or in local shopfloors to earn the incomes which enable them to survive.

8.0 CULTURAL AND SPIRITUAL POWER OF PLANTS

The power of plants over human life and well-being is not just practical, physical and utilitarian, but also cultural and spiritual. The diversity of the natural world has been a constant source of inspiration throughout human history, influencing traditions and the way our society has evolved. Cultural, amenity and spiritual services provided by ecosystems are highly valued by the poor, and play a key role in the medium to long-term Sustainable Development Strategies. Indeed, cultural diversity itself has been affected by the distribution of biodiversity. Cultural ecosystem service generally depends on the importance of particular cultural relationships with various features of the landscape, such as particular stands of forests, and with specific components of biodiversity, such as particular revered species. The vast majority of formal religions and belief systems have clear links with the natural world (Ash

and Jenkins, 2007). Human beings instinctively derive aesthetic and spiritual satisfaction from biodiversity. Many people derive value from biodiversity through leisure activities such as enjoying a walk in the countryside or natural history programmes on television.

Biodiversity has inspired musicians, painters, sculptors, writers and other artists. Many cultural groups view themselves as an integral part of the natural world and show respect for other living organisms. It has always been known that our emotional well-being is enhanced by the proximity of natural beauty. The strong bond between humanity and biodiversity is reflected in the art, religions and traditions of diverse human cultures. This might have been the reason for the worshipping of nature as gods and goddess as mentioned in some ancient mythologies. In ancient times, the man had been known to worship the sun, the moon, the sky, the rivers, the land, some trees, e.g. Iroko (*Milicia excelsa*), Araba (*Ceiba pentandra*) and Ose (*Adansonia digitata*); in South-western Nigeria). Some of these cultural practices have endured in many traditional societies in Nigeria till today. In general, human cultures coevolved with their environment, and therefore the conservation of biological diversity can also be important for cultural identity. The natural environment provides many inspirational, aesthetic, spiritual and educational needs of people from all cultures both now and in the future. The aesthetic values of our natural ecosystems and landscapes contribute to the emotional and spiritual well-being of a highly urbanised population. The cultural, spiritual and religious significance of biodiversity can be further demonstrated by the diverse values attached to some species of plants. The calabash, known botanically as *Lagenaria siceraria* (Cucurbitaceae), is a flowering plant fruit which occurs in various shapes and sizes. Calabashes have been used as ritual vessels as far back as the 9th century A.D. in Igbo – Ukwu in South-eastern Nigeria (Layiwola, 2008). Apart from their popular function as utilitarian objects in food production, they also function as musical instruments e.g. as rattles, drums, resonators and maracas. Calabashes are also used as media of passing on symbolic messages that are coded but understood within a particular culture and context. They are also easily transformed into beautiful decorative objects. The hard but smooth surface of the calabash is a medium through which Artists further explore form and texture. They are also used in many professions such as farming, fishing and wine-tapping among others. One of the most popular cultural festivals in Nigeria, The Argungu Fishing festival in Kebbi State is hinged on the calabash. In Northern Nigeria and the northern fringes of Edo State, young women and girls usually display beautifully decorated calabashes during cultural festivals. Calabashes were also used as a means of expressing African philosophical thoughts. For instance, when a king was to be dethroned he was not told verbally to desert the throne of his forefathers. Such messages were couched in metaphoric language to ease the pain of abdication. In Oyo kingdom, South-western Nigeria, a white calabash was sent to the king who would have to abdicate the throne soon after receiving it (Layiwola, 2008). In Igbo culture (South-eastern Nigeria) the calabash was used as a means of severing links between the spirit and the living world. When a man dies, the cup-shaped calabash which he uses to drink palm wine in his lifetime would be broken at the last stage of his burial rites. This act signifies that he has transcended from earth to the spirit world and disengaged from the gatherings of village elders. The calabash cup personified the owner and it was forbidden for anyone to drink from another person's cup at any time. Moreover, one of the most established uses of calabashes in African Traditional Religion is their use as vessels for conveying sacrifices to the gods during ancestral worship.

In traditional African societies, trees and forests played and still play significant roles in settlement patterns and group identity. For instance, many communities, public spaces, bus stops and landmarks are named after dominant tree species located in that vicinity as shown in Table 18.

Table 18: Communities, Public Spaces and Bus Stops Named after Plant Species

S/N	Vernacular / Common Name	Plant Species	Botanical Family
1.	Idi Araba	*Ceiba pentandra*	Bombacaceae
2.	Idi Iroko	*Milicia excelsa*	Meliaceae
3.	Idi Oro	*Irvingia gabonensis*	Irvingiaceae
4.	Breadfruit	*Artocarpus communis*	Moraceae
5.	Idi Awin	*Dialium guineese*	Fabaceae
6.	Idi Ose	*Adansonia digitata*	Bombacaceae
7.	Idi Omo	*Cordia millenii*	Boraginaceae
8.	Idi Emi	*Butyrospermum paradoxum*	Sapotaceae
9.	Idi Ayunre	*Albizia zygia*	Fabaceae
10.	Idi Aape	*Eclipta prostrata*	Asteraceae
11.	Idi Aba	*Symphonia globulifera*	Guttiferae
12.	Idi Isin	*Blighia sapida*	Sapindaceae
13.	Idi Ori	*Syzygium guineense*	Myrtaceae
14.	Oke Ako	*Brachystegia eurycoma*	Fabaceae
15.	Oke Igbo	Forested hill	Many families
16.	Palm grove	*Elaeis guineensis/ Roystonea spp.*	Palmae
17.	Idi Odan	*Ficus thonningii*	Moraceae
18.	Idi Agbon	*Cocos nucifera*	Palmae
19.	Idi Ope	*Elaeis guineensis*	Palmae
20.	Idi Mongoro	*Mangifera indica*	Anacardiaceae
21	Idi Arere	*Triplochiton scleroxylon*	Sterculiaceae

Source: Olowokudejo, 2010

According to the Catholic Encyclopaedia, about 130 plants, some of which have medicinal properties and most of which are native to Egypt and Palestine are mentioned in the Bible. Examples of symbolic usage of plants in the scriptures include the following:

- **Lilies of the field** – refers to God's generosity and benevolence (Matthew 6:28); (*Clethra arborea*).
- **Olive tree** – symbolises fruitfulness, blessing and happiness, the emblem of peace and prosperity as well as fertility (Romans 11: 17 – 24); (*Olea europaea*).
- **Mustard seed** – depicts the unimaginable greatness of the Kingdom of God (Mark 4: 30 – 32, Matthew 13: 31 – 32); (*Brassica juncea*).
- **All flesh is grass** – indicates the similarity and seasonality of all life forms (Isaiah 40: 6).

- **Withering grass and fading flowers** – symbolise the transience of life (Isaiah 40: 7 & 8); (Family Poaceae).
- **Branches of palm trees** – signify victory and triumph (John 12: 13). (*Elaeis guineensis*).
- **Thorns and thistles** – symbolise sin and its consequences (Genesis 3: 17-18).
- **The fir tree, the pine tree** – represent beauty, glory and virtue (Isaiah 60: 13) (*Pinus* spp.).
- **Vine** – symbolises the relationship between God and humanity (John15:1) (*Cissus quadrangularis).*
- **The wormwood** – typifies bitterness, sorrow and suffering (Jeremiah 9: 13-15).

In the Authorised King James Version of the Holy Bible, Book of Genesis, Chapter two, copious references are made to GARDEN and PLANTS: Verse 8 says, *"And the LORD God planted a garden eastward in Eden; and there he put the man whom he had formed'.* Verse 9 states: *And out of the ground made the LORD God to grow every tree that is pleasant to the sight, and good for food; the tree of life also in the midst of the garden, and the tree of knowledge of good and evil.* Verse 15: *And the LORD God took the man, and put him into the garden of Eden to dress it and to keep it.* Verse 16: *And the LORD God commanded the man, saying, Of every tree of the garden thou mayest freely eat:* Verse 17: *But of the tree of the knowledge of good and evil, thou shalt not eat of it: for in the day that thou eatest thereof thou shall surely die."* These revelations are quite instructive regarding the gardens full of trees and how humans should relate to them.

In traditional societies, the palm frond is also used to demarcate disputed land areas or plots of land that must not be trespassed. The sacredness of shrines is also publicised by adorning them with palm fronds while it indicates the presence of a corpse in a vehicle. In Yorubaland, the leaves of the evergreen tree, Akoko (*Newbouldia laevis)* is an integral component of chieftaincy title conferment rituals.

9.0 PLANTS AS STIMULI OF EXPLORATION AND CIVILISATION

Plants have had a profound influence on man's economic, cultural, and political history. Civilisation would have been impossible without the tilling of land and the deliberate sowing or planting of crop plants- what we now refer to as Agriculture. Before agriculture, people and their ancestors depended for food upon their activities as gatherers and hunters. In ancient preagricultural days, carelessness may sometimes have caused some of the collected grain from the wild grasses to be scattered around the habitation site, where it then germinated. It is likely that the ground near such a place of abode was particularly rich in nitrogen from rubbish and excreta, and, in this soil, seedlings then grew into luxuriant plants. This process might easily have suggested to early man the idea of deliberately sowing seed in order to produce high-yielding plants in proximity to his habitation.

Although the first development of agriculture may have involved plants with food-storing underground parts, it is certain that the development of cereals also came at a very early stage, and it is a significant fact that we know of no important civilisation that was not based on some kind of cereal. Cereals have many advantages as food plants, even apart from their high yield per acre. Their grain-one-selected fruits are compact and dry, and so they store well. They contain carbohydrates, fats, protein, minerals, and vitamins, and thus truly can be called the **staff of life.** The straw from the cereal plants can be used for baskets and bedding, and for the construction of houses. Cereals provide excellent food, but, unlike the root crops, they demand a truly sedentary population. Generally, they can be sown and reaped only at definite times of the year and will not last if they are left beyond the time for harvesting. Nevertheless, the high-yielding, storable nutritious crop they provide offers the possibility of some measure of relaxation to a cereal-growing community. There is time for education and the transmission of knowledge and, therefore, for progress in civilisation. In the Asian tropics, rice promoted the development of civilisation; in its absence, large and concentrated populations did not develop. More than half of the world population depends heavily upon rice for sustenance – in Central and South America now, as well as Asia. Two species are cultivated: *Oryza glaberrima* in West Africa, and *Oryza sativa*, the common rice of the world.

Spices have sometimes been so important that they have been used in place of money. In medieval England, rents and taxes were often exacted in "peppercorns," the dried berries of the true pepper plant. The search for spices and shorter routes for bringing them to Europe constituted a powerful stimulus for exploration and exploitation of newly discovered territories, and naval power became necessary for the protection of trade routes from pirates. **Much of the exploration of the world during the fifteenth and sixteenth centuries was incidental to the quest for spices.** The rediscovery of the American continent by **Columbus** was directly inspired by the search for a shorter route to the spices of the Indies, particularly pepper, and the cost of Magellan's ill-fated voyage around the world (1519 – 1522) was completely paid for by the cloves and other spices that the one surviving vessel brought back to Europe. The use and cultivation of spice plants go back to the beginning of history, and in China, as well as in the ancient civilisations of Egypt, Greece, and Rome, spices were highly prized. One famous spice, **cinnamon**, is mentioned in the **Song of Solomon** and the **Book of Proverbs.** It had already been used in anointing and embalming the dead in ancient Egypt. Many spices are products of the islands of Asia rather than the land mass, and in this connection, one of the most famous groups of islands is the Moluccas, the so-called "Spice Islands," to which nutmeg and clove trees were restricted as wild plants. Next in importance is Sri Lanka, which to this day is almost the only supplier of true cinnamon, produced from the bark of the evergreen shrub *Cinnamomum zeylanicum,* a member of the Lauraceae – the laurel family (Baker, 1978).

Table 19: Plants Species and Parts Used to Season or Flavour (Spices) and Main Sources

S/N	Spice	Botanical name	Parts used; remarks	Main source
1	Allspice	*Pimento officinalis*	Powdered dried fruit	Jamaica
2	Almond	*Prunus amygdalus*	Seed oil use for flavoring baked goods	Mediterranean; USA
3	Basil	*Ocimum basilicum*	Leaves in meat dishes, soups, sauces	Mediterranean
4	Bell pepper	*Capsicum frutescens*	Dried, diced fruit	Widely cultitvated
5	Black pepper	*Piper nigrum*	Dried fruits used as a condiment	India, Indonesia
6	Borage	*Borago officinalis*	Leaves used as beverage flavoring	England
7	Cassia	*Cinnamomum cassia*	Powdered bark used	S.E. Asia
8	Cayenne pepper	*Capsicum annuum, Capsicum frutescens*	Powdered dried fruits	American tropics
9	Chocolate	*Theobroma cacao*	Ground seeds used for flavouring	Africa, South America
10	Cinnamon	*Cinnamomum zeylanicum*	Ground bark, oil from leaves	Seychelles, Sri Lanka
11	Citrus	*Citrus spp.*	Fruits, especially rinds	Medit, S.Africa, USA
12	Cloves	*Syzygium aromaticum*	Dried flower buds	Moluccas
13	Coffee	*Coffea arabica*	Roasted seeds	Tropics
14	Coriander	*Coriandrum sativum*	Ground seeds	Mediterranean
15	Cubebs	*Piper cubeba*	Dried fruits used as seasoning	East Indies
16	Eucalyptus	*Eucalyptus spp.*	Oils from leaves used in tooth pastes	Australia
17	Fennel	*Foeniculum vulgare*	Seeds used in baked goods	Europe
18	Garlic	*Allium sativum*	Fresh or dry bulbs	Widely cultivated
19	Ginger	*Zingiber officinale*	Dried rhizomes	India, Taiwan
20	Grains of paradise	*Aframomum melegueta*	Seeds used to flavor beverages	West Africa
21	Nutmeg	*Myristica fragrans*	Seeds used to flavor foods	Grenada; Indonesia
22	Peppermint	*Mentha piperita*	Oil from leaves	U.S., Russia
23	Poppy	*Papaver somniferum*	Seeds used in baking	Widely cultivated
24	Saffron	*Crocus sativus*	Dried stigmas	Spain; India
25	Sesame	*Sesamum indicum*	Seeds used in baking	Asia
26	Tansy	*Tanacetum vulgare*	Leaves	Europe; Asia
27	Thyme	*Thymus vulgaris*	Leaves	Widely cultivated
28	Turmeric	*Curcuma longa*	Rhizomes powdered	India; China
29	Vanilla	*Vanilla planifolia*	Fruit extracts for flavouring	Malagasay

Source: Olowokudejo, 2012

9.1 The Potato Famine and Irish Emigration

Not only have plants stimulated exploration and exploitation, they have also been responsible – often in a negative way – for human migrations. The failure of the potato to support the Irish people in the middle of the nineteenth century produced one of the most dreadful famines in the history of the Western world, followed by an unparalleled migration. The Potato, *Solanum tuberosum,* was introduced into Ireland at the end of the sixteenth century and was so rapidly adopted by the poverty-stricken population that within fifty years it was the staple food of the whole country. On this diet the Irish peasantry survived until, in 1845 and 1846, the "potato blight," a fungus disease caused by *Phytophthora infestans,* swept over Europe, blackening the leaves of the plants and causing their tubers to rot. Purely vegetative propagation of this plant, done by planting portions of the potato tuber that bear "eyes" (shoot buds), had led to uniformity of genetical constitution of the plants in any area. Technically speaking, all the plants "belonged to the same clone." This meant that once the disease entered a country, all the plants were equally susceptible to it and the epidemic was unstoppable.

In Ireland, over a million persons died of famine and disease, and another million were forced to emigrate within the next few years, mostly to the New World. As the potato's chief biographer, Redcliffe Salaman, has written, "History has few parallels to such a disaster – a disaster due to the criminal folly of allowing a single, cheaply produced foodstuff to dominate the dietary of the people."

9.2 Multipurpose Plants

An important feature of the early cultivated plants is that they have many uses. Hemp can be used as a fibre plant or as a drug plant; in addition, a useful oil can be obtained from its seeds.

Some of the best examples of multipurpose plants are trees. The baobab tree, *Adansonia digitata* (Bombacaceae), in the savanna regions of Africa, while not so much cultivated as

protected, has long been put to many uses. Rope can be made from its bark; its leaves can be dried and used as medicine or to thicken stews. The fruits contain seeds that are a rich source of oil, and the pulp in which they are embedded has long provided Africans with a refreshing drink containing tartaric and other acids. This pulp is also an excellent source of vitamin C. The hollowed-out trunks of old baobab trees also have their uses. They can be used to hold water (a precious commodity in the savanna regions where these trees grow) or for the dry storage of materials. And in these lands where it is difficult to bury corpses in hard ground during the dry season, the dead may be allowed to mummify inside a baobab trunk.

In China, the mulberry tree, *Morus alba* (Moraceae), which has been used since antiquity, grows around villages. It is also a multipurpose plant; the fruit is excellent for human consumption and the leaves are food for silkworms. Its wood is valuable, and a yellow dye can be extracted from its roots.

Another example of a multipurpose plant is the Coconut palm, *Cocos nucifera*, which for coastal peoples throughout the tropics, is an almost universal provider. It has been described as one of nature's greatest gifts to man. It displays the whole range of human dependence on palm products. Its uses are legion.

The Oil palm tree (*Elaeis guineensis*) also has a multitude of uses. It gives the highest yield per unit area of any crop and produces two distinct oils, palm oil and palm kernel oil, both of which are important in world trade. The fronds, leaves, trunk and fibres have a series of uses.
In some countries, several species of the genus *Agave* are renowned as having "a thousand uses".

10.0 PLANT TAXONOMY / PLANT SYSTEMATICS / SYSTEMATIC BOTANY

Plant Taxonomy is defined as the study and description of the variation of plants, the investigation of the causes and consequences of this variation, and the manipulation of the data obtained to produce a system of classification. It is the botanical discipline that pertains to the **classification, nomenclature,** and **identification** of plants. A Taxonomist or Systematist is one who uses many approaches to fit together appropriately, into an orderly storage and retrieval system with a name reference base, the information about organisms gathered by morphologists, anatomists, cytologists, palynologists, embryologists, geneticists, physiologists, biochemists, ecologists, geographers, paleobotanists and molecular systematists. A Systematist is a collector, analyser and synthesiser of information from all fields of evidence for the characterisation, identification and classification of organisms.

Classification (as a process) is the production of a logical system of categories, each containing any number of plants, which allows easier reference to its components (kinds of plants); it is the process of ordering plants into groups which are arranged hierarchically. The term (as an object) is also used for the ensuing arrangement of which there are many sorts. Classification is an information storage and retrieval system: without it there would be chaos (Heywood, 1967). **Identification** is the determination of a plant as being identical with or similar to another known plant; it implies assigning a plant to a particular taxonomic group – ultimately to the species. The plant is therefore given a name by recognising that it belongs to a previously described taxon. The study of the system and methods of naming organisms, and the construction, interpretation and application of the regulations governing this system, is covered by the term **Nomenclature.** It is concerned with the determination of the correct name of a plant according to a nomenclatural system.

Taxonomy can lay claims to being the oldest, the most basic, the most all-embracing and the ultimate (the most derived or synthetic) of all the biological sciences. It is basic because no progress on understanding the wealth of variation can be made until some sort of classification is adopted, and ultimate because taxonomy is not complete until the data from all other

fields of investigation have been incorporated. This dual property is not, of course, manifested in two separate stages, but by a continuous process of anabolism and catabolism as more and more data are utilised.

Plant Taxonomy or Plant Systematics is a broad, unifying and integrating field of science which uses characteristics and data from many disciplines in carrying out its primary objectives of describing, naming, classifying, identifying and determining the relationship of organisms. Systematic data are accumulated from research in the field, laboratory, garden, the herbarium and the library (Fig.4). Systematics is a dynamic science. The duties of the Systematist are neverending. As long as the plant world exists, there will always be more to learn about plants, plant products and plant taxa, for both practical and theoretical purposes. The great challenge today is how to preserve the plant life of the world. We need to learn more about these organisms which are basic to our survival, and how to store and retrieve the vast amount of information on plants for man's use. Taxonomy is the pedestal upon which biology is built; without it, there will be chaos. Also in the determination of relationships based upon diverse characteristics derived from many sources, it is the unifying and integrating discipline which represents the peak of biological endeavour (Radford et al, 1974). Taxonomy synthesises information from various disciplines such as Morphology, Anatomy, Ecology, Geography, Cytology, Genetics, Cytogenetics, Embryology, Palynology, Physiology, Phylogeny, History, Evolution, Palaeobotany, Chemistry and Molecular Studies (Fig.5). The information obtained from these specialised disciplines, according to Solbrig (1966), has affected and profoundly modified the field of taxonomy, transforming it from a mere effort to classify into the scientific enterprise of discovering and understanding the reasons for the apparent order of nature. Taxonomy, in turn, gives back the synthesised information to these disciplines by providing the names, relationships and other pertinent pieces of information on the plant in question.

What is a Name?

A name is a conventional symbol or cipher, which serves as a means of reference and avoids the need for continuous use of a cumbersome descriptive phrase. The purpose of names is to act as vehicles of communication. Names must be clearly understood and have the same meaning for all who use them; implying that they must be unambiguous and universal.

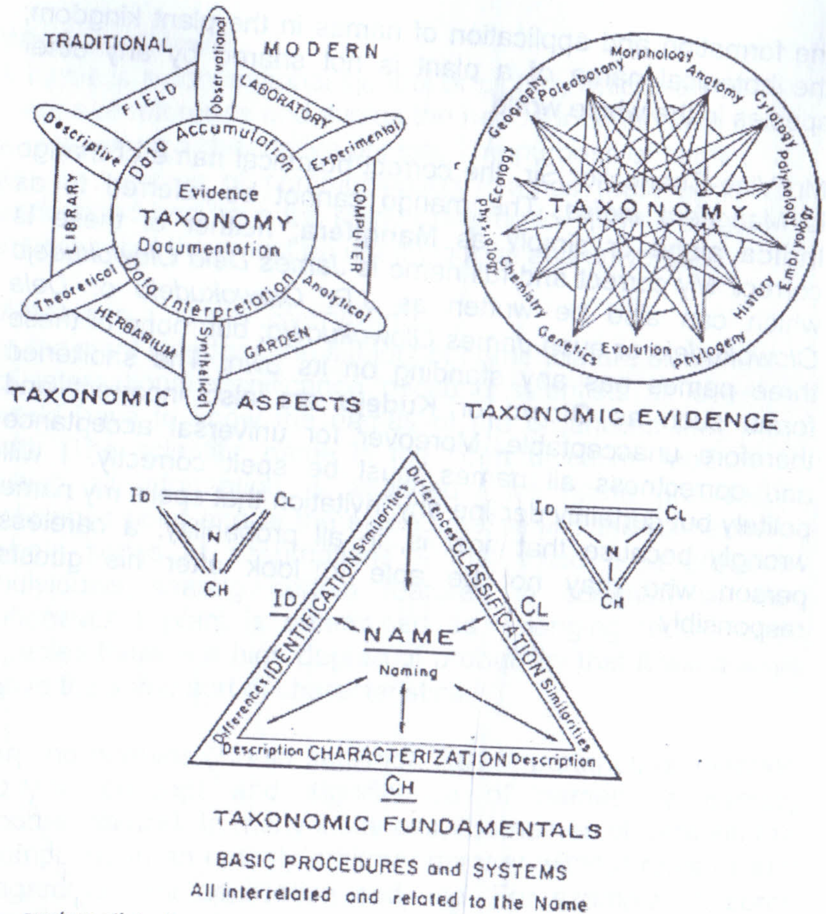
What is in a name? Everything!

In the plant kingdom, the subject of nomenclature or naming is of international significance because scientists all over the world have to know the names of the organisms they work with. The scientific name is the communication medium to which all information is attached. The name provides a reference point and at the same time behind the name lies a whole series of assumptions – that there is a group of individuals sharing certain features in common so that whenever a plant is determined as belonging to a named species there is a high degree of probability that it will always have the same sort of characteristics.

Among humans (*Homo sapiens)*, little importance is attached to the concept and significance of names or naming (nomenclature). In many instances, the names of persons are composed in an entirely arbitrary manner without rules or any regard to their application and use. For example, in some families the father's name is transferred to the first son and the only distinguishing factor is the word 'senior' or 'junior'; i.e. Olufemi Adebayo **Snr.** and Olufemi Adebayo **Jnr.** In other cases, the father's name is adopted as both the surname and first name, i.e. Inyang Inyang, Okoro Okoro, Adamu Adamu, Mohammed Mohammed, etc. As a result of these ambiguities, it is almost impossible to store or retrieve any information pertaining to these human beings, in the absence of their fingerprints or DNA, and this leaves room for impersonation and fraud. Moreover, many individuals bear the same names e.g. Ade Lawal, within one family or small space, and they can only be distinguished by qualifying with their height, stature or complexion. On the contrary, there are strict rules governing

the formation and application of names in the plant kingdom; the botanical name of a plant is not shared by any other species in the whole world.

Mr. Vice-Chancellor Sir, the correct botanical name of mango is *Mangifera indica*. The mango cannot be referred to as **Indica** alone or simply as **Mangifera**; neither of these is correct. My correct and full name is *James Dele Olowokudejo* which can also be written as *J.D. Olowokudejo* or *Dele Olowokudejo* or even *James Olowokudejo*; but none of these three names has any standing on its own. The shortened forms such as **Olowo** or **Kudejo** are also incorrect and therefore unacceptable. Moreover for universal acceptance and correctness all names must be spelt correctly. I will politely but certainly decline any invitation that spells my name wrongly because that host is, in all probability, a careless person who may not be able to look after his guests responsibly.



A systematist is one who uses many approaches to fit together appropriately, into an orderly storage and retrieval system with a name reference base, the information about organisms gathered by morphologists, anatomists, cytologists, palynologists, embryologists, geneticists, physiologists, bio-chemists, ecologists, geographers, paleobotanists and systematists. A systematist is a collector, analyzer and synthesizer of information from all fields of evidence for the characterization, identification and classification of organisms.

Figure 4: Systematics Prospective and Summary
Source: Radford et al 1974

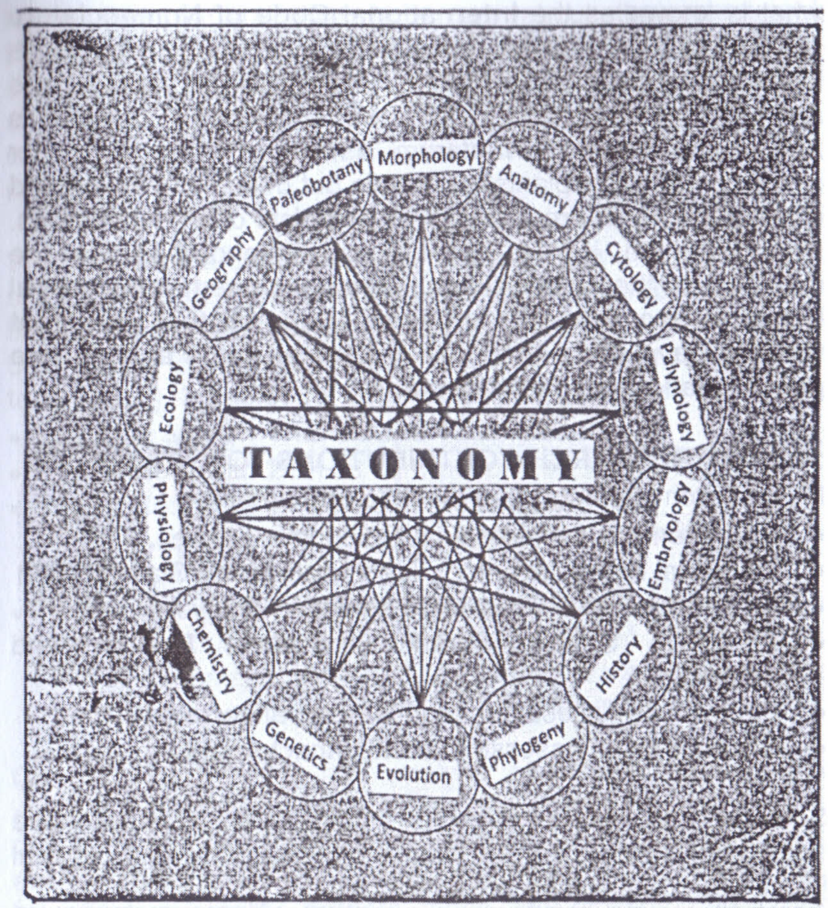


Figure 5: Sources of Taxonomic Evidence

In 1867, more than 100 years after the book *Species Plantarum* (1753) was published by the Swedish naturalist Carolus Linnaeus (1707 – 1778), about 150 European and American botanists met in Paris to standardize rules governing the naming and the classifying of plants. They agreed to use the works of Linnaeus as the starting point for all scientific names of plants and decided that his binomials (binary names), or the earliest ones published after him, would have priority over all others. International congresses of botanists have met at varying intervals since 1867 and have revised and expanded these rules. Today, the modified rules comprise what is known as the **International Code of Nomenclature (ICN),** which is a single book with a common index to its English, French, and German translations of the various rules and recommendations. It now specifically recognizes Linnaeus's *Species Plantarum* as the starting point for scientific names of plants and spells out details of naming and classifying, which are followed by botanists of all nationalities. Nowadays the ICN is ratified and emended during the meetings of the Nomenclatural Section of each International Botanical Congress. **It is universally agreed that one plant will not have more than one botanical name and no two plants shall have the same name.**

11.0 MY RESEARCH CONTRIBUTIONS TO KNOWLEDGE

My research interests span the following areas:

- Biosystematic and Classical Taxonomic Studies,
- Medicinal Plants Inventory, Identification and Classification
- Ethnobotanical Studies and Vegetation Analysis,
- Mangrove Swamp Forest Ecosystem: Ecology and Taxonomy,
- Biodiversity Assessment and Conservation, and
- Environmental Assessment and Impact Analysis.

Some of my significant results and discoveries which have been published in top international botanical and biological journals are highlighted hereunder.

11.1 Biosystematic and Classical Taxonomic Studies of various plant genera and species

The Genus *Biscutella L.* (*Cruciferae*)

Biscutella is a genus of 40 – 80 species which are widely distributed in the Mediterranean region, Central Europe and North Africa. The genus is notorious for its taxonomic complexity mainly because it lacks good characters. The floral and fruiting features show relative uniformity in many taxa and they are unreliable when they do vary. The vegetative parts which have traditionally provided most of the characters are

highly variable and little is known about their range of plasticity. The intricate patterns of morphological variations and polymorphic nature of species in the genus have led students of the group to different conclusions concerning the most natural and desirable taxonomic treatment of the species.

We undertook a comprehensive taxonomic and biosystematic study of this genus throughout its range and reported many findings that were new to science. Chromosome counts were determined for **46** populations of *Biscutella* representing **28** taxa (Fig. 6). Some of the species were found to be:

- **Diploid** with 2n = 12, 16 and 18 chromosomes.
- **Tetraploid** with 2n = 36 chromosomes.
- **Hexaploid** with 2n = 54 chromosomes.
  These constitute a complex **Polyploid Series within a single genus.**
- Chromosomal **instability** was discovered in two species complexes: *B. variegata (sensu lato)* with 2n = **53 or 56 or 57 or 58** instead of **54** and in *B. laevigata* subsp.*laevigata* with 2n = **34 or 35 or 37** instead of **36** (Fig. 6).

Crossing Experiments and analysis of hybrids showed that various instraspecific populations are closely related despite their geopraphical separation. The hybridization experiments also revealed that the ploypoid populations are not separated by effective sterility barriers since the diploids can cross readily with the tetraploids to produce fertile triploid hybrids.

While polyploidy is no longer regarded as an automatic indicator of specific status, due recognition must be given to it as an important evolutionary mechanism and, by inference, of taxonomic significance.

An investigation of the breeding system revealed the following:

- **Annual species** were **self-compatible** and partially **inbreeding**
- **Most perennial** species were **self-incompatible** and **outbreeding**
- **One species**, *Biscutella cichoriifolia* Loisel, showed **both systems (Fig. 7).**

The totality of taxonomic evidence gathered during the research led to the recognition and publication of new plant groups (taxa) and realignment of others, which are new to science (Olowokudejo & Heywood, 1984). As a result of these investigations a new classification which recognised two subgenera, two sections and many varieties which have been described and published by Olowokudejo (1985, 1986a, 1986b, 1986c, 1986d, 1986e, 1986f, 1986g, 1986h). The new classification included the following:

(A) INFRAGENERIC CLASSIFICATION:
   1. **Subgenus** BISCUTELLA:
      (a) Section BISCUTELLAE.
      (b) Section LAEVIGATAE (Malin.) Guinea.
   2. **Subgenus** JONDRABA (Medik.) Coss.

(B) INFRASPECIFIC CLASSIFICATION

New Taxa, New Combinations and Nomenclatural Adjustments

Variation studies and biometric analysis of some species complexes (Figs. 8 – 10) have resulted in the recognition of 14 new taxa (as summarised hereunder), which have been published (Olowokudejo & Heywood, 1984, 1995; Olowokudejo, 1986)

1. *Biscutella variegata* Boiss & Reuter var. *variegata.*
2. *B. variegata* Boiss & Reuter var. megacarpaea (Boiss & Reuter) Olowo. *status nova.*
3. *B. variegata* Boiss & Reuter var. *foliosa* (Mach. – Laur.) Olowo. *status nova.*
4. *Biscutella sempervirens* L. var. *elvira* Olowo., *varieta nova.*

5. *Biscutella glacialis* (Boiss & Reuter) Jord. var. *glacialis.*
6. *B. glacialis* (Boiss & Reuter) Jord. var. *harana* Olowo. *varieta nova.*
7. *Biscutella valentina* (L.) Heywood var. *tenuicaulis* (Jord.) Olowo. *comb. nova.*
8. *B. valentina* (L.) Heywood var. *leptophylla* (Pau) Olowo. *comb. nova.*
9. *B. valentina* (L.) Heywood var. *pinnata* Olowo. *var. nova.*
10. *B. lusitanica* Jord. var. *macrocarpa* (Samp.ex Guinea) Olowo. *comb. nova.*
11. *Biscutella coronopifolia* L. var. *coronopifolia.*
12. *B. coronopifolia* L. var. *intricata* (Jord.) Mach. – Laur.
13. *B. coronopifolia* L. var. *polyclada* (Jord.) Olowo. *comb. nova.*
14. *B. coronopifolia* L. var. *pinnatifida* (Jord.) Olowo. *comb. nova.*

Population Variation in *Persicaria salicifolia* (Polygonaceae) in Nigeria

The detailed taxonomic evaluation revealed taxa relationships and the phenomenon of distyly which was discovered and published for the first time. The variation in style length in relation to the stamens proved to be altitude dependent and genetically fixed. Consequently, the species was split into two subspecies: *Persicaria salicifolia* subsp. *salicifolia* and *P. salicifolia* subsp. *mambillensis* Ayodele, named after Mambilla Plateau in North-Eastern Nigeria where it was discovered and collected for the first time. This taxon has been validly published and it is now a recognised plant group in science (Ayodele & Olowokudejo, 2002). While Hutchinson & Dalziel (1954) recognised 5 genera and 15 species in the family Polygonaceae, Ayodele & Olowokudejo (2006) documented eight genera and 18 taxa including one introduced taxon for the subregion. Further taxonomic analysis of the family has resulted into a new species tentatively referred to as *P. nigerica* Ayodele.

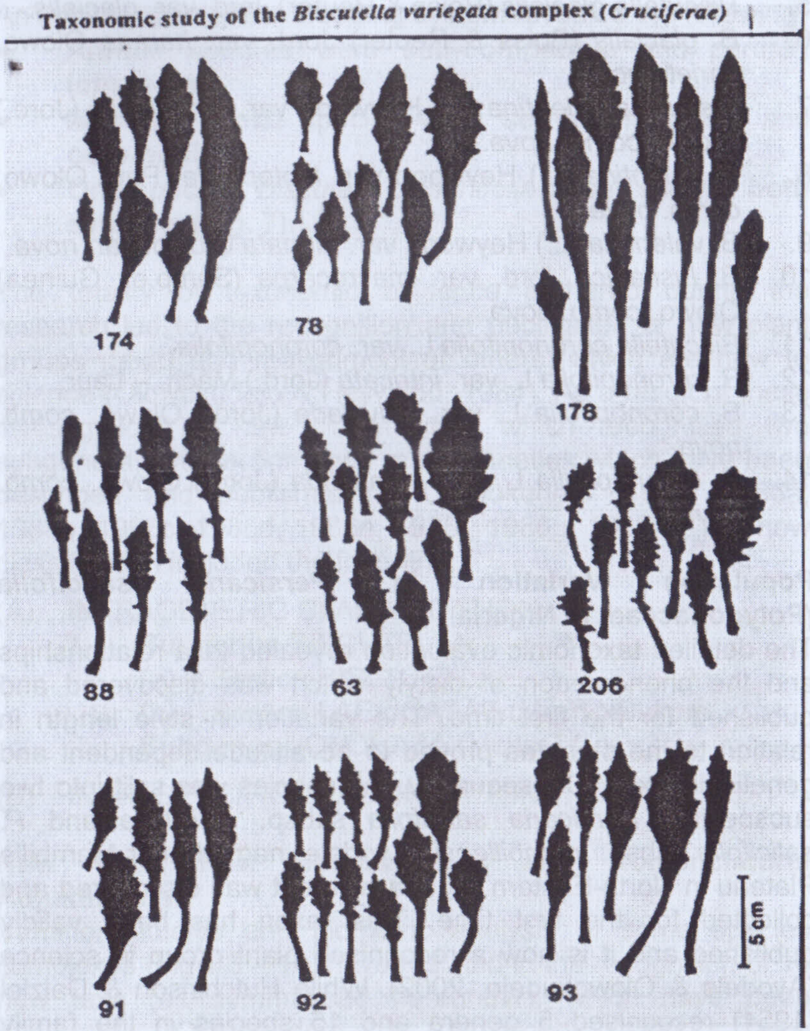


Figure 8: Silhouttes of representative leaf forms illustrating the range of variation within and among 9 representative population samples of the Biscutella variegata complex. Numbers are of populations studied

Source: Olowokudejo & Heywood, 1995

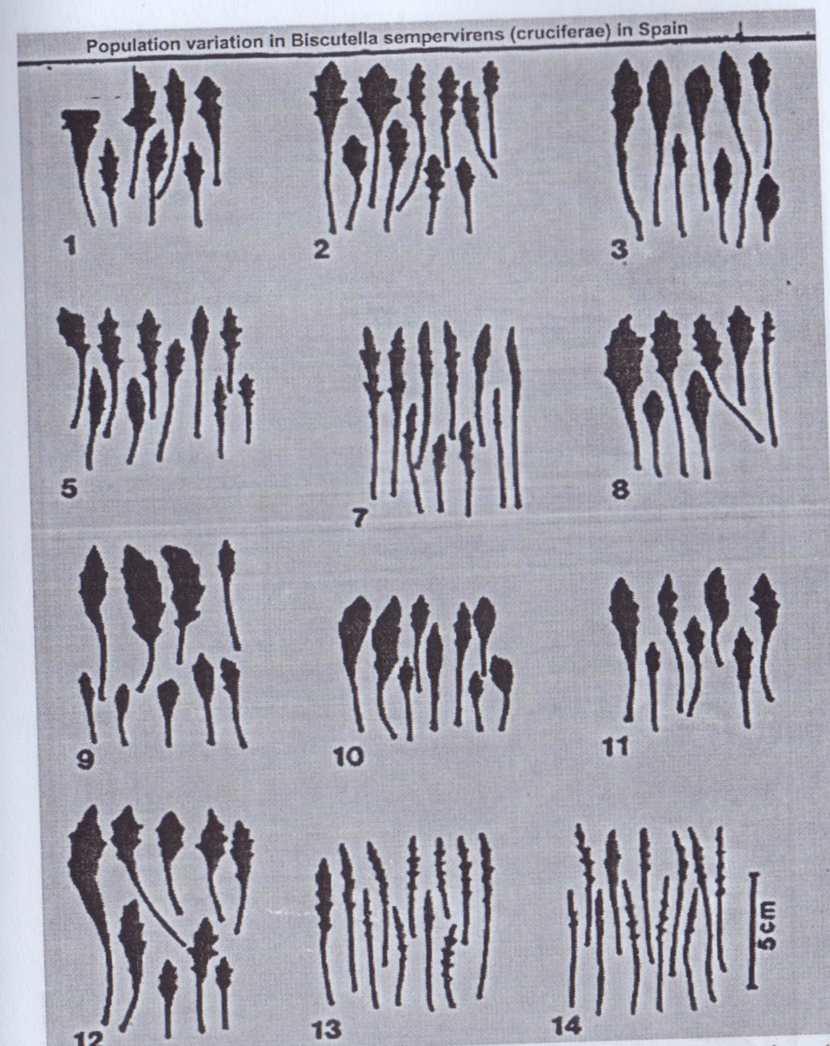


Figure 9: Silhouettes of representative leaf forms illustrating the range of variation in the populations of Biscutella sempervirens

Source: Olowokudejo, 1986f

Variation and Taxonomy of *Biscutella valentina* in Spain (Canadian Journal of Botany, 64(12): 2965 -2972)

Figure 10: **Silhouettes of representative leaf forms illustrating the rage of variation within and among the populations. Numbers designate populations studied**

Source: Olowokudejo, 1986b

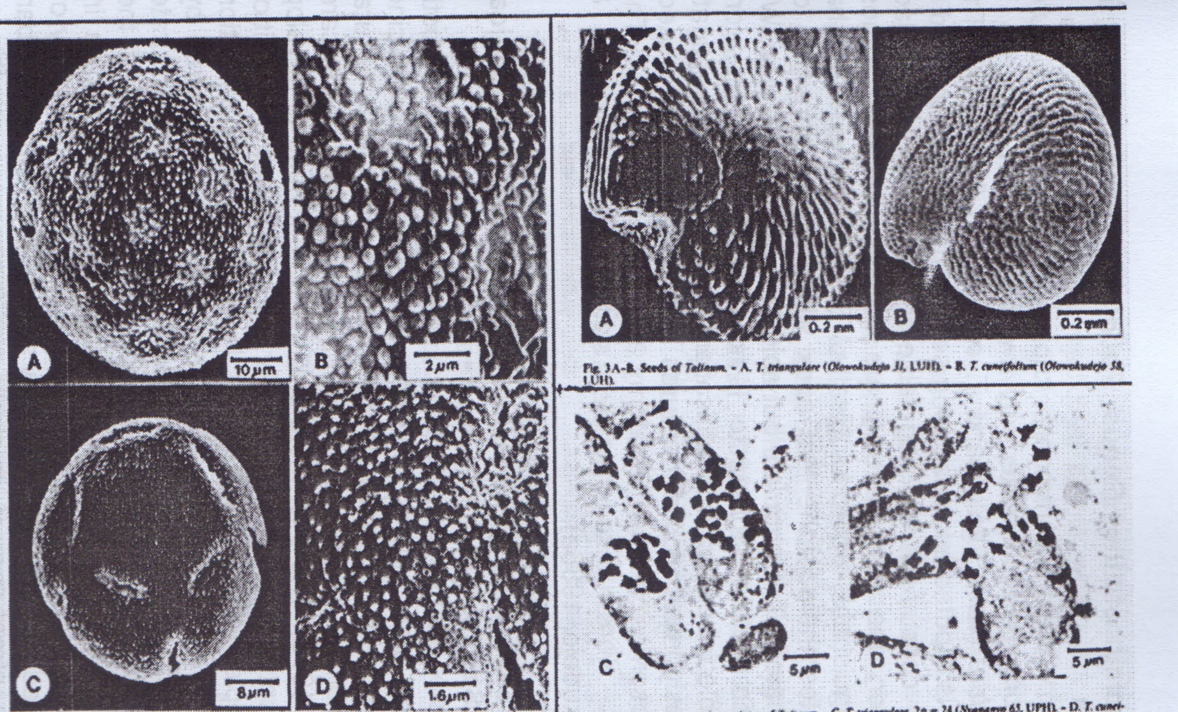


Fig. 1. Scanning electron micrographs of *Talinum* pollen. – A–B. *T. triangulare* (*Wit 27839*, FHI). – A. Polar view. – B. Portion of surface with pori. C–D. *T. cuneifolium* (*Olowokudejo & Shittu 74*, LUH). – C. Polar view. – D. Portion of surface with colpi.

Fig. 3A–B. Seeds of *Talinum*. – A. *T. triangulare* (*Olowokudejo 31*, LUH). – B. *T. cuneifolium* (*Olowokudejo 58*, LUH).

Fig. 3C–D. Mitotic metaphase plates of *Talinum*. – C. *T. triangulare*, 2n = 24 (*Nyananyo 63*, UPH). – D. *T. cuneifolium*, 2n = 24 (*Olowokudejo 36*, LUH).

Figure 11: Taxonomic Studies in the Genus Talinum (Family Portulacaceae) in Nigeria

Source: Nyananyo & Olowokudejo, 1986b

Taxonomy of the Genus *Talinum* (Portulacaceae) in Nigeria

Talinum Adans. commonly known as waterleaf (Gbure/ Odondon) is represented by two species in Nigeria: *T. triangulare* (Jacq.) Willd. and *T. cuneifolium* (Willd.) DC. The former is reputed as possessing several medicinal uses and is widely consumed as vegetable or spinach and salad. However, the two species are very similar and almost indistinguishable morphologically. The only character that separates them is the leaf apex which may emarginate or mucronate in *T. triangulare* but apiculate in *T. cuneifolium*. We discovered that this character is not constant and is therefore unreliable for accurate identification. This led us to investigate previously unexplored features such as pollen, seed, chromosomes, and leaf anatomy as shown in Figure 11. The results were taxonomically significant (Nyananyo & Olowokudejo, 1986a).

11.2 Taxonomy of Medicinal Plants and Ethnobotanical Studies

Medicinal plants constitute an effective source of both traditional and modern medicines. Herbal traditional medicine has been shown to have intrinsic utility and 70 – 80% of rural populations in Africa depend on it as their primary health care (WHO, 1978). There is, therefore, the urgent need to develop the potential of herbal medicine for the wide use and benefit of the people (Olowokudejo, 1987). However, optimal utilisation of the myriads of medicinal plants in Nigeria is hampered by the dearth of reliable information regarding the accurate identification, distribution, ecology and nomenclature of the drug plants. Many species are also inadequately known in terms of their actual existence and status in the wild. Many of these medicinal plants are usually sold in both rural and urban markets, street corners, in sterile and fragmentary conditions. They are highly susceptible to adulteration and substitution which could result in wrong plant materials being bought and utilised in herbal preparations with potentially dangerous and fatal consequences. This situation has greatly reduced the general acceptability of traditional medicine potions.

We embarked on our research to bridge the yawning gaps in our knowledge of the medicinal plants which are frequently used for treating common diseases in this country. For some of the genera, we have provided pertinent information on their geographical distribution and ecology, accurate species description, identification and nomenclature. Light, scanning and transmission electron microscopy have also revealed and elucidated the taxonomic significance of previously unexplored micro and anatomical features of the leaves, petioles and stems in the accurate identification of both medicinal and nonmedicinal species, even when only their fragments are available (Olowokudejo,1987, 1990, 1992, 1993, 2008, 2012; Olowokudejo & Nyananyo, 1990; Olowokudejo & Pereira-Sheteolu, 1988, 1992; Olowokudejo & Bamgbowu, 1993; Olowokudejo et al., 1993, 2008). Some of the remarkably diagnostic micro-features are shown in Figures 12 – 17.

Table 20 provides critical information on Nigerian plants used as vermifuges (worm expellers), giving their local names, parts used and their geographical distribution. The publication generated a lot of interest and contributed to the resurgence of interest in herbal medicine.

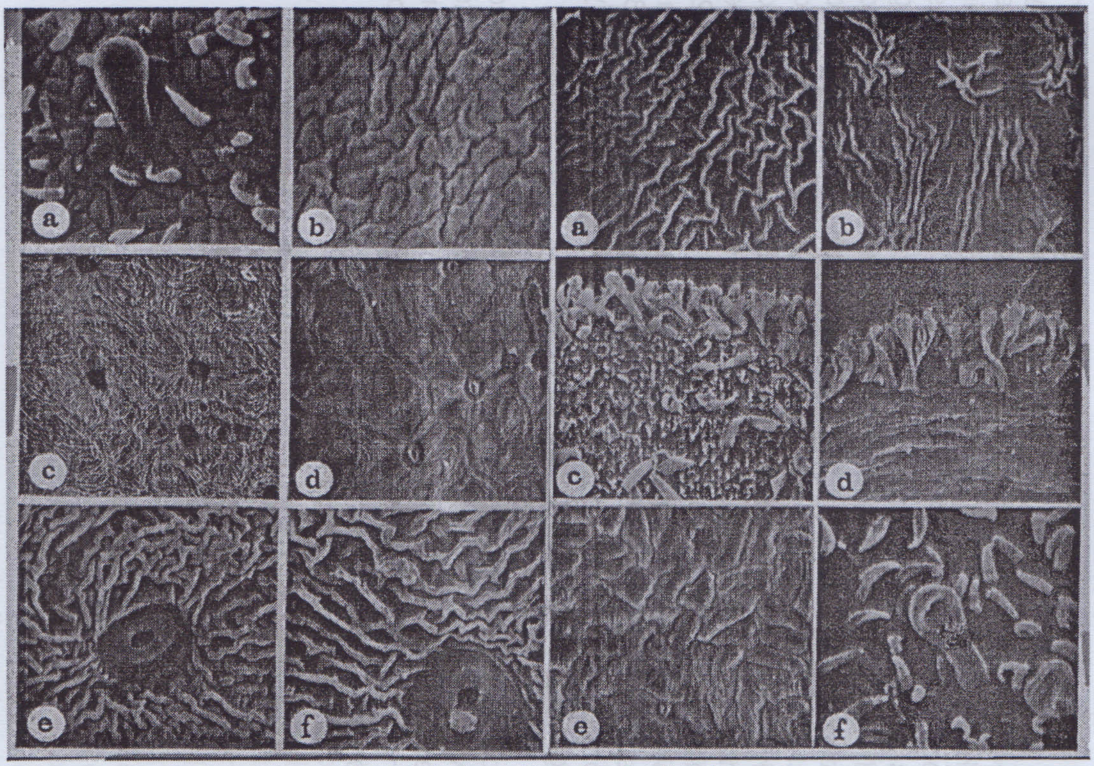


Figure 12: Scanning Electron Microscopy of Fruits in the Genus *Biscutella* L. (Cruciferae)'

Source: Olowokudejo, 1985

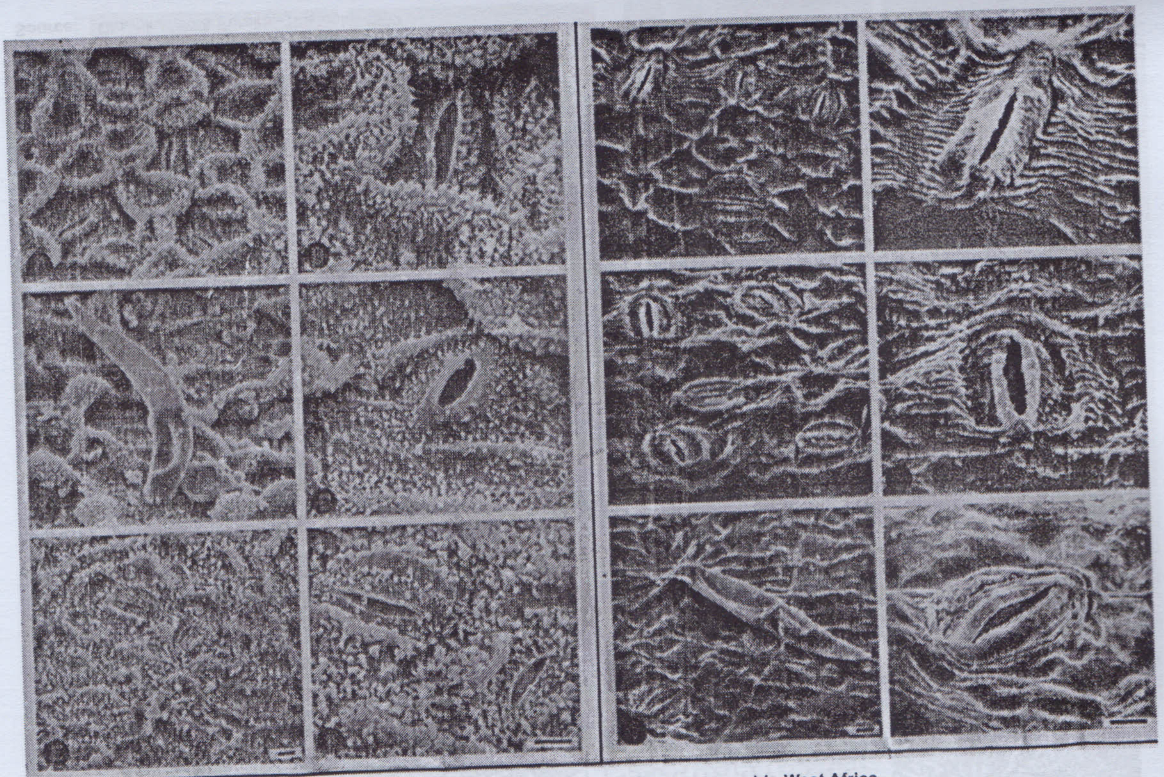


Figure 13: Comparative Morphology of Leaf Epidemis in the Genus *Annona* (Annonaceae) in West Africa

Source: Olowokudejo, 1990

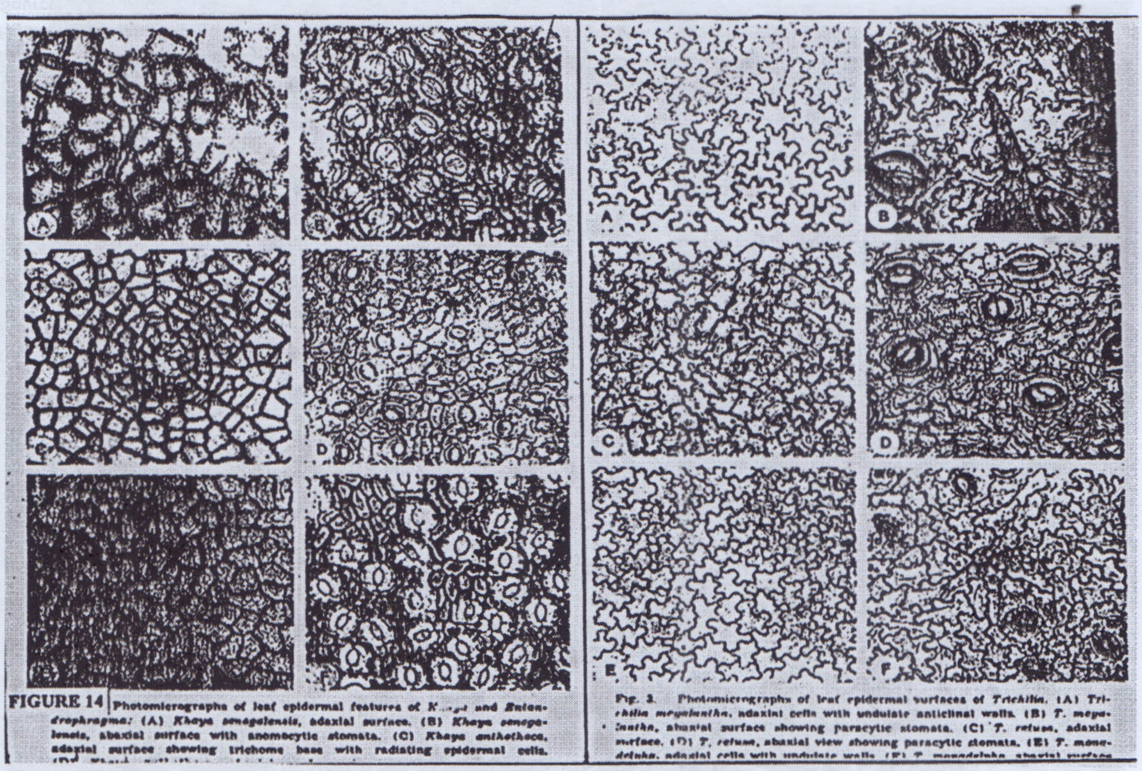


Figure 14: Leaf Epidermal Morphology of Three Genera of Family Meliaceae: Khaya, Entandrophragma & Trichilia

Source: Olowokudejo & Pereira - Sheteolu, 1992

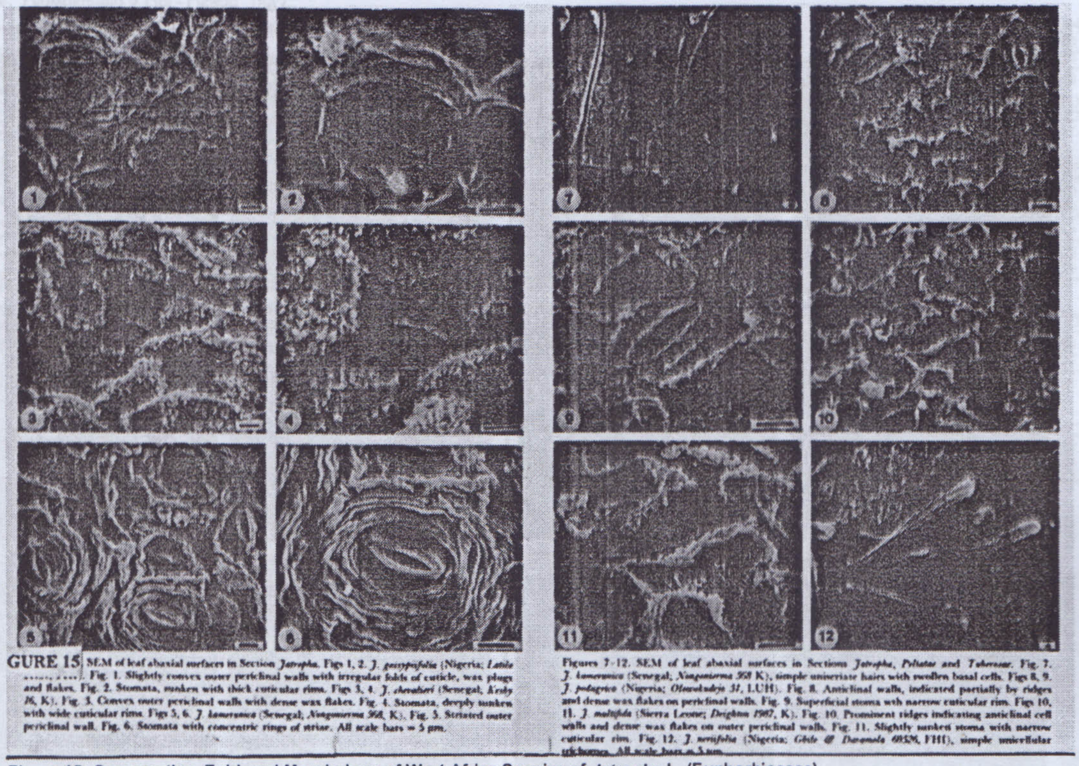


Figure 15: Comparative Epidermal Morphology of West Africa Species of *Jatropha* L. (Euphorbiaceae)

Source: Olowokudejo, 1992

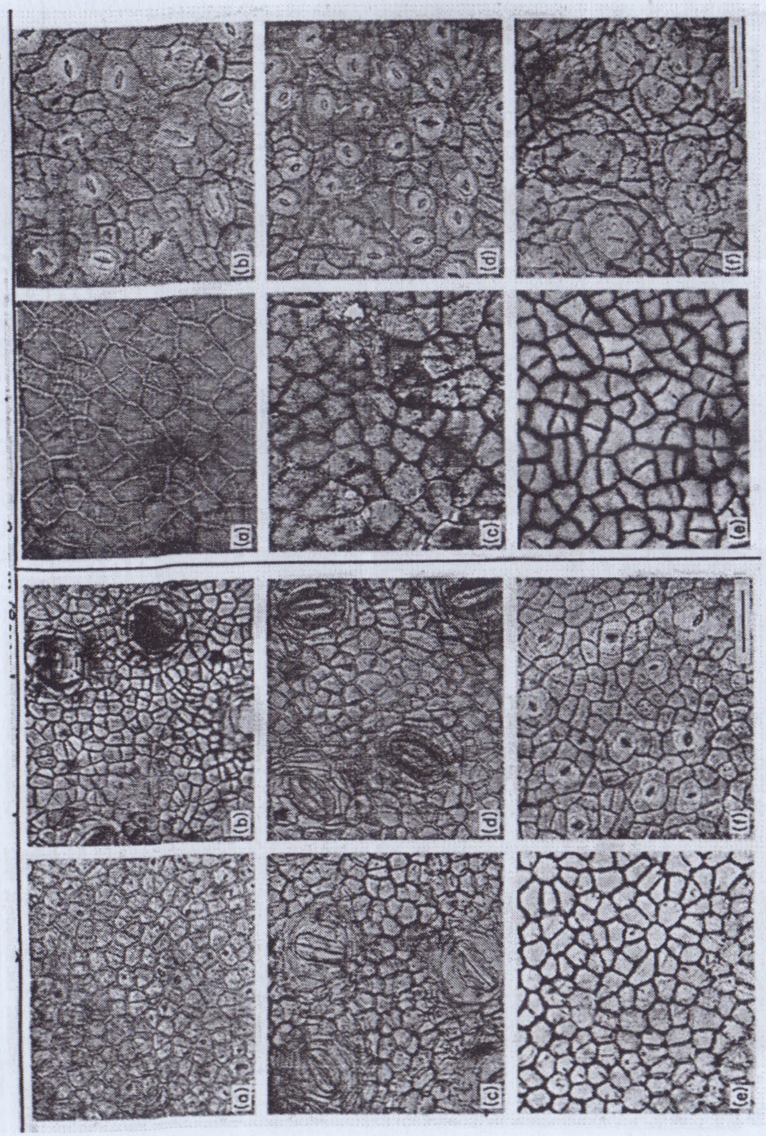


Figure 16: Taxonomic significance of epidermal morphology in Nigerian Rhizophoraceae
Source: Olowokudejo & Obi - Osang, 1993

Table 20: Medicinal Plants Used as Vermifuges (Worm Expellers) in Nigeria

S/N	Species & Family Names	Local Names	Parts used	Geog. Distribution
1	*Abrus precatorius* L. (Leguminosae)	Hausa: Idon Zakara Ibo: Ainya-nwono Yoruba: Oju ologbo	Roots	SW, NC, SE, SS
2	*Acacia sieberiana* DC. (Leguminosae)	Hausa: Farar kaya Yoruba: Sie	Roots and Stem bark	SW, SS, SE, NE
3	*Cassia alata* L. (Leguminosae)	Ibo: Okpo Yoruba: Asunwon	Leaves	SW, SE, SS, NE
4	*Aristolochia bracteolata* Lam (Aristolochiaceae)	Hausa: Gasakuka	Roots and Leaves	NE
5	*Chenopodium ambrosioides* L (Chenopodiaceae)	Yoruba: Marurusi (Indian worm seed)	All plant parts	SW
6	*Jatropha curcas* L. (Euphorbiaceae)	Hausa: Binidazugu Ibo: Olulu-idu Yoruba: Lapalapa Olobontuje (Physic or Barbados nut)	Seeds	SW, SE, SS, NW, NC
7	*Mallotus oppositifolius* (Geisel) Mull.-Arg. (Euphorbiaceae)	Hausa: Kafamutuwo Ibo: Kpokokwa Yourba: Eja	Leaves and Stem bark	SW, SE, SS, NC
8	*Xylopia aethiopica* (Dunal) A. Rich (Annonaceae)	Hausa: Kimba Ibo: Oda Yoruba: Eru	Seeds	SW, SE, SS, NW
9	*Carica papaya* L. (Caricaceae)	Hausa: Gwauda Ibo: Ojo Yoruba: Ibepe (Pawpaw)	Leaves, roots, seedlings	SW, SE, SS, NC, NE, NW
10	*Connarus africanus* Lam. (Connaraceae)		Seeds	SW, NE
11.	*Punica granatum* L. (Punicaceae)	Hausa: Rummani	Root-bark	NE, NC
12.	*Combretum racemosum* P. Beauv. (Combretaceae)	Yoruba: Ogan pupa	Roots and leaves	SW, SE, SS
13	*Momordica charantia* L. (Cucurbitaceae)	Hausa: Garafuni Ibo: Akban ndene Yoruba: Ejinrin (Balsam pear or Bitter apple)	Leaves, Fruits and Embryo	SW, SE, SS

14	*Microglossa pyrifolia* (Lam) O.Ktze (Compositae)	Ibo: Okbakakwu	Roots and leaves	SW, SE, SS, NE
15	*Embelia rowlandii Gilg.* (Myrsinaceae)		Fruits and leaves	SW, SE, SS, NW
16	*Spigelia anthelmia* L. (Loganiaceae)	Yoruba: Ewe aran (Worm grain or worm weed)	Fresh roots and leaves	SW, SE
17	*Balanites aegyptiaca* (L.) Del. (Zygophyllaceae)	Hausa: Adawa	Unripe fruits, roots and leaves	NE, NW
18	*Clausena anisata* (Willd.) Hook f.ex Benth. (Rutaceae)	Yoruba: Ata pari obuko	Leaflets	SW, SE, SS, NE
19	*Heeria insignis* O. Ktze (Anacardiaceae)	Hausa: Kasheshe	Leaves	NC, NW, NE
20	*Pycnanthus angolensis* (Welw.) Warb. (Myristicaceae)	Hausa: Kpokogi Ibo: Ebubi Yoruba: Akomu (African nutmeg)	Roots	SW, SE, SS
21	*Lawsonia inermis* L. (Lythraceae)	Yoruba: Lali	Roots & leaves	SW, SE, NW, NC, SS

Source: Olowokudejo (1987)

11.3 Collaborative Research Work on Medicinal Plants

Phytochemistry and Petiole Anatomy of Three *Jatropha* L. Species

Jatropha is an economically important genus because of the medicinal properties and ornamental uses of some of its species. Of the eight species found in Nigeria, three are widely used in traditional medicine and self-medication. For example, *J. curcas* L. seeds yield 40% of a purgative oil used as a remedy in dropsy, paralysis, worms and common skin diseases (Oliver, 1960). A decoction of the leaves is used as a mouthwash while the crushed leaves are made into a lotion for the treatment of guinea worm sores, sluggish ulcers, wounds and cuts (Dalziel, 1937; Ayensu, 1978). A cold or hot infusion of the leaves with lime juice added is an effective therapy for a toothache, swollen gums and lips. The root decoction is also active against jaundice. The second species, *J. multifida* L.

has seed oil with purgative properties similar to those of *J. curcas* while the leaf juice of the third species, *J. gossypifdia* L., is popularly used for curing sores on babies' tongues. Irvine (1961) also reported that the leaf decoction serves as a vermifuge, purgative and a remedy for fever. Screenings of plants used in traditional medicine and which have been found through experience to be highly efficacious, usually reveal several substances of significant interest (Perdue et al., 1970; Peigen, 1981; Hedberg, 1987) which could lead to the formulation of new drugs. Most of our modern medicines are modelled on naturally occurring compounds in plants which have been in use for centuries in herbal preparations (Hedberg, 1987). As part of a multidisciplinary programme of research on Nigerian medicinal plants, Olowokudejo (Botany), Adeoye and Fadeyi (Pharmacognosy), undertook the phytochemical screening and anatomical investigation of these three *Jatropha* species.

The wide spectrum of folkloric uses of these *Jatropha* species may be accounted for on the basis of the screening results. For example, the purgative action common to all species may be attributed to the occurrence of anthraquinone or possibly the phenolic compounds in all the species. The flavonoids have also been reported to possess a wide range of pharmacological effects. Petiole anatomy provides valuable taxonomic characters for identifying each species (Fig.18), thus preventing adulteration or substitution of herbal samples (Olowokudejo et al., 1993).

Genera and species	No. of cells mm²: mean ± SE		Anticlinal cell wall pattern	Epidermal cell width: mean ± SE	
	Adaxial	Abaxial		Adaxial (μm)	Abaxial (μm)
Rhizophora					
racemosa	700 ± 6·93	658 ± 7·09	Straight	15·39 ± 0·41	13·91 ± 0·58
harrisonii	593 ± 5·14	584 ± 9·13	Straight	16·07 ± 0·38	14·0 ± 0·58
mangle	574 ± 6·22	550 ± 8·60	Straight	17·34 ± 0·52	16·99 ± 0·63
Cassipourea					
congoensis	483 ± 7·49	432 ± 8·82	Straight/curved	21·08 ± 0·54	19·74 ± 0·55
eketensis	478 ± 8·43	461 ± 5·54	Straight/curved	19·97 ± 0·67	16·59 ± 0·93
barteri	433 ± 4·81	304 ± 3·47	Straight/curved	25·0 ± 0·56	24·0 ± 0·73
gummiflua	404 ± 3·0	313 ± 6·55	Straight/curved	23·05 ± 1·03	20·95 ± 1·16
Anopyxis					
klaineana	386 ± 3·55	339 ± 4·49	Curved	22·91 ± 0·6	19·38 ± 1·18
Anisophyllea					
sororia	328 ± 5·28	324 ± 6·65	Undulate	18·57 ± 0·78	17·7 ± 1·55
purpurascens	348 ± 4·71	331 ± 5·24	Undulate	19·42 ± 0·69	16·83 ± 0·81
Poga					
oleosa	305 ± 3·42	288 ± 4·30	Straight/curved	26·82 ± 1·25	23·02 ± 2·25

Abbreviations: mm⁻², per millimetre squared; SE, standard error.

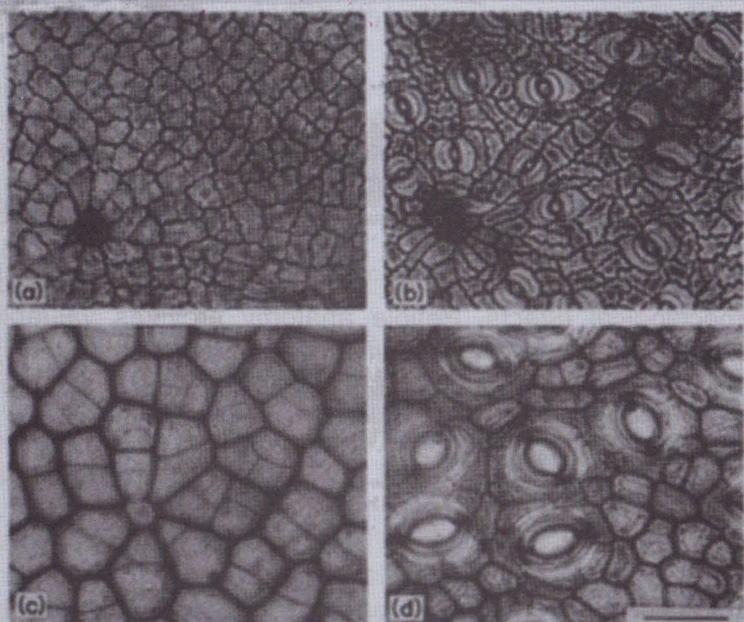


Fig. 3. Adaxial and abaxial epidermal surfaces of *Anisophyllea* and *Poga* species. (a) *Anisophyllea sororia*, adaxial epidermis with undulate anticlinal walls. (b) *A. sororia*, abaxial epidermis showing T-shaped thickenings of stomatal poles and undulate walls. (c) *Poga oleosa*, adaxial epidermis showing secondary anticlinal divisions of the cells. (d) *P. oleosa*, abaxial epidermis with cuticular striations and T-shaped thickenings of stomatal poles. All same scale = 50 μm.

Figure 17: Leaf Epidermal Characters of Family Rhizophoraceae
Source: Olowokudejo & Obi - Osang, 1993

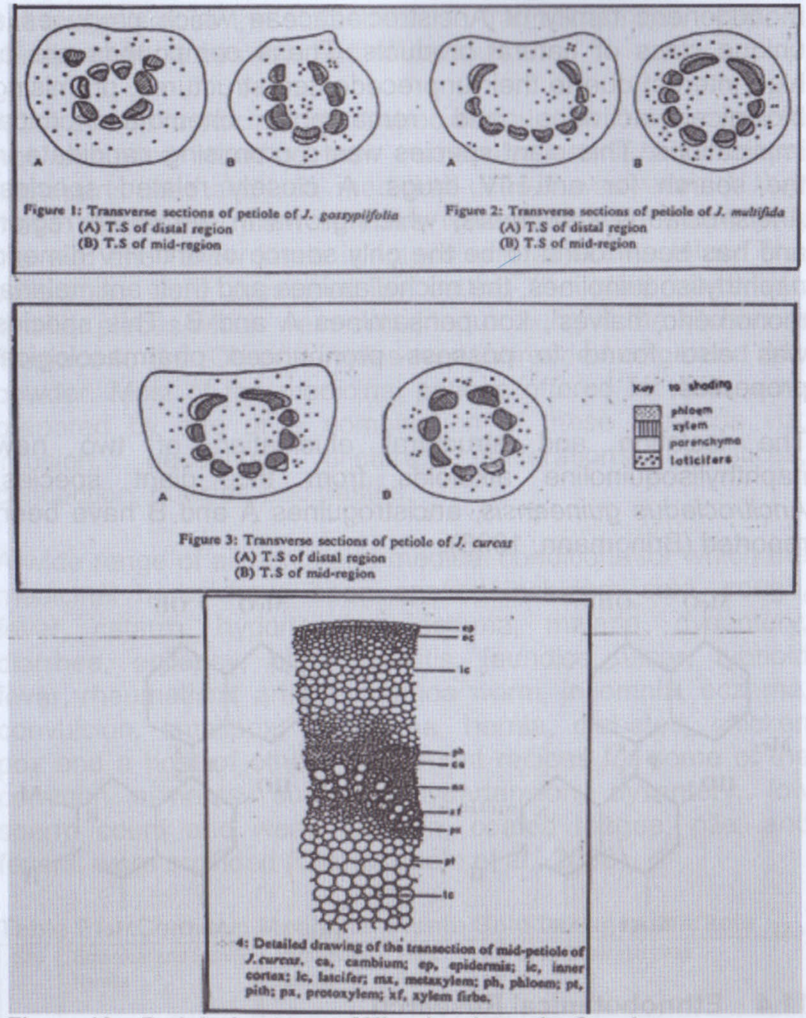
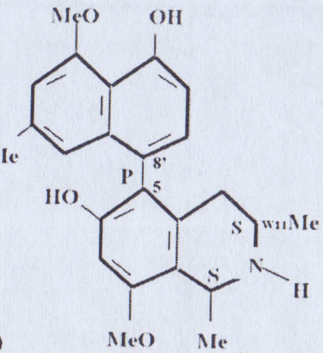


Figure 18: Petiole Anatomy of Nigerian Jatropha Species
Source: Olowokudejo et al., 1993

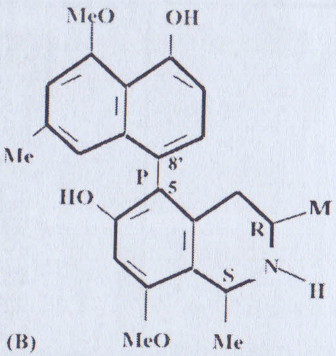
Isolation of three alkaloids from *Ancistrocladus guineensis (Ancistrocladaceae)*

In collaboration with four German chemists, Olowokudejo and Alo (1996) isolated three naphthylisoquinoline alkaloids from the leaves of *Ancistrocladus guineensis*. This plant is only found in Nigeria and Cameroon, and belongs to the small monogeneric family of Ancistrocladaceae which produces a unique class of natural products. These compounds are of high interest due to their unprecedented structures, promising biological activities and remarkable chemotaxonomical implications. This plant species was a promising candidate in the search for anti-HIV drugs. A closely related species, *Ancistrocladus korupensis*, which grows in the same region and has been found to be the only source of anti-HIV dimeric naphthylisoquinolines, the michellamines and their antimalarial monomeric 'halves', korupensamines A and B. This species was also found to possess pronounced pharmacological properties.

The isolation and structural elucidation of two new naphthylisoquinoline alkaloids from this plant species, *Ancitrocladus guineensis,* ancistroguines A and B have been reported (Bringmann, 1998).



(A)



(B)

11.4 Ethnobotanical Research

In furtherance of our multidisciplinary research work on Nigerian medicinal plants, we undertook an extensive survey of three herbal markets – Oyingbo, Mushin, and Bariga – in Lagos Mainland. Information was obtained from herb sellers and traditional medicine practitioners. Medicinal plant samples on display in the markets were examined and identified. Cross-referencing of facts was carried out at the Lagos State Traditional Medicine Board and the Nigeria Natural Medicine Development Agency in Lagos. Herb sellers enjoy good

patronage across the state because traditional health care is cheap, easily accessible and efficacious.

A list of 110 medicinal plant species found in these markets was compiled including their vernacular and family names, plant parts used and local medicinal uses. It was revealed that these commercial plant samples were collected randomly in the wild and fallow lands in Lagos and adjacent states. The collections were preserved by cutting the plant parts into smaller pieces which were sun-dried or hung in the kitchen or fireplace to dry. Other samples were shredded or ground into powder. Most of the medicinal potions offered for sale were prepared by one or a combination of these methods viz: infusion, decoction, tincture, macerations, poultices, concoction, powder, and pastes.

A wide range of ailments and medical conditions for which the medicinal herbs have been applied included: cold, cough, fever, catarrh, hypertension, asthma, malaria, dysentery, diarrhea, epilepsy, pile, hepatitis, jaundice, ulcer, typhoid fever, rheumatism, arthritis, guinea worm, insomnia, eczema, convulsion, smallpox, gonorrhea, hernia, diabetes, chicken pox and a host of others. Treatment recipes for some of the common ailments, such as hypertension, dysentery, low sperm count and weak erection, coated tongue, pile, and fevers, were provided (Olowokudejo et al., 2008).

Table 21: Common Medicinal Plants Sold in Lagos Markets

S/N	Botanical and Family Names	Vernacular Names	Plant Parts Used	Local Medicinal Uses
1	*Butryospermum paradoxum* (Gaertn. F.) Hepper (Sapotaceae)	Ori	Seeds	Nasal decongestion, catarrh, hypertension, diuretic, antihelmintic
2	*Allium sativum* L. (Liliaceae)	Ayu	Bulb	Fever, cough, asthma, antibiotic, diaretic, malaria, hypertension
3.	*Bryophyllum pinnatum* (Lam.) Oken (Crassulaceae)	Abamoda	Leaves, roots, leaf juice	Cough, diarrhea, dysentery, wounds, sedative, diuretic, epilepsy, fever
4	*Zingiber officinale* Roscoe	Atale, Jinja	Rhizome	Cold, cough, asthma, rheumatism, pile, malaria, hepatitis, typhoid,

	(Zingiberaceae)			fever, malaria, stimulant, obesity, liver diseases, digestive disorder
5.	*Enantia chloranta* (Annonaceae)	Awopa	Stem-bark	Typhoid fever, malaria, jaundice, ulcer, hepatitis, rockettsia, haemostatic
6.	*Khaya grandifoliola* CDC (Meliaceae)	Oganwo	Stem-bark, root	Convulsion, fever, rheumatism, threatened abortion, dermatomycosis
7	*Tetrapluera tetraptera* (Schum & Thonn) Taub (Leguminosae)	Aridan	Stem-bark, pod	Convulsion, fever, cough, asthma, insomnia, poison, antidote, fractured bones, gonorrhea, rheumatism, bilharzias, infertility
8	*Lecaniodiscus cupanioides* Planch	Akika	Leaves, roots, young shoots, seeds, stem-bark	Fever, burns, abscesses, jaundice, cough, malaria, purgative, aphrodisiac
9	*Pterocarpus osun* Craib (Leguminosae)	Osun	Roots, stem-bark	Asthma, dermatomycosis, candidiasis, antipyretic
10	*Dioclea reflexa* (Leguminosae)	Agbarin, Epe, Arin	Seed	Asthma, head lice, dandruff, stimulant
11	*Ficus exasperata* (Moraceae)	Epin	Leaves, seed, stem-bark, roots	Hypertension, scabies, stomach disorder, gonorrhea, urinary ailments, jaundice, arbotifacient, antipyretic
12	*Phyllanthus amarus* Schum & Thonn. (Euphorbiaceae)	Eyin-olobe	Whole plant	Fever, ringworm, gonorrhea, diabetes
13	*Mucuna pruriens* (L.) DC. (Leguminosae)	Werepe, Ewe-ina	Hairs on the pod	Intestinal worms, genital-urinary ailments
14	*Ocimum gratissimum* L. (Labiatae)	Efirin	Whole plant, leaves	Cough, diarrhea, colic, convulsion, fever, cold, bronchitis, diabetes, pile, antihelmintic
15	*Telfairia occidentalis* Hook F. (Cucurbitaceae)	Ugwu	Leaves	Convulsion, gastrointestinal disorders, anaemia, blood tonic
16	*Sida rhombifolia* L. (Malvaceae)	Iseketu pupa	Leaves	Diarrhea, wound, emollient
17	*Thaumatococcus daniellii* (Benn). Benth (Marantaceae)	Ewe moi-moi	Fruits	Diabetes, emetic
18	*Adansonia digitata* L. (Bombacaceae)	Ose	Leaves, stem-bark, fruit pulp	Malaria, asthma, caries, prophylactic, diarrhea, kidney and bladder diseases
19	*Aerva lanata* (L.) Juss. (Amaranthaceae)	Efun-ile	Whole plant	Ulcer, wounds, snake bite, kidney and bladder stones, sore, diuretic, purgative
20	*Aframomum melegueta* K. Schum	Atare	Leaves, seeds	Stimulant, cough, chicken pox, wounds, anaemia, measles,

	(Zingiberaceae)			malaria, rheumatism, toothache
21	*Caesalpinia pulcherima* (L.) SW. (Leguminosae)	Eko-omode	Stem-bark, leaves, seeds	Purgative, emollient, abortifacient, emmenagogue
22	*Alternanthera sessilis* (L.) DC (Amaranthaceae)	Reku-reku	Whole plant, leaves	Astringent, antibacterial, boil, headache, snake bite antidote
23	*Baphia nitida* Lodd. (Leguminosae)	Osun, Irosun	Stem-bark, leaves, twig, roots	Constipation, skin diseases, venereal diseases, ringworm, enema, flatulence, smallpox
24	*Calotropis procera* (Ait) Ait. F. (Asclepiadaceae)	Bomubomu	Leaves, roots, stem-bark, latex	Diarrhea, dysentery, elephantiasis, leprosy, chronic, eczema, cough, ringworm, diaphoretic, emetic, asthma, convulsion, abortifacient, antipyretic
25	*Ceiba pentandra* (L.) Gaertn (Bombacaceae)	Araba	Flowers, leaves, stem-bark exudates	Diabetes, asthma, emetic, gonorrhea, emollient, menorrhagia
26	*Tridax procumbens* L. (Asteraceae)	Igbalode, Muwagun	Whole plant	Antipyretic, haemostatic, backache, stomach ache
27	*Uraria picta* (Jacq.) DC (Leguminosae)	Alupayida	Leaves	Snake bite antidote, aphrodisiac, repositioning foetus intra-uterine
28	*Voacanga africana* Stapf (Apocynaceae)	Ako-dodo	Latex, stem-bark, root	Fever, toothache, cardiac tonic, sores, carious tooth, hypertension, improves mental alertness
29	*Artocarpus altilis* (Park) Fosberg (Moraceae)	Berefurutu	Fruit, root	Fever, astringent, sedative
30	*Carpolobia lutea* G. Don (Polygalaceae)	Osunsun	Leaves, stem-bark	Rheumatism, toothache, aphrodisiac.

Source: Olowokudejo et al., 2008

The methods of preparing herbal potions for eight common ailments are summarised below:

1. **Hypertension**
   a. Leaves of *Persea americana* are shredded, dried and taken as an infusion.
   b. Leaves of *Senecio biafrae* added to the fermented seed of *Parkia biglobosa* are used to prepare soup. The leaves of *Talinum triangulare* or *Basella alba* may also be used.
   c. Kola nut's mistletoe mixed with honey is also effective.

2. **Dysentery**

a. A decoction of the leaves of *Grewia flavescence* is made and drunk.

b. Leaves of *Parquentina nigrescens, Jatropha gossypifolia, Pergularia daemia, Ocimum gratissimum* and *Momordica charantia* are all blended and taken with cold pap, or as a decoction.

3. **Low sperm count and weak erection**

a. Powdered *Piper guineensis* and extract from 10 big onions are poured into honey and boiled between 5 – 10 minutes. A cup to be taken in the morning and at night.

b. *Manihot esculenta* roots. *Dioscorea sp.* Tuber, *Garcinia cola seed, Cola nitidia* cotyledon, dried *Zea mays, Cnetis ferruginea*, seeds of *Mucuna sloanei*, unripe *Musa parasidiaca* and *Piper guineensis* are all ground together with sugar and taken with water or cold pap.

c. The same plants as the foregoing in addition to *Klainedoxa gabonensis*,sugar, and pure honey are mixed together. A spoonful to be taken either alone or mixed with cold pap.

4. **Coated tongue**

a. Bark of *Khaya ivorensis, the* bark of *Pycanthus angolensis,* the bark of *Hymenocardia acida, the* bark of *Bridelia ferruginea,* bark and root of *Rauvolfia vomitoria, the* bark of *Alstonia boonei,* twigs of *Citrus medica, the* bark of *Enantia chlorantha, the* bark of *Milicia excelsa* are all cooked and the decoction to be taken.

b. *Leaves of Costus afer,* bark of *Khaya grandifoliola, the* bark of *Bridelia, ferruginea, the* fruit of *Alchornea cordifolia, the* bark of *Bridelia micrantha, the* bark of *Pycnanthus angolensis,* sulphur, and lime water, all mixed in a container. One tablespoonful of the extract to be taken daily before breakfast.

5. **Piles**

12 Seeds of *Croton penduliflorus* and 7 cubes of sugar are ground and poured into a bottle containing kernel oil (30cl), then left for 7 days, after which the first dose of two tablespoonfuls will be taken. Subsequently, one spoonful to be taken every morning before breakfast. The drug is to be taken daily at a four- day- interval.

6. **Menstrual disorder**

Water or alcohol extract of the leaves of *Dalbergiella welwitschii* mixed with potash is to be taken every morning and evening for 3 days.

7. **Leucorrhoea (Virginal discharge)**

a. The root of *Glyphea brevis,* root and leaves of *Senna podocarpa, Senna alata, Allium ascalonicum* and potash are put together into a container of hot water. The recipe is left until the next day. One glass cup to be taken every morning before breakfast for 3 days. The preparation is also suitable for seminal discharge in men.

b. Roots of *Croton zambesicus,* 3 seeds of *Garcinia cola, Acacia nilotica* leaves, 3 seeds of *Aframomum melegueta,* leaves of *Mimosa pudica* and a small quantity of potash are ground together, and taken with cold pap.

8. **Fevers**

A decoction of the root of *Sphenocentrum jollyanum, Zingiber officinale, the* bark of *Khaya grandifoliola,* root and bark of *Rauvolfia vomitoria,* the bark of *Alstonia congensis,* root and bark of *Senna sceptabilis, the* root of *Zanthoxylum xanthoxyloides and* leaves of *Ocimum basilicum* is taken for fever.

11.5 Mangrove Swamp Forest Ecosystem: Ecology and Taxonomy

Mangroves are forest ecosystems specially adapted to saline soil and water conditions. They grow along sheltered coastlines of most tropical and subtropical regions. They may colonise the banks of major rivers up to 100km inland. Some 60 species of trees, many associated plants and thousands of species of mammals, birds, fish and invertebrates have been recorded from different mangrove forest (IUCN, 1993). Nigeria has the third largest mangrove forest in the world and the largest in Africa (World Bank, 1995). The mangrove forest stretches across the entire coastline where it occupies an area of about 970,000ha which is about 1% of the country's total land area. This vegetation derives most of its physical, chemical and biological characteristics from the sea and the inflowing freshwater from upland forests. The mangrove zone consists of an area of low-lying land fringing the coastal swamps and creek areas across the entire southern region. Beginning as a narrow strip in Lagos, Ogun, and Ondo states in the west, the mangrove widens and reaches its greatest extent and development in the Niger Delta region which encompasses Delta, Bayelsa, Rivers and Akwa Ibom states and tapers finally to Cross River state in the east.

Mangroves play an important role in sustaining the economic and social welfare of coastal nations because they generate a diverse range of renewable resources that can be harvested indefinitely if properly managed. Mangroves also play a valuable role in supporting fisheries, and in protecting coastal communities and agricultural land from coastal storms, tsunamis and other natural hazards. Mangrove forests are highly productive ecosystems with many important environmental, social and economic functions. More than 70 major uses of mangrove plants have been identified, ranging from timber extraction to the preparation of medicine (Saenger et al., 1983). Moreover, they are of considerable scientific interest for so many reasons, among which are the following: Mangrove forests differ from other forest ecosystems because they are generally located in dynamic environments with major daily and seasonal fluctuations in water levels; they are wetlands which are subject to constantly flows of fresh and salt water; they flourish in tropical tidal zones where the salt content of the water is high enough to plasmolyze the cells of

most other plants, they still obtain water via osmosis, which takes place because the mangrove cells accumulate an unusually high concentration of organic solute; some are also able to excrete salt. In addition, the soil type which ranges from deep peat to poorly consolidated sands, silts, clays and mud, which are poorly aerated and the existence of special roots, known as pneumatophores, which are connected with an extensive system of cable or horizontal roots which have an aerating function. The phenomenon of vivipary in some mangrove species has also attracted interest for a long time.

In Nigeria, oil and gas deposits are found in geological structures underlying mangroves and associated coastal ecosystems. As a direct consequence of inadequate planning and poor management, oil exploration and exploitation have caused significant environmental damage to mangroves and imposed negative social impacts on local communities. The mangrove ecosystem is fragile and at risk. We, therefore, undertook this research in order to provide critical information pertaining to the adaptive features which have ensured the survival of these unique plant species in their peculiar environment.

Avicennia germinans

Laguncularia racemosa

Figure 19: Adaptive Features of Mangrove Plant Species
Source: Olowokudejo, 1992

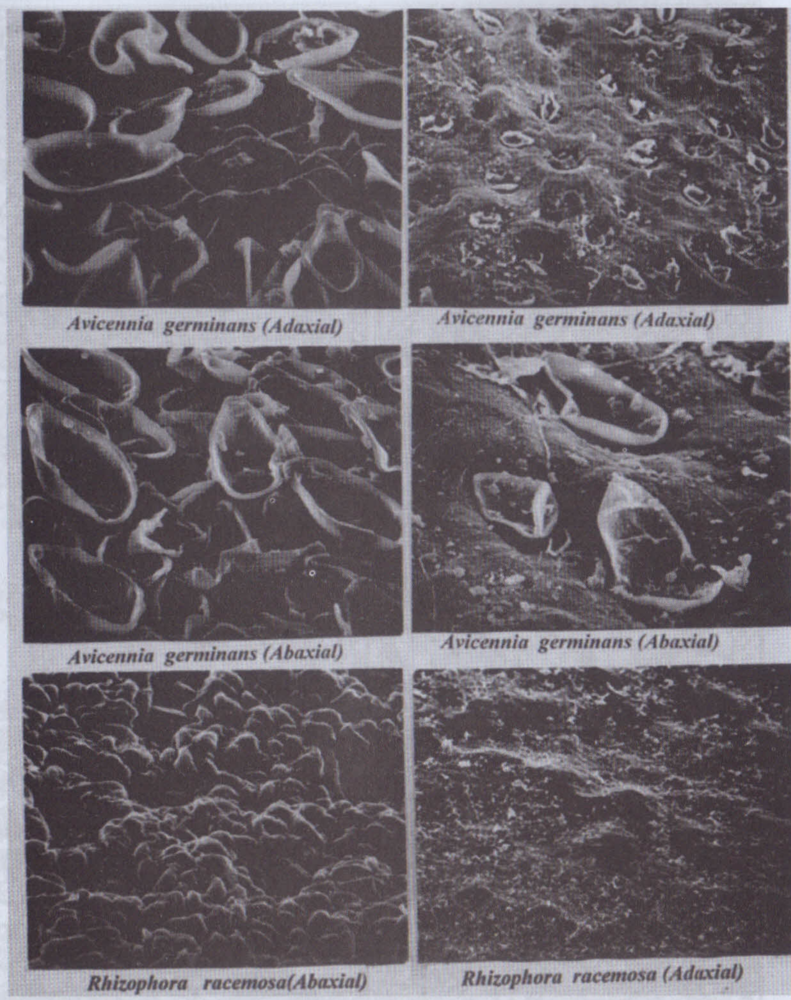


Figure 20: Epidermal Features of some Mangrove Species
Source: Olowokudejo, 1992

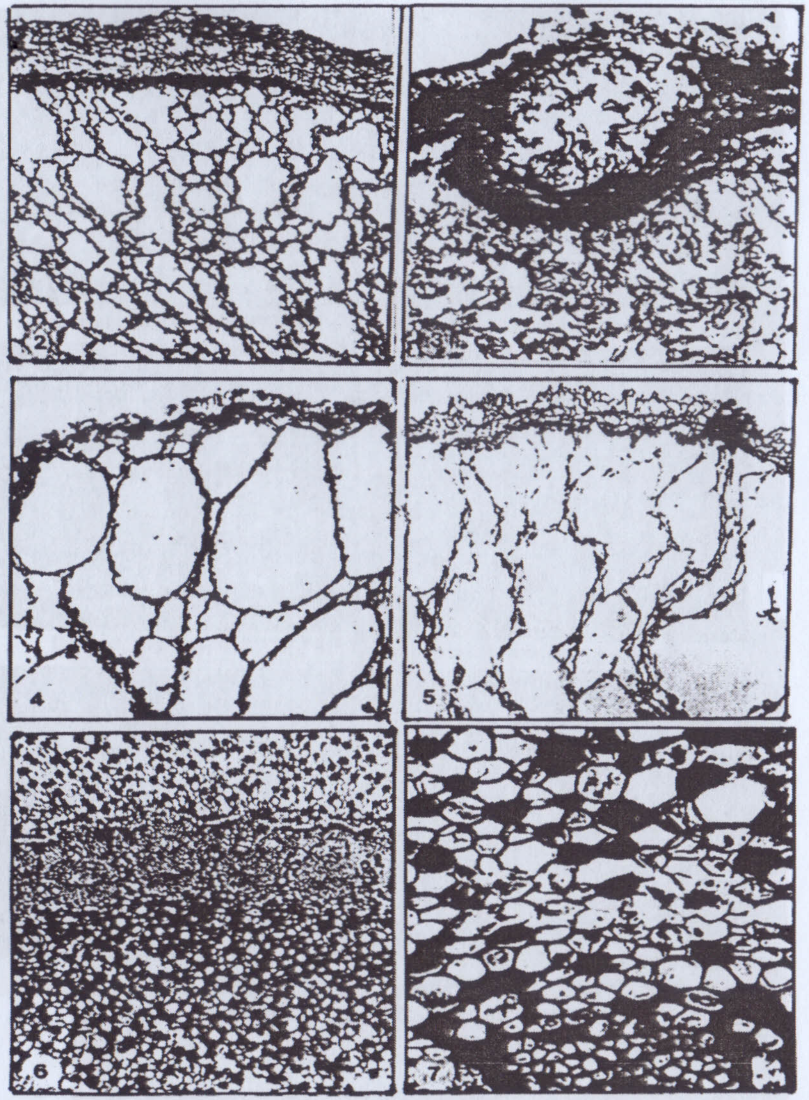


Figure 21: Root Anatomy of Halophyte Species in Nigeria
Source: Olowokudejo, 2010

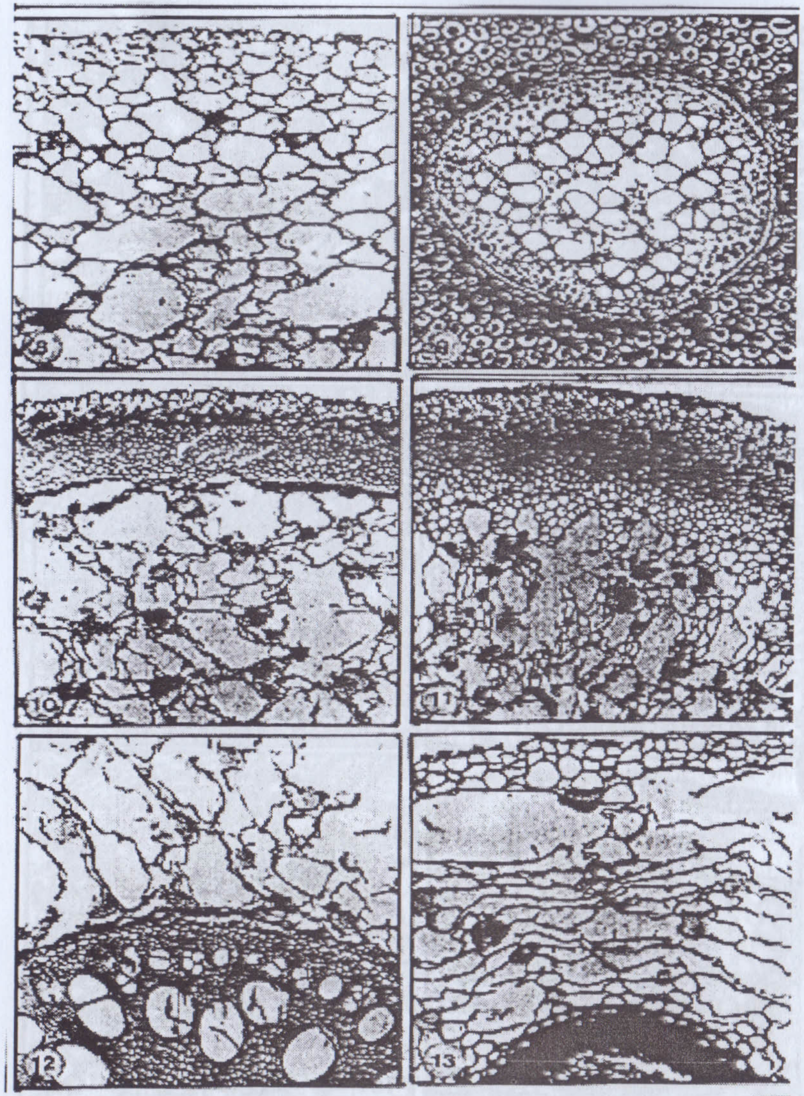


Figure 22: Root Anatomy of Halophyte Species in Nigeria
Source: Olowokudejo, 2010

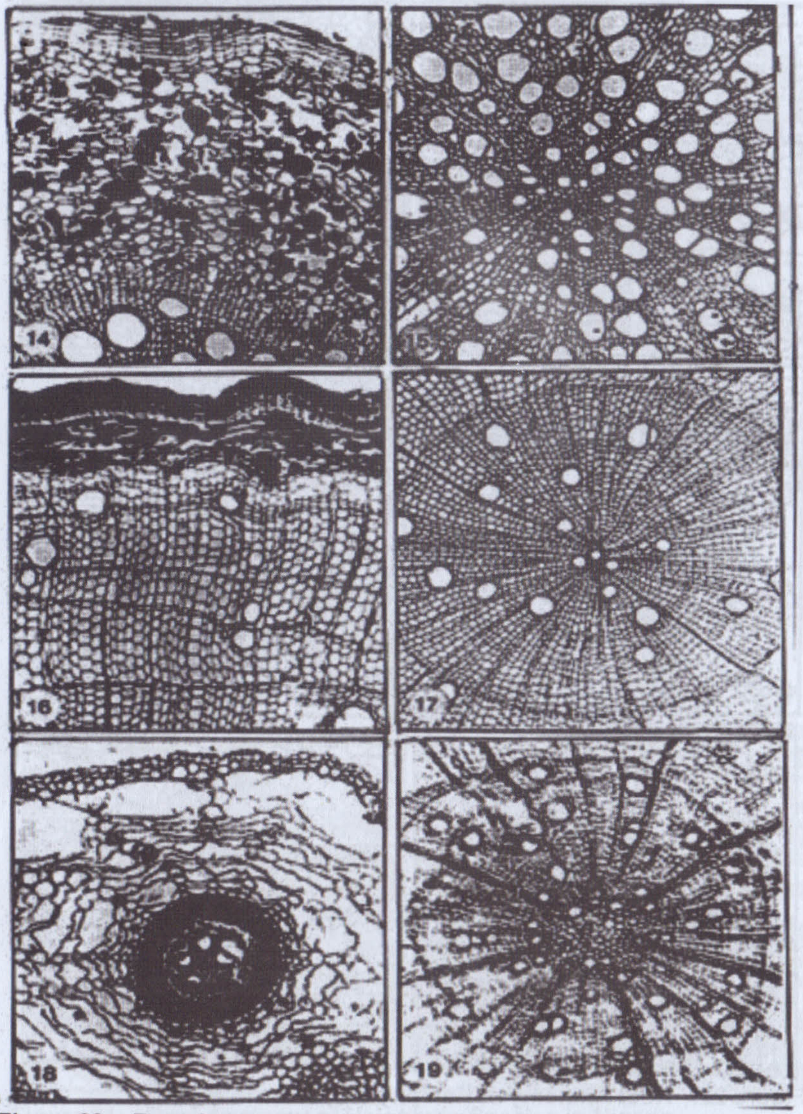


Figure 23: Root Anatomy of Halophyte Species in Nigeria
Source: Olowokudejo, 2010

The root systems of these plant species growing in the mangrove swamps, in which the soil is periodically inundated and devoid of oxygen, exhibit various adaptations to their

habitat. These involve features that ensure sufficient aeration, water conservation and additional support. *Rhizophora* species are characterised by bow-shaped, interlacing stilt roots which descend from the stems and are strengthened by new roots growing down from the branches. These represent a complete system of anchors which may cover an area of about 30 – 40 sq. metres on the forest floor. The cortex of these stilt roots is spongy due to the development of complex intercellular spaces. In *Phoenix reclinata,* there are, at the base of the stem, special roots which descend into the mud and which contain lenticels and aerenchyma produced by the phellogen. Aerial, negatively geotropic root projections, which are termed pneumatophores, are produced by *Laguncularia* and *Avicennia* species. These serve for gaseous exchange and are connected to an extensive system of horizontal or cable subterranean roots. In cross-section, the narrow stele of the pneumatophore is surrounded by a wide aerenchyma which is produced by a phellogen. In general, the cortex is penetrated by large air spaces which act as gas reservoirs for respiration (Figures19 – 22).

11.6 Biodiversity Assessment and Conservation

Biodiversity or biological diversity means the variety of living organisms on earth, the range of species, the genetic variability within each species, and the varied characteristics of ecosystems. It is the key indicator of a healthy planet and healthy society (O'Riordan& Stoll-Kleemann, 2002). It forms the foundation of the vast array of ecosystem services that critically contribute to human well-being. The first World Summit on Environment and Development held in Rio de Janeiro (1992) emphasised the importance of biodiversity as the basis of our very existence, to be used wisely, sustainably, and conserved for current and future generations. Biodiversity-based assets can generate significant economic benefits not only to sustain wealth for the richest but also to enable the poor find their way out of poverty. The depletion of biodiversity in an ecosystem has been shown to reduce the efficiency of production and nutrient use, and make the ecosystem less resistant to disturbance (Fig. 24).

The loss of biodiversity in the modern era, at rates that appear unequalled since the major extinction events in the distant geological past (WCMC, 2000; Anderson, 2001), is a matter of considerable public concern. According to an influential report by the UNEP, the US National Aeronautics and Space Administration and the World Bank (1998), 'the Earth currently is approaching the point where its physical and biological systems may not be able to meet human demands for environmental goods and services, threatening the ability of nations to meet their populations' needs for adequate food and clean water, energy supplies, safe shelter and a healthy environment'. The Report gave concrete examples of the weakening of the capability of natural ecosystems to maintain life, such as:

- Half the world's wetlands have been lost in the past century.
- Logging and conversion of woodland ecosystems have shrunk the world's forests by as much as half, and another quarter is being fragmented by roads, farms and residences.
- About one in ten of all tree species is at risk of extinction.
- Most freshwater and coastal ecosystems no longer have the capacity to maintain healthy water quality. The poor are especially exposed to declines in drinkable and reliable water. Poverty is an outcome of environmental degradation as well as a cause of it. Over pumping for agriculture exceeds natural replenishment by over 160 million cubic metres annually.
- Introduced species, transmission of pathogens and incurable damage to natural immune protection are leading to a chaotic reduction in species numbers and densities. The consequences for ecosystems, within which these species play a critical part, are unfathomable.

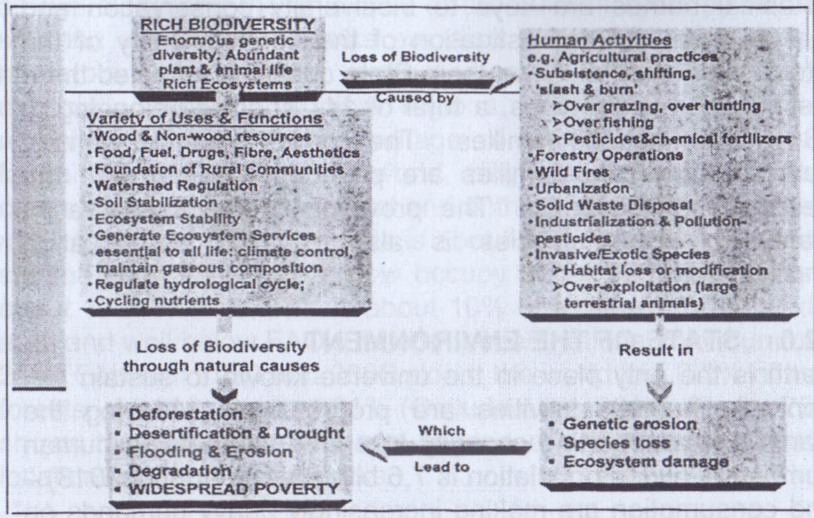


Figure 24: Conceptual Framework of the Dynamics of Biodiversity Exploitation in Nigeria

Thus, it is becoming increasingly clear that the loss of biodiversity will diminish the capacity of ecosystems to provide society with a stable and sustainable supply of essential goods and services. This is well demonstrated in Figure 24 – the conceptual framework of the dynamics of biodiversity exploitation in Nigeria (FMEnv., 2006). Much of this is due to the negative impacts of human activities which are progressively reducing the planets' life-supporting capacity. Thousands of plants and animals could disappear by the middle of this century if urgent measures are not put in place. Some of these plants might have provided new medicines, others new food. In addition, their various habitats are also being degraded and destroyed at an ever-increasing rate. The threats from climate change and global warming are also real and would accelerate the degradation.

In response to these threats, we embarked on biodiversity assessment of the coastal areas of Nigeria because of their vulnerability to the negative impacts of human activities and climate change. Developing a reliable taxonomic base is crucial to all biodiversity programmes because correct botanical names are keys to biodiversity conservation and management. An investigation of the floral diversity of the littoral vegetation of Akwa Ibom State coastline revealed three distinct ecosystem types, a total of 147 species belonging to 134 genera and 58 families. The correct botanical names, author citation and families are provided together with the geographical locations. The provision of the conservation status for each species is also of high conservation importance.

12.0 STATE OF THE ENVIRONMENT

Earth is the only place in the universe known to sustain life. Ironically human activities are progressively reducing the planet's life-supporting capacity at a time when rising human numbers – (world population is 7.6 billion as of August 2018) – and consumption are making increasingly heavy demands on it. According to Allen (1980), the combined destructive impacts of a poor majority struggling to stay alive and an affluent minority consuming most of the world's resources are undermining the very means by which all people can survive and flourish. The state of some components of both the local and global environment is outlined below: the atmosphere, forests, biological diversity, marine water, land, wastes and hazards, among others.

Atmospheric Pollution

This is a major problem facing all nations of the world. Various chemicals are emitted into the air from both natural and man-made sources. Common air pollutants include sulphur oxides, nitrogen oxides, particulate matter, hydrocarbons and carbon monoxides. Many volatile organic compounds and trace metals are emitted into the atmosphere by human activities e.g. zinc, lead, nickel, mercury, copper, chromium, cadmium and arsenic. Air pollution affects human health, vegetation and various materials.

Deforestation and Degradation of Forests

Forest cover is of great importance from the ecological point of view. It protects and stabilizes soils and local climates as well

as hydrology and the efficiency of the nutrient cycle between soil and vegetation. Forests are also the habitat of people, numerous plants, and animal species. Virgin forests, especially those in tropical regions, are an irreplaceable repository of the genetic heritage of the world's flora and fauna. In all parts of the world, degradation of forests is caused by a number of natural and anthropogenic factors. The rate of deforestation in Nigeria is about 3.5% per year. Recent studies show that forests now occupy about 923,767 km^2 or about 10 million ha. This is about 10% of Nigeria's forest land area and well below FAO's recommended national minimum of 25%. Between 1990 and 2005 alone, the world lost 3.3% of its forests while Nigeria lost 21% (Onilude et al, 2011). Figure 25 shows the vegetation types of Nigeria and the geographical locations of the national parks.

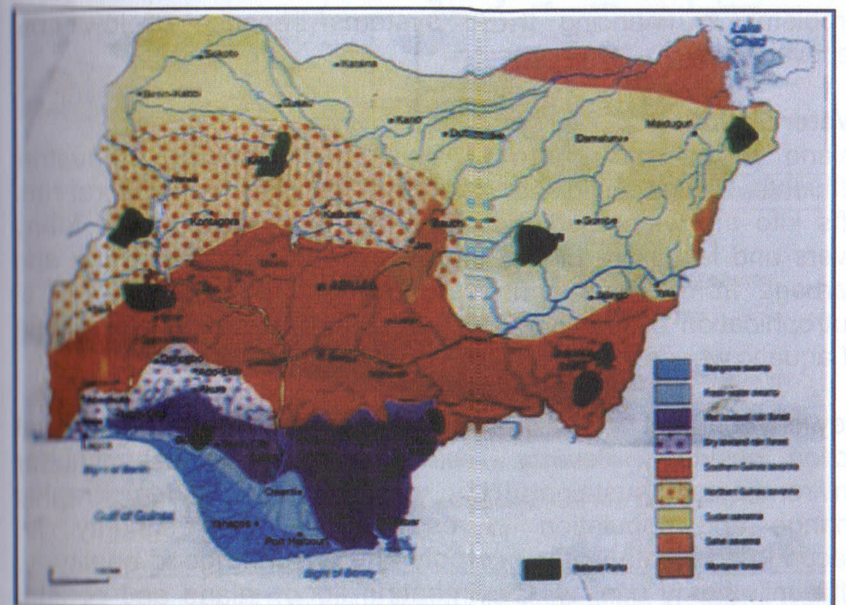


Figure 25: Vegetation Map of Nigeria

The glaring and alarming negative outcomes of the excessive vegetation exploitation and deforestation which occurred in the tropical rainforest, mangrove and freshwater swamp forest zones in Nigeria from the year 1500 to 1991 are graphically illustrated in Figure 26. While the Freshwater and Mangrove forests are still, more or less, intact and thriving in many locations due to their difficult terrain which makes them inaccessible, only fragments or relics of the original tropical lowland rainforest are left standing, as shown in Fig.26e.

Waste in the Environment

Arrangements for waste disposal and management are often insufficient and ineffective in both rural and urban areas. The per capita generation of waste is ever increasing and likely to double in the foreseeable future. The various agencies and bodies involved in the management of waste disposal have problems in financing the systems because of low cost recovery.

Water Pollution

Inland waters are polluted by domestic sewage, industrial effluents, silting, pesticides and fertilizers from agricultural run-offs into the water bodies from the catchment areas. Many rivers and lakes are highly polluted with human sewage and garbage from drains and sewers. These have resulted in eutrophication of many waterways and consequent blooming of aquatic weeds.

Key environment and development issues that require urgent action include: i. Poverty alleviation which is essential for environmental sustainability. ii. Managing demographic change and population pressures. iii. Food security. iv. Securing adequate water supply and ensuring good quality. v. Efficient energy use. vi. Combating flood, inland and coastal erosion. vii. Sustainable industrial production. viii. Preventing and reversing desertification. ix. Managing forest and wildlife resources.

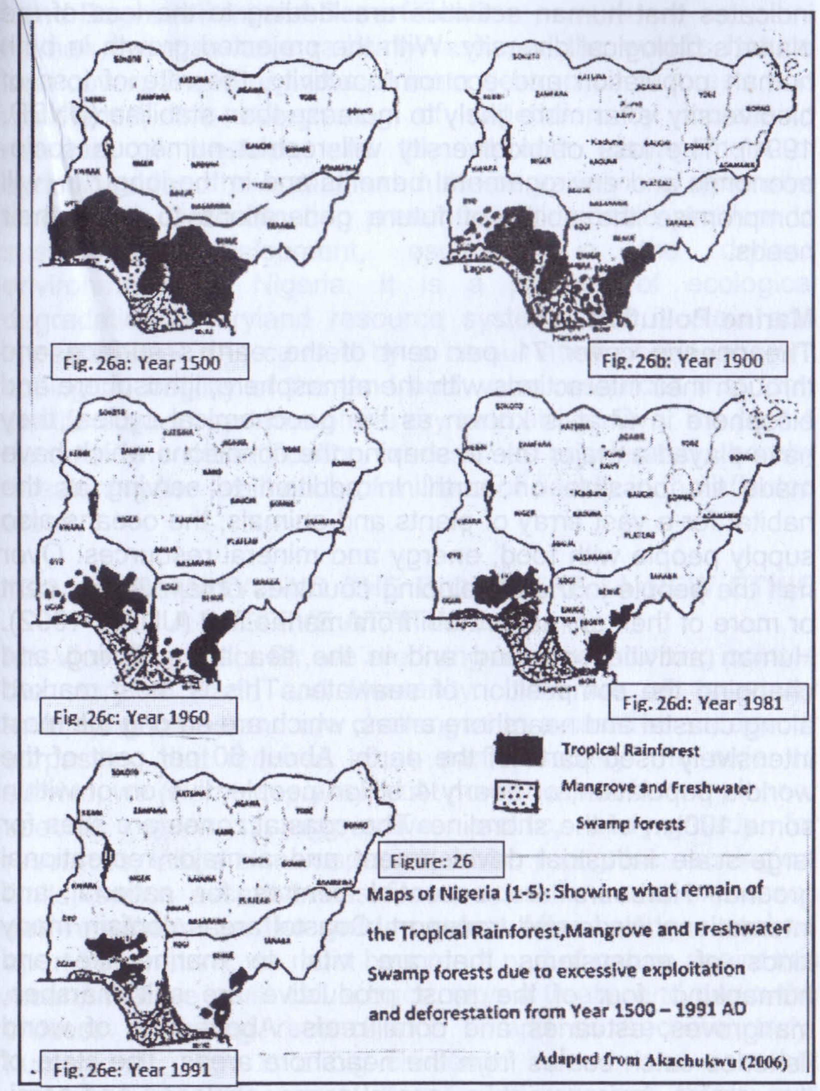


Figure 26: Excessive Exploitation and Deforestation in Nigeria (1500-1991 AD)

Loss of Biological Diversity

The earth's genes, species and ecosystems are the products of hundreds of millions of years of evolution and have enabled human species to prosper. However, available evidence indicates that human activities are leading to the loss of the planet's biological diversity. With the projected growth in both human population and economic activity, the rate of loss of biodiversity is far more likely to increase than stabilise (UNEP, 1991). The loss of biodiversity will restrict numerous socio-economic and environmental benefits and in the long run, will compromise the ability of future generations to meet their needs.

Marine Pollution

The oceans cover 71 per cent of the earth's surface and through their interactions with the atmosphere, lithosphere and biosphere in what is known as the geochemical cycles, they have played a major role in shaping the conditions which have made life possible on earth. In addition to serving as the habitat for a vast array of plants and animals, the oceans also supply people with food, energy and mineral resources. Over half the people in the developing countries obtain 30 per cent or more of their animal protein from marine fish (UNEP, 1992). Human activities on land and in the sea are polluting and changing the composition of seawater. This is most marked along coastal and nearshore areas, which are among the most intensively used parts of the earth. About 60 per cent of the world's population, or nearly 4 billion people, live on or within some 100km of the shoreline. The coastal zones are sites for large-scale industrial development and a major recreational ground. Harbours are essential centres for national and international trade and transport. Coastal areas contain many kinds of ecosystems that are vital to marine life and humankind: four of the most productive are salt marshes, mangroves, estuaries and coral reefs. About 95% of world fisheries catch comes from the nearshore areas. The state of the marine environment in coastal areas, enclosed and semi-enclosed seas is declining. The two dominant pathways by which potential pollutants reach the oceans from the continents are the atmosphere and rivers.

Land Degradation and Desertification

Human activities have radically reshaped the world's natural land cover. The often indiscriminate destruction of forests and woodlands, the overgrazing of vegetation by increasing numbers of livestock, and the improper management of agricultural land have resulted in the degradation of extensive land areas. Desertification presents a formidable problem to sustainable development, especially in the dryland environments of Nigeria. It is a process of ecological degradation of dryland resource systems that is slow and imperceptible. It is caused by a combination of the inherent ecological fragility of the land and water resources that form the life support systems of the dry land areas. Over the past 4 decades, the desertification process has accelerated, thereby threatening the livelihoods of millions of people in the affected areas.

13.0 HUMANITY AND THE BIOSPHERE: A NEW ETHIC AND A POSITIVE ATTITUDE

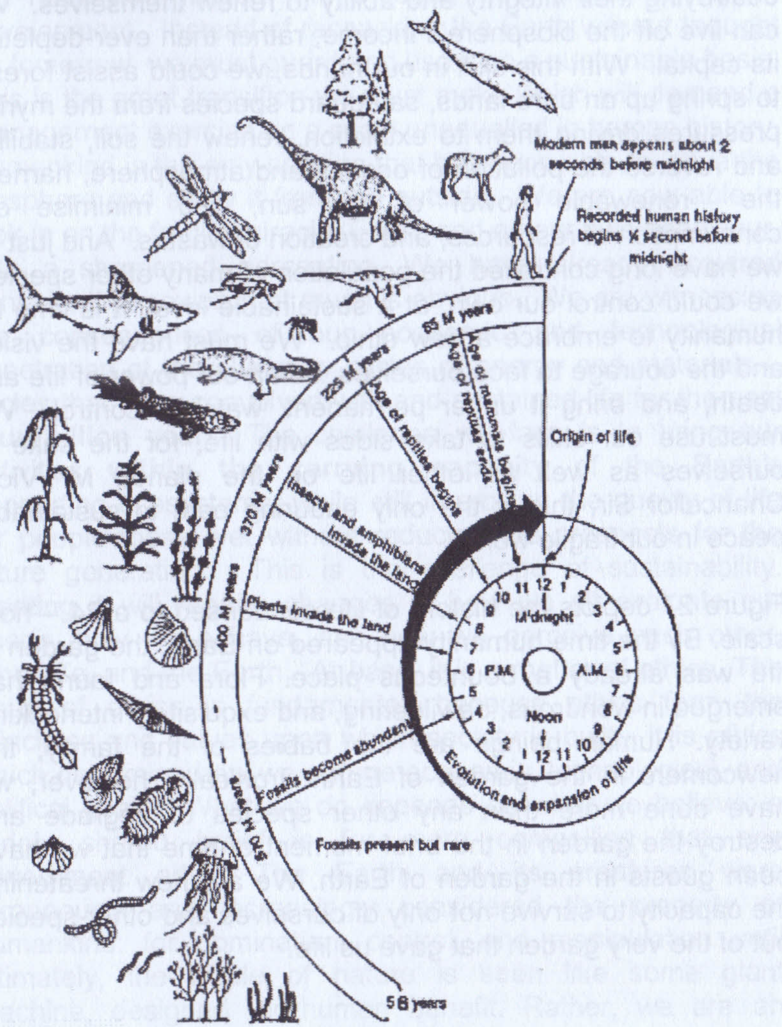
Mr. Vice-Chancellor Sir, we are living at a great turning point in the story of Earth and Humanity. We are all faced by multiplying crises and are challenged to a creative endeavour surpassing that required of an earlier society. In order to survive, we *(Homo sapiens)* must now advance from a pioneer species, which is aggressive, prolific, and greedy for resources, into a climax species, which recognises ecological limits, swaps assertiveness for co-operation, and expresses **self-regulation as the golden rule.** After setting ourselves apart from nature, we must become a part of nature again: this means that we must call a truce, sign a treaty, and begin the process of lasting reconciliation – and so become, truly, humankind. This is a big challenge indeed, and one that requires a sweeping **revolution in how we act, think, and feel; in how we use our technology; and above all in how we manage ourselves,** and thus the impact on the fragile Earth of each and every one of us and of the collective global human family and its institutions, as aptly put by Myers (1993).

Sustainable Management

We have now moved into a totally new phase of human development. Instead of ransacking the Earth without thought for tomorrow, we must guard and use it on a sustainable basis. This is the great transition we must make which will demand a management exercise on a scale unequalled in human history. Humankind is the only species that has been able to leave the biosphere and study it from the outside. We are now able to look in on the fragile miracle, Earth, and on our own behaviour, with a sharpened perception. We have already acquired considerable power; that much is obvious. We are witnessing the consequences of our economic and technological penetration of the planetary cycles of energy and materials – cycles that have coevolved with and sustained life for the past **four billion years.** The challenge we face is to bring our activities **within the carrying capacity** of the Earth's supporting ecosystems, while still improving the quality of life for people today, yet without reducing the prospects for the future generation. This is the challenge of sustainability. Meeting it will require changes in how we all evaluate our needs, how we behave, and how we perceive each other, other life, and the Earth. At base, it is a matter of ethics. The issue of ethics is fundamental, because ethics form the principles and values upon which society is built. It is ethics which determine how we pursue economic, technological, and political goals. What we do depends on what we believe; a widely shared belief is far more compelling that any government edict. The Earth and its creatures were erroneously and increasingly considered the property of humankind: for domination, control, and manipulation until ultimately, the whole of nature is seen like some giant machine, designed for human benefit. Rather, we are an integral part of nature. "Every human being is a part of the community of life, made up of all living creatures. This community links all human societies, present and future generations, and humanity and the rest of nature. It embraces both cultural and natural diversity" (Myers, 1993).

In the words of Myers (1993), we now have the skills to work with natural systems to derive benefits from them, without destroying their integrity and ability to renew themselves. We can live off the biosphere's income, rather than ever-depleting its capital. With this skill in our hands, we could assist forests to spring up on bare lands, safeguard species from the myriad pressures driving them to extinction, renew the soil, stabilise and reverse the pollution of oceans and atmosphere, harness the renewable power of the sun, and minimise our consumption of resources, and creation of wastes. And just as we have long controlled the population of many other species, we could control our own, at a sustainable level. It is time for humanity to embrace a new ethic. We must have the vision and the courage to face ourselves, admit our power of life and death, and bring it under permanent, watchful control. We must use our skills to take sides with life, for the sake of ourselves as well as other life on the planet. Mr Vice-Chancellor Sir, this is the only enduring path to sustainable peace in our fragile world.

Figure 27 depicts the history of life condensed to a 24 – hour scale. By the time humanity appeared on Earth, the garden of life was already a bounteous place. Flora and fauna had emerged in wondrous, bewildering, and exquisitely interlocking variety. Human beings are the babies of the family, the newcomers in the garden of Earth. Ironically, however, we have done more than any other species to degrade and destroy the garden in the brief moment of time that we have been guests in the garden of Earth. We are now threatening the capacity to survive not only of ourselves and other species but of the very garden that gave us life.



The history of life condensed to a 24-hour scale. (From *Life: An Introduction to Biology*, 2nd ed., by George Gaylord Simpson and William S. Beck, © 19. 5 by Harcourt Brace Jovanovich, Inc. Reprinted and reproduced by permission of the publisher.)

Figure 27: The History of Life condensed to a 24-hour scale

14.0 CONCLUSIONS AND RECOMMENDATIONS

In the past couple of minutes or so, I have attempted to give meaning to the scientific discipline called BOTANY, elucidate its various subdisciplines, and shed more light on the traditional and modern approaches to this subject. I have also tried to outline the overwhelming influence of the Plant Kingdom on other forms of life, including humans and the environment; and how plants constitute the foundation of all existence including society and civilisation. In a modest way, I have touched on some of my contributions to the knowledge world. The environmental crisis has also been highlighted and reconciliatory approaches between humans and nature have been proffered as the only viable option if mankind is to escape the looming catastrophe. I have also tried to convince the audience that we are all plants and therefore a part of Nature, rather than thinking that we own Nature.

Mr. Vice-Chancellor Sir, the Plant Kingdom remains an Enigma because the more we know about the diverse hierarchies of categories and groups, the more that remain to learn about the constituent taxa and species complexes.

My recommendations are as follows:

14.1 Reorientate Education to support Sustainability

The traditional subject compartments and categories can no longer remain in isolation from each other and we must work increasingly at the interface of disciplines in order to address the complex problems of today's world. Understanding and solving complex problems will require intensified co-operation among scientific fields as well as between the pure sciences and the social sciences. Interdisciplinarity is very important, particularly in fields such as environmental studies which are not easily confined to a single discipline. The interface between disciplines is becoming a frontier for scientific breakthroughs and Universities must continue to play a key role in international co-operation.

14.2 Allocate more Resources to Education at all Levels

Governments should allocate more resources to the Education sector because education is the most effective means that society possesses for confronting the challenges of the future. Progress increasingly depends upon the products of educated minds; upon research, invention, innovation and adaptation.

Access to education is the ***sine qua non*** for effective participation in the life of the modern world at all levels. Education, to be certain, is not the whole answer to every problem. But education, in its broadest sense, must be a vital part of all efforts to imagine and create new relations among people and to foster greater respect for the needs of the environment.

Education serves society in a variety of ways: the goal of education is to make people wiser, more knowledgeable, better informed, ethical, responsible, critical and capable of continuing to learn. The products of our secondary schools are half-baked or never baked at all and Universities are at the receiving end since they have to cope with many unteachable. Basic education is critical to every segment of our society.

The World Conference on Education for All used the term "basic education" to refer to all forms of organised education and training that meet the basic learning needs of individuals, including literacy and numeracy, as well as the generally knowledge, skills, values and attitudes that they require to survive, develop their capacities, live and work in dignity, improve the quality of their lives, make informed decisions and continue learning.

14.3 Make Budgetary Provisions for Research, Teaching and Learning

Universities must always be active schools for education and research; vigorous academic communities which must remain relevant to the society and serve the best interest of the nation. There should be massive investments in research because research is knowledge and new knowledge always

provides educational, cultural, and intellectual enrichment which leads to social benefits, endogenous development and progress.

14.4 Prioritise, Coordinate and Intensify the Conservation of Plant Diversity

Efforts should be redoubled towards the conservation of plant diversity and wise-use of all medicinal plants so that our future benefits and knowledge are not put at risk. There is the urgent need to formulate a concrete and consistent strategy for conservation of vegetation in various geographical zones of the country.

14.5 Revive and Fund Current Interest in Phytomedicine

Medicinal plants are an important part of our natural wealth. They serve as important therapeutic agents as well as valuable raw materials for manufacturing numerous traditional and modern medicines. There is the need to intensify the systematic search for new drugs while improving on the traditional medical practices. This should be accompanied by:

- Intensification of breeding programmes for high-yielding medicinal plants
- Establishment of adequate and appropriate gardens for the cultivation of medicinal plants
- Production of new medicinal plants via cell – and tissue – cultures and by genetic engineering.

14.6 Revitalise and maintain National and University Herbaria

The Herbarium is an important resource and facility for teaching, research and accurate identification of plants and plant material, making the information available to whoever needs it, including other scientists, conservationists and the general public. The Herbarium is critical to the preparation of local, regional or national checklists of endangered, rare, or threatened species and to locate their present and past sites. The Forest Herbaria in Ibadan and Enugu need renovation and staffing while a third Herbarium should be established in Kano.

The small Herbarium of the Department of Botany should be enlarged, upgraded, equipped and staffed for efficient service delivery and fund generation. It is providing important local and international services to the academic community and the general public despite its limited capacity.

14.7 Commission and finance the Flora of Nigeria Project

The government should fund the compilation of the Flora of Nigeria without further delay, considering its importance in various spheres of National Development. Efforts have been made since 1984 to get this project going.

14.8 Intensify the Greening of the University of Lagos Campuses

Appropriate indigenous trees should be planted on both campuses to replace the old and ageing ones while the young actively growing trees should be trained by grooming. This ensures a healthier environment. Indiscriminate clearing of vegetation in some areas should be halted forthwith; because of their important ecological functions.

14.9 Solid Waste Management

Collection and eventual disposal of solid wastes within and around the campuses should be closely monitored and strictly enforced. The sorting area near the uncompleted Printing Press building requires attention.

14.10 Halt the reemergence of 'Slums' on the Campuses

The neighbouring communities of Akoka and Idi-Araba campuses, i.e. residents of Bariga, Iwaya, Abule-Oja, and those of Mushin, usually perceive these campuses as big markets or Free Trade Zones where they could easily bring their wares and set up 'shops'. These categories of people have no business on the campuses and would only congest and degrade the academic environment. Security personnel must be vigilant at all times to prevent this potential menace.

ACKNOWLEDGEMENTS

Mr. Vice-Chancellor, I give honour and glory to God for his mercies and grace. My life has always been a joy to me wherever I have gone in this world because He endowed me with the wisdom and capacity to live in harmony with both friends and foes.

I want to acknowledge with sincere gratitude the sacrifices and unconditional love of my late parents, Pa Isaiah Giwa Adelodun and Chief (Mrs.) Emilia Eminlola OLOWOKUDEJO, who ensured that I received a good education. I am grateful to all my siblings and in-laws, who have always been solid pillars to lean on, and my maternal grandfather who introduced medicinal herbs to me when I was 14 years old. My uncle, late Mr. S.O. Ayodele, was a guiding light to the family throughout his lifetime. He will always live in my heart. I owe a special debt of gratitude to my Secondary School Principal, late Chief S.F. Adeniran, for dedicating his life to moulding future leaders.

I am immensely grateful to my alma mater, The University of Lagos, for giving me the opportunity to actualise my dream and providing a conducive environment to reach the peak of my academic career. Having graduated with a Special Honours Degree at the top of my class in June 1975, I was invited as the first Graduate Assistant in Botany and given the opportunity to study in any of the best universities in the world for a Ph.D. degree in Plant Taxonomy& Biosystematics. I chose the University of Reading in England- the world best in Plant Systematics. I hereby express my heartfelt gratitude to my teachers and mentors whose personalities and professional conducts made positive impressions that influenced my later choices: Professor and Chief (Mrs) T.O. Orebamjo acted like parents and were wonderful; Prof. O. T. Okusanya and Prof. (Mrs) A. E. Uduebor whose pieces of advice are invaluable. I thank all my friends and the Unilag class of 1972–1975, for the unforgettable campus experience. Professors V.H. Heywood and D.M. Moore (University of

Reading) supervised my Ph.D. Programme and taught me the fine art of careful observation and phylogenetic deductions; as well as Prof. S.L. Jury- our Curator who is always willing to render assistance. I will also like to thank Prof. C. Gomez-Campo, Technical University, Madrid, Spain, for assistance during field explorations; Prof. J. Varo Alcala, University of Granada, Spain, for leading our team to the peak of the Sierra Nevada; Trustees of the Godman Exploration Fund, British Museum (Natural History), London for the Travel Grant. I thank Professors Reed C. Rollins and I.A. Al–Shehbaz of Harvard University for excellent reviews and useful interactions. I also appreciate Professor Peter R. Crane of Yale University, who is also the President of Oak Spring Garden Foundation, for the good time we had in Whiteknights, Reading, Berkshire.

For the support and encouragement offered each other during some of our precarious field expeditions to the Niger Delta Region, I sincerely thank Emeritus Professor Kola Kusemiju, Professors Babajide Alo, Olukayode Amund, Dike Nwankwo and Jonathan Ekpenyong. I appreciate the Dean and colleagues of the Faculty of Science for maintaining the culture and tradition of excellence. The Department of Botany is special in so many ways and I thank all my colleagues there. The Vice-Chancellor is sincerely appreciated for the energy, vision, drive and dynamism he has brought to the office. To all my past 13 Ph.D. and 184 M.Sc. graduates and numerous undergraduates who have made valuable contributions to our unending botanical and taxonomic engagements, I extend my appreciation. I want to place on record the uncommon support of the former Vice-Chancellor Prof. Oye Ibidapo-Obe and former Registrar, Mr. Oluwarotimi Shodimu Esq, during the infamous and senseless Student Union crisis of January 18, 2005, when my residence was reduced to ashes. That was the session that this lecture would have been delivered.

Mr. Vice-Chancellor Sir, I want to seize this rare opportunity to publicly acknowledge the love, affection, support and understanding of my beautiful wife, Dr. (Mrs.) Folake Feyisayo Olowokudejo – a darling, friend and mother like no other. I am

what I am because you love me and my world is a better place because of you. Thank you for everything. I also want to appreciate my children, Ayoola – a graduate of Pharmacy, Unilag and MBA degree holder of the University of California; and his wife Oluwapelumi – Physiotherapist; Adetokunbo who is also a Pharmacy graduate, presently in LUTH; my only girl child – Adeola Mosunmola, formerly a student of Psychology, University of Lagos but lately of Alcorn University, Mississippi, U.S.A; the remaining two boys – Olaoluwa and Okikioluwa - are still engrossed in charting a path for themselves in this turbulent world of ours. With them in the house, there is never a dull moment. I thank you all for being an inseparable part of my life journey.

Once again, distinguished ladies and gentlemen, I thank you all for your attention.

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