BOTANY IN HUMAN AFFAIRS

BY

FRANCIS A. ONOFEGHARA
PROFESSOR OF BOTANY AND
DEPUTY VICE CHANCELLOR
UNIVERSITY OF PORT HARCOURT

INAUGURAL LECTURES 1985-80

SERIES NUMBER 3

Printed by The Printing & Binding Division Iir.o
State Library Board, P.M.B. 1118 Owerri, Nigeria.

BOTANY IN HUMAN AFFAIRS

INTRODUCTION

I have great pleasure in delivering today, the third in the University of Port Harcourt Inaugural Lecture Series, but the first by a Professor of Botany and the first by a Professor in the Faculty of Science. This appears to be a logical development for* when I assumed duty as a Professor of Botany in the then School of Biological Sciences on 30 June 1977, I was the only Professor in the then Schools of Biological, Chemical and Physical Sciences.

If the purpose of an inaugural lecture is to inaugurate me to the Chair of Botany or to formalize the commencement of my professorial career, mine will certainly be regarded as inappropriately scheduled, since I have already been a Professor for a period of nine years. However, one is conscious of the fact that an inaugural lecture is an academic exercise, an occasion to survey one's field, to explain what it is one does, to demonstrate its relevance and to place one's contributions in their proper perspective. It provides an opportunity for one to tell his mixed audience what he claims to profess.

I am also conscious of the fact that an inaugural lecture is neither an occasion of terrible ordeals to the generalist or non-specialist nor a session of intolerable boredom to the specialist. Furthermore, as a pioneer Professor of Botany in this University, who has been actively involved in the building up of what is now the Department of Botany, I cannot be saved the ordeal of speaking both as a generalist and as a specialist, in this very first Inaugural Lecture by a Professor of Botany. I have an obligation not necessarily to write the genesis of the multidisciplinary subject I profess, from biblical times, but to draw attention to the subject, highlight the contributions of the subject (the theoretical and practical, the pure and applied, the intellectual and authoritarian aspects) to human welfare, and to draw attention to the specific discipline of plant physiology which I profess and my contributions within it. The above considerations have largely influenced both the choice and the treatment of the theme "Botany in human affairs". One aims at satisfying two criteria, namely, general intelligibility and reasonable acceptability. My success in this venture, depends, in the final analysis, not only on my competence but also on the indispensable sympathy of my audience.

Plants are all around us, no matter where we live. In the tropics, they grow rapidly and luxuriantly, hiding the earth beneath our feet. During the brief summer of the Arctic zone, rock crevices and pockets where the ice melts give forth brilliant flowers. Deserts, which are often depicted as sandy wastes, become vivid with bloom when moisture strikes them. Prairies and plains are carpeted with grasses and flowers. High above the line where trees can grow on mountain tops, small plants find the means to survive and reproduce in harmony with their rigorous environment. In lakes and running rivers and to a depth of about 274.3m (or 900 feet) in the ocean, green plants thrive. There are other plants too, such as the fungi (singular fungus) which lack green colouring.

The dust-like spores or reproductive bodies of these are in the air about us at all times. The plants themselves have various forms, sometimes of microscopic dimensions. They may appear as a bluish mold upon old or damp shoes, as rust on wheat or smut on corn or blast on rice, as a greyish web which helps to reduce dead plant remains to their primal substances or they may be the invisible cause of a skin infection such as athletes' foot. They give us succulent mushrooms for our table, put the flavour in our cheese, make our bread rise and ferment grapes for wine, they have also become the source of one of the most effective weapons of medical practice - antibiotics.

In all life on earth, plants are the only producers; all consumers particularly man, are dependent on them for their nutritional requirements of carbohydrates, proteins, fats, vitamins and minerals. If the vegetation is deficient in one or more dietary requirements, the animals including man do not remain i."[1] good health. If the crops of the field fail, animal life suffers, if forests are decimated, man is affected in many ways through loss of raw materials, power, water and protection from erosion of his lands. In the course of this lecture, you will see how plants not only feed, clothe, shelter, warm us and gratify our senses, but also how they provide the primary sustenance for every living creature; from the microscopic units of the oceans plankton to man himself and his domestic animals. Plants furnish medicines and perfumes and flavouring. About 50% of the millions of prescriptions filled each year in the world, contain a drug of plant origin. The sales of drugs from botanical sources have been increasing sharply since 1950. Products from green growing and non-green plants go into much of today's manufacturing.

allies' to? with out T4m" he ^c a t .^ * n-uv , . , . ne
can not survive. Thp t Biblical statement that "all flesh is grass" (is 40:6) applies not only to the animals thai ' devour plants but also to the organisms tha subsist on these animals, and to the micro-organisms that produce their substance as they decompose the remains of other plant or animal life. Some plants, however, are man's enemies - those that produce diseases in his garden plants, in his crops and in himself; those that poison and those that grow so much * more persistently than wanted plants that they I are classed as weeds. ij

To have a knowledge of plants - Tiow they grow and reproduce; what uses they have; how they may be improved or controlled - is one of the most rewarding of all accomplishments derived from study, for it provides an understanding of the fundamentals of all life. The Science which is concerned with the study of plant life is called Botany (or Plant Biology).

What problems concern Botanists in their efforts to accumulate significant knowledge of plant life of the biosphere? These include among others:

a. The nomenclature and classification of plants.

b. The principles underlying the great diversity of plants.

c The mechanisms that control the precise patterns of growth.

d. Since plants are the only producers, what kinds of plants growing under what conditions of temperature, soil, moisture and nutrients will produce most abundantly?

e. Rapid propagation of plants through organ, tissue and protoplast culture.

f. Parasites and disease including host parasite relationship.

g. The relationship of plants to their environment and how changes in the biosphere brought about by man eventually affect plants and man.

It is known that many people including the farmer, gardener, forester, florist, nurseryman, orchadist, pharmacologist, physician, environmentalist, geologist, geographer and others find themselves to a greater or lesser degree confronted by an array of problems that lie within the field of Botany, as does the student or anyone-else who wishes to exercise his or her thumb in planting a garden or raising some house plants. Some of the answers to these problems have been arrived at through trial and error, some through insight, but many have been and will be arrived at through the experimentation of trained Botanists.

BRANCHES OF BOTANY

Within the broad science of Botany there are many phases of study which have developed •vith ever-expanding knowledge. Each comprises a series of highly specialized fields, yet each is dependent on knowledge gained in certain other fields. Some of the branches of Botany are:

Morphology - the study of the external forms of plants and their organs;

\natomy the study of the internal structure of plants generally as revealed by a microscope;

the study of the several intrinsic aspects of the smallest units of structure the cells;

the study of heredity and variation, a study of the ways in which plants transmit their own visible or invisible characteristics to their offspring and the mechanisms by which these characteristics are borne in the internal structure of the plants' own cells.

the study of identification nomenclature and classification of plants.

the study of plants of simple forms, the algae (singular alga) which inhabit the lakes, streams, and oceans ranging from microscopic size through sizes tfiat can just be seen with the unaided eye, up to "giant" forms several hundred feet long;

the study of the group of plants known as liverworts and mosses;

the study of plant communities, i.e. the study of plants in relation to their environment;

the study of plant diseases;

Molecular Biology - the study of the molecules of the cell aimed at gaining an understanding of the genetic code to reveal how the sequence of nucleotides in DNA determines the sequence of amino-acids in enzymes and other proteins;

Physiology - the study of natural phenomena in living plants. It is the science concerned with processes and functions, the responses of plants to changes in the environment and the growth and development which result from the responses;

These branches are "galaxies" in the Botanical Universe. Within the galaxy of Plant Physiology, my field of profession, are located the following "solar" systems namely:

Dormancy	Respiration
Germination	Translocation
Growth	Nitrogen Metabolism
Development	Hormones and Growth Substances
Tropisms	Flowering
Water Absorption	Seed Formation
Ion Absorption	Fruit Formation
Mineral Nutrition	Host-Parasite Physiology
Transpiration	In Vitro Culture
Stomatal Movement	Symbiosis
Enzymes	Tree Physiology
Enzyme Histochemistry	Physiology of Marine Algae
Photosynthesis	Stress Physiology

By training I am housed in the solar

systems of 'Host-Parasite Physiology, In Vitro Culture and Enzyme Histochemistry', but in the planets of 'Mistletoe Parasitism','Organ Culture' and Microscopic enzyme histochemistry' respectively. By research and adaptation, I have wandered into the solar systems of Growth Hormones and Growth Substances and Stress Physiology. The galaxy of Plant Physiology together with the appropriate solar systems and planets will be given a special attention later in this lecture as in this Galaxy lies my contribution to knowledge. For now, I wish to highlight the importance of plants and therefore, of their study to man's welfare.

THE ROLE OF PLANTS IN HUMAN AFFAIRS I hope in

this section to consider

i) Plants and Man's Food
ii) Plants and Man's Clothing
iii) Plants and Man's Shelter
iv) Plants and Man's Economy
vi) Plants arid Man's Environment
vii) Plants and Man's Explorations.

Plants and Man's Food: An adequate ^ food kUpply is and always has been one of man s most outstanding needs, second, only to, I make bold to say, man's need for a spiritual rebirth, his need for God (Matt. 6:33). In the last analysis, all his food comes from plants. To be sure, he may eat the flesh of animals, but these animals are just as dependent on plants as man himself, for they are equally unable to manufacture any of their food from raw materials.

Man has had comparatively little success in harnessing solar energy. However, plants as the main source of organic matter are extremely efficient in utilizing the radiant energy reaching the earth as sunshine to effect the combination of carbon, hydrogen and oxygen atoms derived from carbon dioxide from the atmosphere and water from the soil. The process leads to the formation of a new compound alien to any of the substances found anywhere in the earth's crust, a compound of greatest importance to the living world. This compound is carbohydrate, an organic substance typified by the common sugars, starches and woody tissues of plants. This is the starting material for the synthesis of proteins, fats and the vast majority of other plant products. This process known as photosynthesis universally carried out by green plants, studied by chemists, biochemists, phytochemists, biophysicists and plant physiologists the world over, but with very insignificant success in its duplication by man, is the leading synthetic process in the whole world.

The Carbohydrates are obtained directly from plants while fats, proteins, vitamins and mineral salts are obtained either directly from plants or from animals which have fed upon plants. Sugars are obtained from sugar cane *(Sacchorum officinarum),* sugar beat *(Beta vulgaris),* corn *(Zea mays),* Bananas *(Musa paradisiaca subsp. sapientum)* and the sap of maple trees *(Acer saccharum).* Honey, although prepared by bees is essentially natural sugar collected from flowers. Much of the starch we use is obtained from maize, wheat *(Triticum sp)* yam *(Dioscorea spp),* cassava *(Manihot esculenta),* cocoyam *(Colocasia spp),* sweet potato *(Ipomea batatas),* Irish potato *(Solarium tuberosum),* arrow root *(Maranto arundinacea)* plantain *(Musa paradisiaca),* bread fruit *(Artocarpus cummunis)* and rice *(Oryza sativa).* Yam forms an important component of the diets of Nigerians. It can be prepared and eaten in various forms, boiled, boiled and pounded,

(pounded yam;, fried, roasted, maae into flour as 'elubo' or fried in oil as "dundu". Plantain also is eaten as 'dodo' (fried ripe plantain) or 'kpekere' (fried unripe plantain), boiled (ripe and unripe), boiled and pounded. Yams and plantains can also be fried as chips. Cassava also lends itself to a number of uses. Infact, yams, plantains and cassava constitute the primary staple food of Nigerians.

Of particular importance to man in general are the cereal or grain crops, the legumes (sometimes called 'poor man's meat' because of their relatively high protein content) and the vegetables. The principal cereals include wheat, corn, rice, barley *(Hordeum vulgare),* oats *(Avena sativa),* millet *(Pennisetum gloucum, Elecine corocana* or *Panicum miliaceum)* and *Sorghum*. Today, rice and maize are consumed in reasonably large quantities in Nigeria. The legumes include among others beans, soybeans, peas. *(Pisum sativus),* lentils and groundnuts *(Arachis hypogaea),*[9] and many hairy and forage plants for livestock. Beans and groundnuts in particular are heavily consumed in Nigeria. The vegetables include a wide variety of plants with edible parts. Some, such as the Irish potato, sweet potato, carrot, *(Daucus car rota)* and radish *(Raphanus sativus)* grow underground. Others such as cabbage *(Brassica oleracea),* lettuce *(Lactuca sativa)* water leaf *(Talinum triangulare)* bitter leaf *(Vernonia arnygdalina),* crain-crain *(Corchorus oJitorius)* ~ Ewedu (Yoruba), Ahihiara (Ibo)), green *(Amaranthus spj, Celosia argentea* (Soko (Yoruba)),
Telfaria occidental is (Ugu, Ibo) are called leafy vegetables.

In some West African countries, notably Sierra Leone, the young fresh leaves of cassava and Irish potato are highly prized vegetables. Many kinds of fruits, both temperate ancl tropical, such as banana, mango *(Mognifera indica),* orange *(Citrus spp),* tomato *(Lycopersicon esculentum)* garden egg *(Solatium melongena),* guava *(Psidium guajava),* soursop *(Anona muricata),* star apple *(Chrysophyllum africana,* - Ibo Udara) and African pear *(Dacroyodes edulis,* Ube Ibo), pawpaw *(Carica papaya)* and pineapple *(Anonas comosus)* form an important part of man's diet.

All the spices used in cooking in the home are from plants. The most familiar of them are pepper *(Capsicum spp),* cinnamon *(Cinnamomun zeylonicum)* mustard *(Brassica spp),* nutmeg *(Myristica fragrans),* ginger *(Zingiber officinale)* thyme *(Thymus vulgaris),* chives *(Allium schoenoprasum)* garlic /*Allium sativum)* which are used for seasoning. Our beverages - coffee *(Coffeo arabica),* tea *(Camelia sinensis),* cocoa *(Theobroma cacao),* cola *(Cola nitida),* and all types of drinks are plant products. Edible oils are extracted from cotton seeds, olives, maize, soybeans and peanuts.

A number of aquatic plants are increasingly becoming important sources of food. They provide three types of food: foliage for use as a green vegetable; grain or seeds that provide protein, starch, or oil and swollen fleshy roots that provide carbohydrate, mainly starch. Examples, include water spinach *(Ipomea oquatica),* a tropical trailing herb of muddy stream banks and fresh ponds and marshes, whose fresh young leaves and stems are used as vegetable, boiled or cooked in oil (very popular in Hong Kong comprising about 15% of all the vegetables grown for the local market); watercress *(Nasturitium officinale),* a herb of the mustard family, prized as a fresh-salad herb or as a cooked green vegetable, a rich source of iron, iodine and vitamins A, B and C; and *Neptunia oleracea,* a curious leguminous plant with feathery leaves and stems made bouyant by their spongy white covering, used as green vegetable when young, to name only a few.

In a sense aquatic weeds constitute a' free crop of great potential value - a highly- productive crop that requires no tillage, fertilizer, seed or cultivation. Aquatic weeds have potential for exploitation as animal feed, soil addictives, fuel production and waste water treatment. The leafy parts of aquatic plants such as duckweed *(Lemna spp)* and water hyacinth *(Eichhornia crossipes)* and some submerged weeds contain 25-35 percent protein, which is exceptionally high. In Southeast Asia, some non-ruminant animals are fed rations containing water hyacinth. In China, pig farmers boil chopped water hyacinth with vegetable wastes, rice bran, copra cake and salt to make a suitable feed. In Malaysia, fresh water hyacinth is cooked with rice bran and fish meal and mixed copra meal as feed for pigs, ducks and pond fish. Similar practices are much used in Indonesia, the Philippines and Thailand.

From all available evidence, it is known that food obtained directly or indirectly from plants is more important than is generally realized. About 33-40% of the average American diet consists of livestock products and 57-60% comes directly from plants - mostly small grains and potatoes. Of the Chinese diet, 95-100% is plant food, In India, plant sources account for 90-95% of the diet. In Spain, Italy and throughout most of the Mediterranean region, 85-95% of the food eaten comes directly from plants. In Nigeria, in a majority of homes, plants account directly for about 95-100% of the diet.

PLANTS AND MAN'S CLOTHING

Although animal products were available early in Man's history, yet he needed some form of clothing that was lighter and cooler than hides and skins. For his snares, bow-strings, nets and the like, he needed some form of cordage that was easier to procure than animal sinews and strips of hide. Moreover, some other types of covering for his crude shelters was desirable. All these needs were admirably met by the tough, flexible strands that occurred in the stems, leaves and roots of many plants. Plant fibres have had a more extensive use than wool, silk and other animal fibres. As civilization advanced and man's needs multiplied the use of these vegetable fibres increased greatly. Today, they are of enormous importance in our daily life. The most important use of fibres at the present time is in connection with the textile industry, which is concerned with the manufacture of fabrics, netting and cordage. In making fabrics and netting, flexible fibres are twisted together into thread or yarn and then woven, spun, knitted or otherwise utilized. Fabrics include cloth for wearing apparels, domestic use, awnings, sails, etc. The fabric fibres are afl of commercial importance. Netting fibres which are used for lace, hammocks and all forms of nets include many of the commercial fabric fibres and a host of native fibres as well.

Examples of plants yielding textile fibres are cotton *(Gossypium barbadense, G. hirsutum, G. arboreum* and *G. herboceum),* Flax plant *(Linum usitatissimum),* hemp plant *(Cannabis sativa),* ewedu *(Corchorus olitorius* and C. *capsular is)* which yields jute fibre, pineapple *(Anonas comosus)* - its leaves yield fibre for making pina cloth in the Philippines. Certain tree basts with tough interlacing fibres can be extracted from the bark in layers or sheets which can then be pounded into rough substitutes for cloth or lace. These tree basts which constitute natural fabrics are derived from the paper mulbery *(Broussometia papyrifera)* used by Polynesia and parts of Eastern Asia, the tauary *(Couratori tauori)* used by American Indians, wild fig *(Ficus Nekbudu* - used in Mozambique as the source of the native mutshu cloth), the upas tree *(Antiaris toxicaria* - used in Ceylon for bark cloth). The so-called lace bark is the product of *Lagetta lingearia,* a small Jamaican tree. There are a host of plants yielding useful fibres for different articles of clothing.

PLANTS AND MAN'S SHELTER

Plants especially those that yield fibres and wood play a key role in man's quest for the provision of adequate shelter. All the wood used for constructing temporary sheds, batchers; kiosks; buccaterias; boats and permanent dwelling houses; offices and business houses; markets; furniture, etc. whether in the form of veneers (thin slices or sheets of wood of uniform thickness); plywood (built-up stock); wood alloys (densified wood); recohstructed wood (wood in which the fibres are taken out of their original unidirectional grain and reconstructed and re-arranged in multi-directional patterns), sawdust and shavings and wood flour, comes directly from plants. Veneers are used in connection with furniture and cabinet work to cover up inferior woods and they were initially made from mahogany, walnut and other woods with beautiful colour, grain and figure. Now, many species are used and the veneers are utilized in the Manufacture of boxes, baskets; door panels; trunks; mirrors; musical instruments; etc. Plywood is now a fully recognized engineering material with its peculiar properties. It has extensive uses in the home for doors, walls, flooring, partitions, shelves, cabinets, furniture and interior trim. Enormous quantities are used in concrete forms, pre-fabricated houses, air planes, boats, railroads, cars and the bodies of trailers and station wagons. Common wood yielding plants include conifers *(Pin us sp),* obeche *(Triplochiton scleroxylon)* Mahogany *(Khayo senegalensis),* Iroko *(Chlorophoro excelsa)* cedar, Abura *(Mitragyna spp),* teak *(Tectona grandis),* ebony *(Diospyros Ebenum),* Afara *(Terminolio superba* and *T. Ivorensis),* white mangrove *(Avicennia africana),* red mangrove *(Rhizophoro mangle; R. racemosa* and *R. harrisonii)* to name only a few. The leaves of many palms and grasses provide roofing materials for the thatched houses of the majority of our rural dwellers.

PLANTS AND MAN'S HEALTH

From very early times, mankind has used plants in an attempt to cure diseases and relieve physical suffering. In China, as early as 5000 to 4000 B.C. many drugs were in use. There are sanskrit writings in existence which tell of the methods of gathering and preparing drugs. The Assyrians, Babylonians and ancient Hebrews were all familiar with their use. Some of the Egyptian papyri, written as early as 1,600 B.C. bear records of the names of many of the medicinal plants used by the physicians of that day, among them myrrh, cannabis; opium; aloes; hemlock and cassia. The Greeks were familiar with many of the present-day drugs as evidenced by the works of Aristotle, Hippocrates, Pythagoras and Theophrastus. The first extensive compilation is in the Chinese *Materia Medica* of 2737 B.C. Plants were used by the ancients (and are still being used by people today) for everything from growing hair to curing backaches and broken bones. Many of these uses were based upon quite fanciful or imagined curative properties, but some (the number is increasing) did have a real basis in medical fact, and plant drugs have a very important place in modern medicine. Although the raw plant material is often not usable in modern medicine because of its adulterants, impurities, and other unknown or dangerous aspects, it has served as the basis for the extraction and purification of natural plant drugs or for the manufacture of synthetics having similar medicinal properties and fewer dangerous side effects.

Many plant products are used in medicines simply as sweeteners, colouring agents, suspending agents, (emulsifiers) binding agents in pills, or agents adding a pleasant taste or smell to medication. Others, however, have a very specific medicinal or curative value. Some of the better known examples include digitalis, from the leaves of *Digitalis purpurea* (Foxglove) which has a highly specific action on heart muscles, hesperidin from the rind of unripe green citrus fruits, implicated in the prevention or correction of capillary permeability in cerebrovascular or cardiovascular diseases, hypertension; treatment of haemorrhage; nephritis and habitual or threatened spontaneous abortion, atropine from the deadly nightshade *(Atropa Belladona)* which is a parasympatholyte (blocks the actions of the parasympathetic nerves), cocaine from *Erythroxylon Coca* which is used as a local anaesthetic and cerebral stimulant; quinine from the bark of *Cinchona calisaya;* C. *officinalis;* and C. *succuribra,* which is used in the treatment of malaria; mescaline from the cactus *Lophophora* sp.; used as a tranquilizer and as a treatment of certain mental disorders; opium and its derivatives, especially morphine and codeine from *Pa paver sominferum* used for its hypnotic; sedative; pain-relieving and other qualities; reserpine from *Rauwolfia serpentina* used as a sedative and tranquilizer.

Other plant products of medicinal value include cascara (from *Rhamnus purshiana);* Colchicine (from *Colchicum autumnale);* eucalyptus oil (from *Eucalyptus globulus);* curare (from *Strychnos toxifera, Chondodendron tomentosum; Abuca spp.* and *Cocculus spp)* and Ephedrine (from *Ephedra sinica* and *E. equiselina).* Others include the antibiotics produced primarily by certain micro-organisms - the molds, actinomycetes and bacteria being the chief sources. Examples are penicillin, the best known antibiotic and one of the most important drugs in medicine; produced by several species of *Pencillium;* but chiefly from P. *notatum,* streptomycin - discovered in 1944 "from *Streptomyces griseus,* aureomycin (1948) from S. *aureofaciens,* Chloromycetin (1947) from S. *venezuelae,* tetramycin (1950) from S. *rimosus* and neomycin (1949) from S. *fradiae.* They are used for treating various bacterial fungal and protozoan infections. The leaf, bark and root extracts of the neem tree (Dogoyaro), *Azadirachta indica* are commonly used in Nigeria for malaria and various forms of fever. Extracts of other plants such as *Vernonia amygdalina* (Bitter leaf) *Cola nitida* (Cola); *Euphorbia hirta, Ricinus communis* (Castor oil); *Rauwolfia vomitoria, Cassia alata; Cymbopogon citriatus* and *Anacardium occidental is* (Cashew) have also been known to have medicinal values. The list indeed is, literally speaking, endless. The few examples are nonetheless sufficient to underscore the primary role plants play in man's health.

PLANTS AND MAN'S ECONOMY

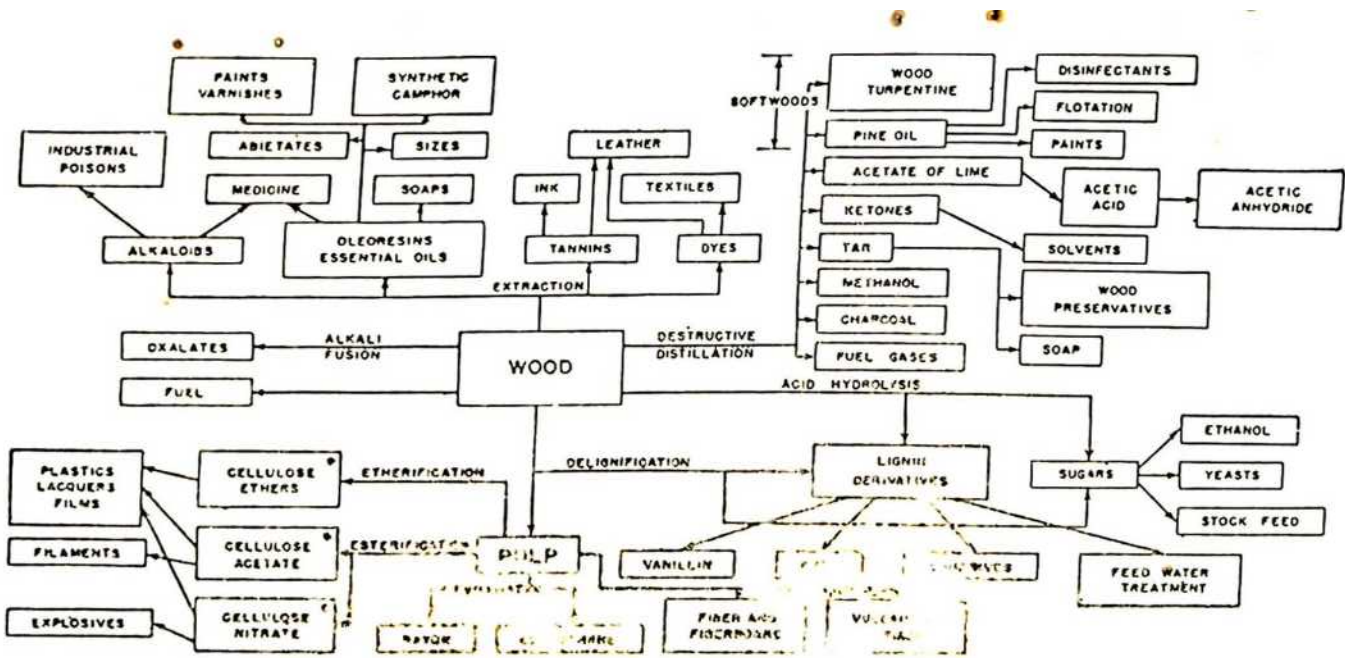
Plants play a dorminant role in man's economy. Fuel is one of the great necessities of modern life and it is indispensable both in the home and in industry as a source of heat and power. The most important of the plant products used for this purpose are wood peat and coal which represent different stages in the carbonization of the original plant material. Wood makes an excellent fuel since it is 99% combustible when perfectly dry and leaves only a small amount of ash. Although much less wood is used for fuel at the present time than formerly, the total consumption is probably greater than for any other purpose especially in farms and rural communities which account for over 90% of the total consumption. Peat consists of deposits of vegetable matter which have accumulated in logs and swamps and slowly decomposed; becoming somewhat carbonized and compacted, but with the various plant tissues still discernible. Peat is a valuable fuel in countries where wood is scarce. It is more bulky to handle and leaves from five to fifteen times as much ash. Coal is a cheap source of power and heat and also of many valuable chemical products including benzol, naptha, coal-gas which is used for fuel and illuminating purposes, ammonia, coal tar, the source of dyes, antiseptics and countless other materials and coke. Coke which is nearly pure carbon and burns without smoke or flame is an excellent fuel and is also used in metallurgy.

Either directly of indirectly, wood is important in a variety of industries: timber construction, boxes and crates; furniture and fixtures, railroad cars, vehicles, posts, poles, and piling, cooperage, railroad ties, veneers, plywood, distillation, cork, paper. and paper products, to name a few. Other wood working industries produce the following products: agricultural implements, caskets and coffins, refrigerators and kitchen cabinets, ship and boat building, matches, wooden-ware and novelties, musical instruments, tanks and silos, signs and supplies, professional and scientific instruments, electrical machinery and apparatus, machine construction, toys, laundry appliances, handles, supplies for diarymen, poultrymen and beekeepers, patterns and flasks, sporting and athletic goods, boot and shoe findings, shade and map rollers, brooms and carpet • sweepers, picture frames and moldings, motion picture and theatrical scenery, brushes, plumbers woodwork, shuttles, spools and bobbins, trunks, sewing machines, pulps, wood pipes and conduits, airplanes, toothpicks, printing materials, play-ground equipment, dowels,» chacks, paving materials, saddles, gate and fencing, butcher blocks, firearms, scales, elevators, whips, canes, and umbrellas, flutes and artificial limbs (Hill, 1952).

Apart from its use for fuel, sawdust serves as bedding for stables and kennels,as a floor covering to absorb moisture, for cleaning; drying and polishing metal; as a packing medium; as a soil conditioner and an insulating material. It plays a part in the making of leather and the conditioning of fur and is an ingredient of composition flooring, artificial wood, wallboard, abrasives, floor-sweeping compounds and many other products. Wood flour which consists of fairly ground sawdust, shavings and other forms of wood waste is of increasing importance in the manufacture of linoleum, plastics, nitroglycerin explosives, veneer bonds, composition flooring, insulating brick and many other products. It is used as a filler, an absorbent, or a mild abbrasive.

In the light of the above, we should not be surprised at the great pains taken by the Forestry Department to forestal poaching and indiscriminate felling of trees, which yield us various grades of timber - Abura, Obeche, Iroko, Afara and Mahogany. While the Nigerian forests contain about 600 potential timber species, the export market demands are dominated by less than ten species of which mahogany *(Khaya senegolensis),* Obeche *(Triplochiton scleroxylon),* Iroko *(Chlorophora excel so),* Abura *(Mitragyna spp),* Afara *(Terminalio spp)* and teak *(Tectona grondis)* are predominant. Obeche makes up more than seventy percent of the logs exported. It is also not surprising that there is a high consumption of wood annually, worldwide. According to Zon and Sparhawk (cited by Hill, 1952), the total annual consumption of wood in the world is 56 bi.cu.ft. Of this amount, 28 bi.cu.ft (50%) is used in North America; 17 bi.cu.ft in Europe; 8 bi.cu.ft. in Asia, 2.5 bi.cu.ft. in South America and the remainder in Africa, Australia and Oceania. The per capita consumption is 188 cu.ft. in North America; 225 cu.ft. in U.S.; 15 cu.ft. in Britain; 26 cu.ft. in France and 27 cu.ft. in Western Germany. In countries where the forests are abundant, the per capita consumption can be greater than in the U.S.

Charcoal is a wood product and its conversion to coke is important in the iron and steel industry. It is also used as an absorbent, a reducing agent, a drawing material and an ingredient in gunpowder. Few plant products are more useful to man than cellulose obtained chiefly from cotton and wood. We know cellulose most commonly in the form of paper, cotton cloth and wood, but this substance has been transformed by Polymer Chemists into rayon fibres; explosives, plastics, lacquers, synthetic sponges, cellophane, camera films, bottle caps,



INDUSTRIAL SIGNIFICANCE
OF
CHEMICAL WOOD PRODUCTS

* USUALLY MADE FROM COTTON IN THE UNITED STATES

FIG. 1 Industrial significance of chemical wood products ... from Panshin, *Forest Products*, McGraw-Hill Book Company, Inc.)

eye-glass frames, etc. Forest trees also yield turpentine, gums, resins, waxes, cork and rubber. Tannin, a wood extract is important because of its ability to combine with protein, forming nonputrescible compounds. When used, on animal hides, it makes the hide decay- resistant, strong, yet soft and pliable. Thus, it is used in the leather industry in an activity called tanning. Tannins are also used in the manufacture of certain inks, where it reacts with iron salts forming coloured compounds Figure 1 illustrates the industrial simificancp nf chemical wood products.

In Nigeria, plants such as oil palm coconut, cocoa, rubber, and groundnut are important economic crops providing revenue for the government and its citizens. Cocoa is the chief revenue yielding crop in the Western states and to a lesser extent in the Eastern States. Rubber *(Hevea* brasiliensis *Funtumia elostica)*, one of the most indispensable of plant products with a wide range of uses especially in tyre industry, contributes a fair quota to the revenue of the Western and Eastern states, broundnut, the source of utility groundnut oil, is an important source of revenue for the i orthern States. The palms generally constitute an important group of plants. Today, oil palm, the major source of cheap cooking oil in most homes is gradually regaining its position as a major source of revenue. The coconut *(Cocos nucifera)* is often called 'Man's most useful ree . The meat of the coconut (actually endosperm tissue) is dried to produce copra. U1* is extracted from the copra and the remaining coconut cake is used primarily as a lvestock feed. The fibrous husk of the coconut, the coir is used in making rope, mats, rugs etc. The shells are used for eating or rmking utensils, fuel, and bowls, for making artistic novelties or grinding up as fillers in plastics. The coconut milk (liquid endosperm tissue) is used as a drink, or in plant tissue culture work as a cheap but good source of growth promoting substances. The leaves are used for thatching huts, for making baskets and hats while the wood is used to some extent in construction and furniture making. The oil palm similarly lends itself to a wide variety of uses.

In the absence of appropriate raw plant materials such as wheat, corn, millet, sorghum, cassava, plantain, yam and grass for fodder and forage, the businesses of bakers, cattle rearers, livestock and poultry keepers will [1] completely crumble. Only a few days ago, it was reported that the Apapa Flour Mills, the largest in the country was closing down > resulting in the sack of many workers and the insecurity of the jobs of others, all because the mill had run out of wheat. The Federal Government invested heavily in importation of rice, sugar and wheat in the last six-years particularly between 1979 and 1983. Trafficking in cocaine and hemp made many millionaires but also sent some to face the firing squad and heightened societal ills. Plants are no doubt important in man's economy.

PLANTS AND MAN'S ENVIRONMENT

The aesthetic value of plants has no small influence on the quality of man's environment and man's enjoyment of life as evidenced by the host of garden enthusiasts and flower lovers, ^including historians, linguists, philosophers, geographers, economists, political scientists, sociologists, educationists, zoologists, ^biochemists, chemists, doctors, engineers, etc. The fields and forests constitute retreats where solitude and quietness are enjoyed by millions of people. The beauty of plants has been responsible for a vast industry involving seedsmen, horticulturists., nurserymen, landscape gardeners, and florists. Today in Nigeria, many have found self-employment in growing and selling plants, either whole or in part. Many flower lovers spend fortunes in procuring plants for their residential quarters including the inside of the building and offices. Plants add beauty and glamour to the room, office, official function, wedding reception, burial ceremonies, birthday parties and reception of dignitaries. The fragrance produced by some flowers has helped to improve the quality of the environment. All flower lovers are familiar with the refreshing aroma of the rose *(Hibiscus rosa-sinensis),* the queen of the night, the lily, the frangipani *(Plumeria),* and *Cananga odorata (Annonaceoe).*

We are also familiar with other ornamental plants such as *Gmelina, Terminalia, Casuorino, Cassia, Caesalpinia, Thevetia, Ailamanda, Croton, Lantana* and the much-liked hedge plant, *Ixora* and different types of orchids all of which have helped in no small measure to improve the quality of our environment.

The presence of well maintained grass on a football pitch adds glamour to the game as it makes for fluidity of play, other things being equal. The care of rock gardens, herb gardens, gardens of roses and many other kinds of plants provides pleasure to many who eagerly await the offerings of new varieties as the annual catalogues appear. The numerous organizations associated with gardening further attest to the recreational value of plants. Pleasure is provided also by the plants in lawns, parks, streets, botanical gardens, conservatories, golf courses and even cemeteries. That Port Harcourt is gradually regaining its former state that earned it the

=,tJSrden ?ty" is lar^ely because
investment in plants. Trees help to check decertification and erosion. This is why the national tree planting campaign launched on Monday, 7th July, 1986, is a step in the right direction. Apart from the huge sums of money spent each year in the advanced countries on ornamental plants, there are values in seeing and growing them that cannot be measured in monetary terms.

The vigour that makes it one of the world's worst weeds appears to make the water hyacinth ideal for water treatment. Water hyacinth is already being farmed on a 3.6 ha sewage lagoon serving the city of Lucedale, Mississippi (a population of 2,500) by the National Space Technology Laboratories. The University of Florida and the Texas State Department of Health Resources are also treating sewage with water hyacinth on an experimental basis. In warm water, water hyacinth can increase at a phenominal rate of 15 per cent surface area per day. At this rate, 20-40 tons of wet water hyacinth could be harvested per ha per day, removing the nitrogenous waste of over 2,000 people and the phosphorus waste of over 800 people. When sewage was passed through a pond at a rate of 2.2.m litres per ha per day (200,000 gallons per acre per day) water hyacinth growing in the pond removing 80 per cent of the nitrogenous compounds and 40 percent of the phosphorus compounds in two days. Water hyacinth culture removes algae and faecal bacteria, greatly reduces suspended matter, and removes odour-causing compounds. Reportedly, the resultant effluent is clear, odourless and contains little nitrogen; some phosphorus remains because it is removed more slowly than nitrogen. Part of the improvement in water quality is caused only indirectly by the water hyacinth. The floating vegetation fosters the growth of organisms such as *Daphnia* (a Zoo-plankton) that feed on bacteria and it shades the lagoon and reduces wind and wave action, thus helping suspended matter to settle out. (NAS, 1977).

PLANTS AND MAN'S EXPLORATIONS

When we think of Botany and plants, we often conjure up scenes of an innocent past because of the elegance, fragrance, beauty and fragility of many flowers and plants. Botanists know that this view of the history of plants is far from the truth. Men have gone forth with sword in hand to distant lands, have set out on long and dangerous voyages of discovery and have conquered empires all for certain kinds of plants. A few examples will suffice.

The story of spices is a great romance complete with tales of war, conquest, theft, envy and hatred. One spice in particular, black pepper *(Piper nigrum)* holds an important place in history, perhaps the most important of any plant. Although pepper is very common now, in ancient times, only the richest could afford it and it was measured out with balances for its equivalent weight in gold. In medieval times, it was so highly prized that rich men wrote wills bequeathing pepper to their sons. Beautiful women, fine horses and expensive jewels could be had for pepper. Many other spices such as ginger and olives also were valuable, for they were used to preserve food, flavour wine, make perfumes, prepare medicines and even embalm the dead.

tho ^,ny sPices came from India, Ceylon and oiuccas. The Venetians monopolized the pice trade and suppressed competition from European powers. Then in 1497 the

Portuguese explorer, Vasco Dagama opened up the spice trade of the Far East by navigating around the Cape of Good Hope. Columbus' discovery of America was inspired by the desire to find a direct route to the spice treasures of the East. The great rivalries between Portugal, Holland, England and Spain in the sixteenth, seventeenth and eighteenth centuries were caused by disputes over trading rights in China, India and the spice Islands. Although sugar had replaced spices as the world's chief flavouring material, we should note that it was pepper, cinnamon and ginger that caused the Spanish, Portuguese, Dutch and English to make their most daring voyages.

Many food plants have played a role in history too. An example will suffice. The soldiers of Alexander, the Great, first reported that the barbarians of th& Indus obtained honey from reeds, that is, from sugar cane. The growing of sugar cane spread to Persia and thence to Egypt and Spain and by the sixteenth century, to the new world. Sugar soon became a very important commodity in Europe and nations plotted, fought and struggled for trade supremacy in sugar.

Sugar also figured prominently in the Napoleonic Wars of the early nineteenth century. The British navy blockaded the continent, closing down the sugar refineries which had been importing raw sugar and selling it to France, Germany and other countries. Everywhere, there was sugar shortage and finally in 1811, Napoleon subsidized the esablishment of a sugar-beet industry. Sugar beet factories sprang up by the hundreds in France. The British ridiculed the idea of

making sugar from beets and published satirical cartoons such as one showing a nurse thrusting the end of a root in the mouth of Napoleon's soil, saying *"Sucre mon cheri, sucre con pere* *dit que c'est du sucre"* (Norstog and Long, 1976). Although Napoleon lost his empire, tjie sugar beet survived and Botanists were able to breed beets that contain up to 28 per cent sugar. Today, it is one of the best examples of an important crop that has been brought about through the joint efforts of politics and science, (Botany).

THE GALAXY OF PLANT PHYSIOLOGY

At this juncture, and for the rest of this lecture, I intend to dwell in the Galaxy of Plant Physiology. Within this galaxy, as I stated earlier, are located the solar systems of Host-parasite Physiology, In Vitro Culture and Enzyme Histochemistry which house respectively the planets of mistletoe parasitism, organ culture and microscopic enzyme histochemistry. I had also indicated earlier that by research, I am associated with the solar systems of Hormones and Growth Substances, Growth Physiology ahd Stress Physiology. Before delving into my sojourn in the planets of my primary concern, it is pertinent to intimate you with the place of the galaxy of plant physiology not only in the Botanical Universe but also its specific role in human affairs. By doing so, you will be able to appreciate why the galaxy has a particular attraction for me.

PLANT PHYSIOLOGY: WHAT ROLE?

From its environment, the plant takes raw materials and makes them into organic chemicals suitable for its own use. With these chemicals, the plant makes more of its own living substance, makes and uses its own food, carries on digestion and assimilation, and grows and reproduces, according to the pattern laid down by its inheritance. Plant physiology is the field of study that observes, analyses and experiments with these life processes. What minerals does a plant need and how much of each? What does each mineral do in the plant? How does the plant transport the minerals and chemicals it makes? What happens if some mineral is lacking? What goes on in a plant during the day, and during the night? How do variations in length of day and night or in the amount of light affect it? What chemicals within the plant stimulate it to grow or to flower or to fruit, or to respond to gravity, or to lose its leaves or shed its fruits?

In solving some of these problems of plant nutrition and plant behaviour, plant physiologists have given us much practical infomation. For example, mineral deficiencies in the soil produce symptoms and an analysis of the soil will show what kind of fertilizer to apply to make up for the lack of certain minerals. There is hardly a farmer or home gardener who does not make use in one way or another of knowledge gained by plant physiologists from such simple things as what time of the year to sow seed or how much sun or shade to provide, to the more advanced use of plant hormones and even to growing plants without soil.

The world is confronted by an ever-deepening food crisis. We live in an age of chronic food shortage, which is intensified as the population of the world increases faster than our current production of food. On a global level, the available food supply in 1949 approximated that of 1939 but in these ten years, the world's population had increased by 15 per cent. A few areas of the earth including the Americas, are fortunately, regions of food surplus. These areas of plenty are more than offset, however, by great areas of food deficiency. Although many economic factors bear on this problem, it is evident that food production over the world as a whole must be increased if everyone is to be adequately fed. (Bonner and Galston, 1952).

0 Large increases in agricultural production cannot be immediately achieved by the subjugation of additional land, since the bulk of the fertile soils are already in use. Further research may indicate methods for the successful and stable utilization of certain of the vast tropical regions which cannot now be exploited effectively. More important at present are- the increases in agricultural productivity which may be achieved through a better understanding of plants and through the application of existing knowledge to a larger portion of the world's agriculture7)1 While the applications of our knowledge 01 genetics, genetic engineering, chemical pest control and proper cultural and fertilization practices would perhaps, most rapidly and significantly increase agricultural output in the food deficient areas Of the world, many problems of food production still await solution in the hands of plant physiologists. Not only is it desirable to achieve still further^*tfontrol* and guidance over crop ftdevelopmentfjttw So Intfrely* new approaches. It is necessary, for instance, to conceive of new crop plants or of new ways for the production of edible fats or proteins from existing crop plants, more intensive utilization aciuatic plants and acquisition of more at T ^ow t0 create and maintain soils a satisfW ertl^ty- 11 is dear, therefore, that sUpplv wi ril for the WOrld'S food

ot d p?a rp^sl ofo e ey development of our

O) Plant physiologists work to obtain a better understanding of, and better control over the growth of plants. They have the satisfaction of seeing their findings translated into practice in the world's largest industry. The ability of the world to support its growing population depends on the future developments of plant physiology and the application of these developments. The fact that man is completely and absolutely dependent on plants for the necessities of life makes it imperative that he gains as thorough a knowledge, as possible of the science of Plant Physiology .(^Moreover, a knowledge of plant physiology is essential to all fields of applied botany, whether agronomy, floriculture, forestry, horticulture, landscape gardening, plant breeding, plant pathology or pharmacognosy. All these applied sciences depend on plant physiology for information regarding how plants grow and develop.

There are many aspects of practical agriculture which can benefit from more intensive research efforts in plant physiology. These include among others:

i. The efficiency of photosynthetic conversion of solar radiation in the production of food nutrients that are acceptable to human diets can be increased.

ii. Better ways to utilize information regarding biological nitrogen fixation will result in increased utilization of nitrogen by plants.

iii. Techniques of tissue culture developed during the past several years by plant physiologists can be refined to decrease the time required to produce desirable strains of crop plants.

iv. Crop yields can be increased by learning how and. when the application of plant growth regulators to plants is most effective.

v. Losses of water from plants by transpiration can be minimizedby increasing the e

vi. The growth and development of certain crops can be regulated by artificial means of irradiation.

vii. The quality of human food nutrients in field and vegetable crops can be regulated through suitable micro-nutrient additions to soils.

viii. The exact growth conditions necessary for optimum yields of crop plants can be determined precisely by growing them in controlled environments.

ix. Now, useless weeds and jungle plants can be converted to high-quality animal fodder by the addition of fats and proteins produced through large-scale culture of algal and yeast cells.

In the light of the above, it should not surprise anyone that I chose to pitch my tent with plant physiology.

It is my intention for the rest of this lecture to summarize my research activities and in so doing, lay bare the nature of the endeavours to which one's life has been deeply committed, show what contributions one has made to knowledge and the relevance of such contributions to the overall subject of this lecture *Botany in human Affairs.*

MISTLETOE PARASITISM

As I arrive at this planet, I cannot but mention briefly how I came here. I was introduced to host parasite physiology and mistletoe parasitism in particular by Professor S.N.C. Okonkwo (FAS) in 1966, soon after my first degree final examinations. After some discussions, I agreed to return in September, 1966 to start my Ph.D. programme under his supervision. He gave me a copy of his own Ph.D. thesis on *Striga senegalensis,* an angiosperm parasite. By the time I returned in September, 1966, because of the imminent civil war, Professor Okonkwo had left for the East. From September-December, 1966, I was reading literature on-the subject hoping that Professor Okonkwo would return, but this was not to be. By January, 1967, I opted to have another supervisor, the late Dr. J.R.S.L. Lawton of blessed memory who told me clearly that what I was planning to do was not at all in his field and that I would be primarily responsible for designing and executing my research
experiments. This was indeed a challenge which I had to face along with Professor Agnes E. Uduebo who had also come to work with Professor Okonkwo.

The mistletoe, family *Loranthaceae,* a ^ group of semi-parasitic angiosperms (flowering plants) are mostly herbs or shrubs parasitic on tree branches and are attached to the host by means of a modified root-like structure, the haustorium. These mistletoes attack a variety of hosts causing considerable damage (Williams, 1963; Kuijt, 1965J Onofeghara, 1969; 197Ta)• The hosts are usually woody trees including tree crops such as cocoa *(Theobroma cocao),* cola *(Cola nitida* and *C. MUennii),* sweet orange *(Citrus sinensis),* grape fruit *(Citrus paradisi),* lime *(Citrus aurantifolia),* bitter cola *(Corcinia kola),* Pepper fruit *(Dennettia tripetala)* and local peer *(Dacryodes edulis).* Of the seven genera of the *Loranthaceae* in West Africa described by Balle (1958) and Balle and Balle (1961), the best known are *Tapinanthus* and *Phragmanthera,*At least, six to eight species of mistletoes have been found on cocoa and cola and two to three on *Citrus spp.* These include *Tapinanthus bangwensis,* 7. *buntingii,* 7. *globiferus,* 7. *dodoneifolius, Phragmanthera* Jncana,; P. *Leonensis,* P. *Kamerunnensis, P.* ^njgrfwta^ In Nigeria, about 75% of all individuals are 7. *bangwensis* which is characterized by flowers whose perianths lobes are red below, pink then grey above, red berries and a globular or elongate haustorium; a further 15-20 percent are P. *incana* (particularly abundant on *Cola nitida)* characterized by yellow flowers, blue berries and an elongate haustorium, and the remaining 5-10 percent is accounted for by 7. *globiferus,* 7. *dodoneifolius,* P. *Kamerunnensis* and P. *nigritata.* Similar figures have been reported for mistletoe distribution on cocoa in Ghana (Room 1977). In Sierra Leone, 7. *bangwensis* and 7. *bintingii,* together account for 60% of all individuals while P. *leonensis* and P. *incana* together account for 35%; the remaining five percent is accounted for by rarer species such as P. *vignei, Englerina parviflora, E. gabonensis* and *Agelanthus bruneus.* Table I shows the host range of some West african mistletoes. Although the morphology and taxonomy of all mistletoes in West Africa have been described in some details by Balle and Balle (1961), the work of Onofeghara (1969, 1971a, b 1972a,b; 1973) on *Tapinanthus bangwensis* represented the first detailed study on the biology of any given species. In this section of the lecture, I intend to summarize the work done on *Tapinanthus bangwensis* and *phragmanthera incana* (Onofeghara, i982) between 1966 and 1983.

+ K^^es on the development and establishment of the parasite on different hosts were carried out in order to establish:

i. the mode of penetration of host;

ii. the manner of haustorial development;

iii. the location of vascular connection between host and parasite;

iv, the effects of parasitism on the gross structure and distribution of host tissues;

v. the nutritional requirements of the parasite through *in vitro* studies;

vi. the specificity or otherwise of the parasite through field observations on natural hosts and developmental studies using various plants and hosts;

vii. the pest status (if any) of mistletoes' in the light of i-iv and Vi;

viii. possible control measures.

TABLE I

HOST-RANGE OF SOME WEST AFRICAN MISTLETOES

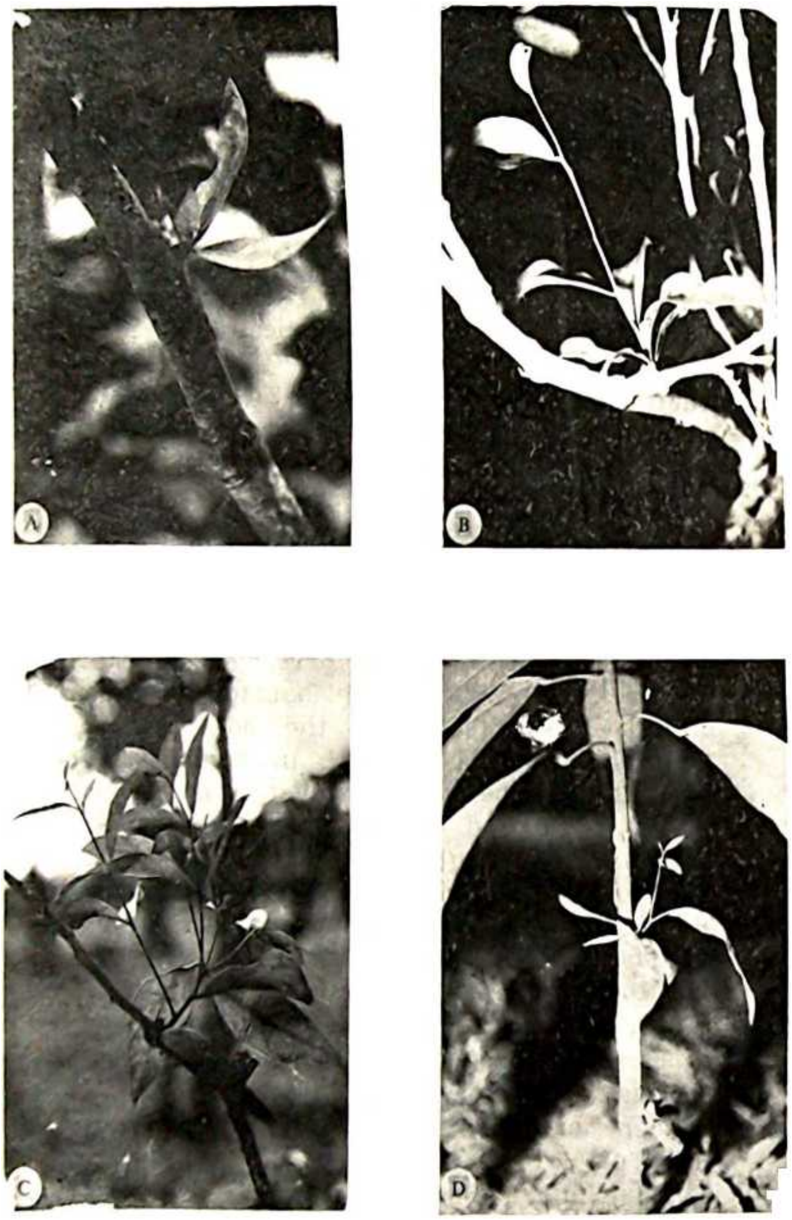
TAPINANTHUS BANGWENSIS

ON	
Acacia spp. *Butyrospermum spp.* *Ceiba spp.* *Gardenia spp.* *Landolphia heudelotii* *Zizyphus mauritania*	Reported by Hutchinson & Dalziel (1954) Williams (1963)
Parinaria curatellifolia Paulinia pinnata Bridelia	
Cola nitida Cola milennii Theobroma cacao Ficus exasperata Phyllanthus discoideus Casuarina equisetifolia Terminalia catappa	Onofeghara (1971)
7. *bangwensis, Phragmanthera incana and others* *Citrus spp.* *Garcinia kola* *Dennettia tripetala* *Dacryodes edulis*	Onofeghara (1982)

Germination takes place within 24-48 hours of planting. Within 24-72 hours of germination, the growing seed dries up if contact is not made with a suitable host-surface. Plumular leaves appear within one week of planting and establishment of contact with host surface and by the 8th week, a miniature shoot of the parasite is established (Plate 1). By the 52nd-64th week, the parasite flowers and bears fruits. The rate of development is dependent on successful contact with host vascular system. Penetration is both mechanical (by growth pressure) and chemical (by enzyme action - Onofeghara, 1969, 1971a, 1972a, b, 1973). In all cases examined, penetration is initially centrepetal until the outer layers of the host xylem are reached. Thenceforth, penetration and gradual encirclement of the host-wood proceeds tangentially and unidirectionally in the majority of cases. In a few instances, however, penetration is bi-directional as a result of a bifurcation of the primary haustorium (Onofeghara, 1971a). The haustorial tissue is directly in contact with the host xylem and presumably the cells just in contact become conducting. The vascular system is completely xylary composed essentially of strands of thraceids (Onofeghara, 1971a). Observations made on 7*. *buntingii, Phrogmont hero leonensis* revealed development patterns similar to those of 7". *bongwensis* and *P. incana.*

The involvement of enzymes in the penetration process was unequivocally demonstrated for the first time by the histochemical localization of some of the enzymes that play a key role in the host-parasite relationships. These enzymes include acid phosphatase, alkaline phosphatase and B-glucosidase. They are involved in energy transfer reactions, cell wall synthesis and carbohydrate transformations, particularly at

Plate I



Later stages in the development of *Tapinanthus bangwensis* **showing parasite shoots of different ages and sizes.**

a. 9-week-old parasite on *Afzelia africona*

b. 14-week-old parasite on *Solanum macracarpon*

c. 17-week-old parasite on *Theobroma cacao*

d. 18-week-old parasite on *Cola nitida* critical stages in morphogenesis. It has thus been possible for the first time to utilize enzyme histochemical methodology in the study of host parasite relationships with particular reference to mistletoe parasitism.

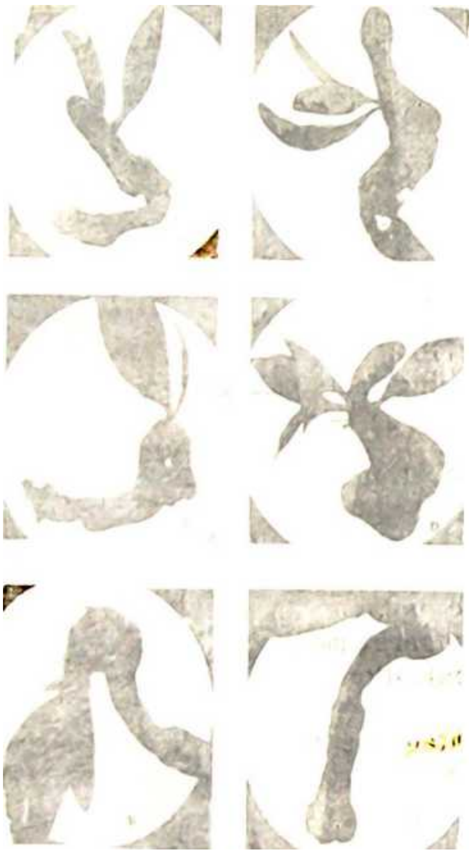
The nutritional requirements of *T. bangwensis* were determined by in vitro culture of seeds and embryos on chemically defined media. The carbohydrate nutrition of the parasite was examined by the incorporation of different concentrations of various sources of carbon, sucrose, glucose, maltose, fructose, galactose, raffinose, sorbose, lactose, xylose, mannose and ribose. The growth substances (IAA, GA3 and Kinetin) and photoperiod were also investigated. The detailed results of these investigations have been reported elsewhere (Onofeghara, 1971b, 1972a, 1973). From such studies, the following facts emerged:

i. By and large, the parasite will thrive well in a medium of mineral salts and sucrose at an optimal concentration of 4% (Plate 2).

ii. The parasite is able to metabolize a wide range of sugars most of which showed similar concentration optima.

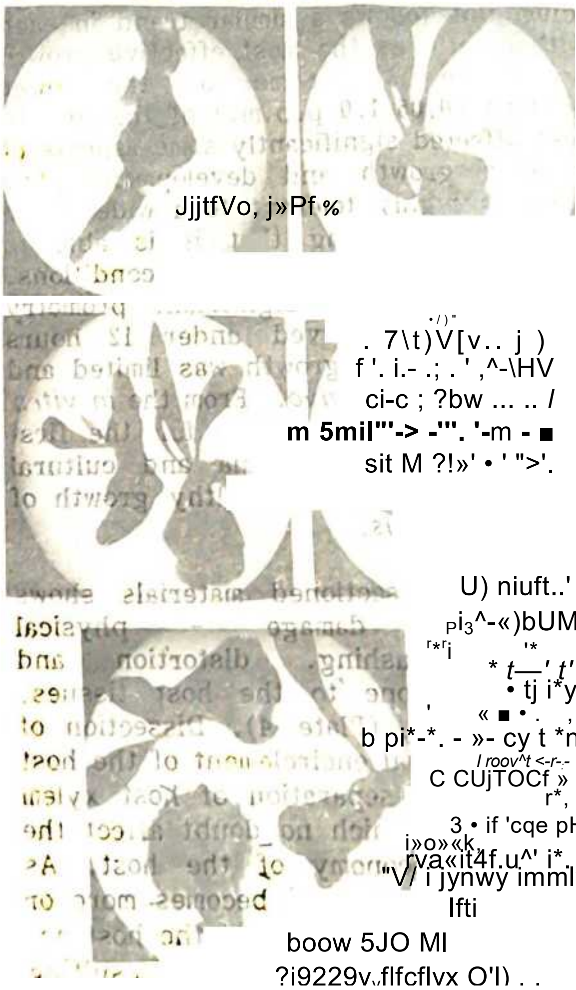
This seems advantageous to the parasite in the sense that in the intact, plant in nature, the parasite can utilize whatever sugar was available to it, either from its own store or from the host. One remarkable finding is the ability of the seedlings of the parasite to metabolize xylose, a pentose sugar (Onofeghara, 1971b). In no other case prior to this finding, except in *Striga senegalensis* (Okonkwo, 1966), have the tissues of a higher plant been found to metabolize this pentose (Gautheret, 1959). Since this sugar is normally a part of the complex of the plant cell wall, the ability of the

Piote 2



Seedling: of *Topmonthtst bchgwenus* grown o« Knop'i medium (A-D) ond *on* MufOjhige Skoog't med.om (E-F) for 12 order I2h light dolly of 27± I'C A-0 S<»dlingt on *Knop t* med'um «iin 4% uiCfou lowing »lou» houitorio (A 0), hou»torwm with »ide bronches at me proximol . .

·t t)



JjjtfVo, j»Pf %

. 7\t)V[v.. j)
f '. i.- .; . ' ,^-\HV
ci-c ; ?bw ... .. /
m 5mil"'-> -"'. '-m - ■
sit M ?!»' • ' ">'.

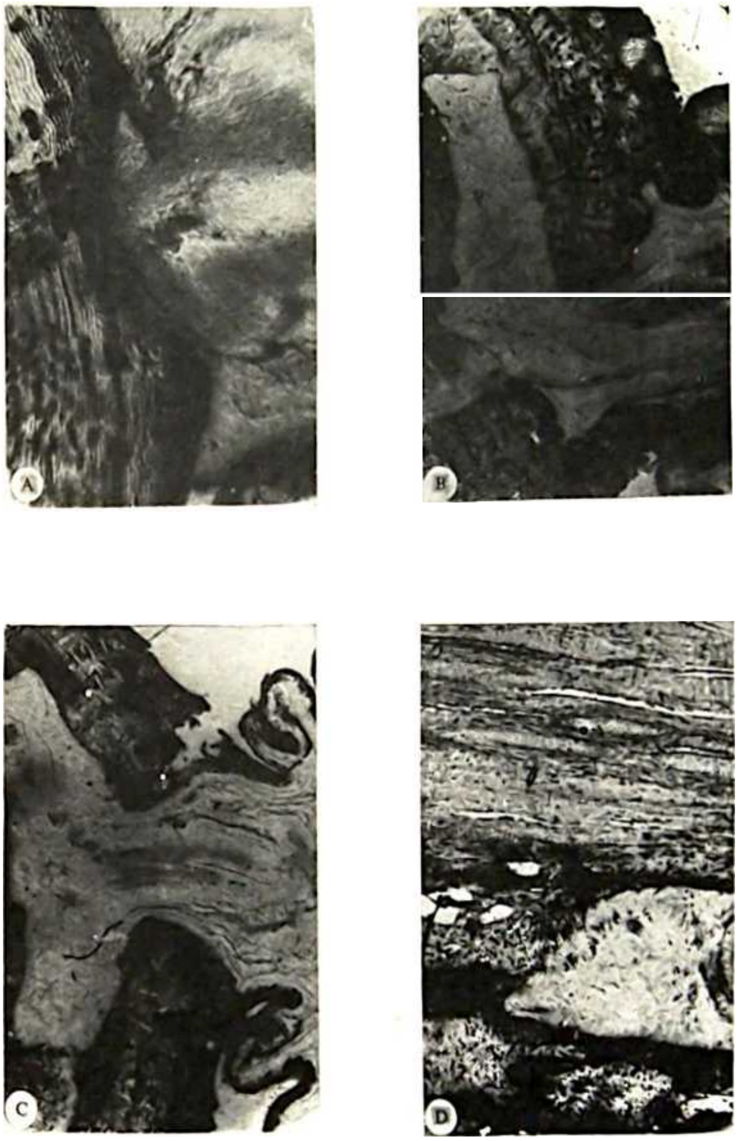
U) niuft..' 1
Pi3^-«)bUMO:
* t—' t' ftcn:** t"
• tj i*y> V\t%c
« ■ •. , v/» "»l
b pi*-*. - »- cy t *n?»i toj •
l roov^t <-r-.-
C CUjTOCf »
r*,
3 • if 'cqe pHc^aicr
i»o»«k,
rva«it4f.u^' i*, OM»M
"V/ i jynwy immlwoM)
Ifti
boow 5JO MI
?i9229v,,flfcflvx O'l) . .

t>Oil -*fU : »r«c* •n**
•*{!"" . n^fl'joVir '1o f. '
lo ^erioitr/id gni\i«>oflj..v
lo ^nilli)! ^rlT .beUbi yi^nibioooft ,
9ii) <9^i>mrb Jaoit 9fi) lo 20il0nc^.
n . .o•

parasite to utilize it suggests that the parasite is able to utilize this part of the host cell walls that it breaks down during haustorial invasion of the host tissues. The growth response to IAA, GA_3 and Kinetin not only varies with the concentrations of each of these substances in the medium but follows a similar trend in each case, with kinetin as the most effective growth promoter (Plate 3). Some of the lower concentrations (0.05-1.0 p.p.m.) of the growth substances affected significantly some aspects of the parasite's growth and development. The parasite seems highly tolerant to a wide range of photoperiods, showing that it is able to thrive under a wide range of light conditions. However, consistent and significant promotry effects were only observed under 12 hours photoperiod. Generally, growth was limited and slower *in vitro* than *in vivo*. From the *in vitro* culture studies, it was possible for the first time to establish culture media and cultural conditions favourable to the healthy growth of *Tapinanthus bangwensis.*

-Examination of sectioned materials shows that considerable damage - physical disorganization, crushing, distortion and discoloration - is done to the host tissues, particularly the bark (Plate 4). Dissection of the host wood, gradual encirclement of the host wood with increasing separation of host xylem and bark are events which no doubt affect the water and mineral economy of the host. As encirclement of the host wood becomes more or less complete, the xylem vessels of the host are occluded by the parasites haustorium resulting in the arrest of growth and death of the host branches distal to the points of infection. The young actively photosynthesizing branches of the host are accordingly killed. The killing of the young branches of the host damages the canopy. Capsid pockets are known to form in

Plate 4



a T.S. 3-week-old parasite on *Bixa ore liana* showing an early stage in the penetration procetai o portion of the host bark has been raised and cortical tissues within penetratioh path are crushed.

Sections of host-parasite showing discoloration and disintegration of host tissues adjacent to or remote from the site of entry.

b.c. T.S. 7-week-old and lO-week-old parasite respectively on *Cola nitida.* d. T.L.L. 6-week-old parasite on *Thiobromo cacao.*

damaged parts of unshaded canopy (Williams, 1953) and so mistletoes encourage capsid pocket formation. This promotes the spread of mistletoes by letting in more light. Mistletoes provide food, through a mealybug for crematogaster ants. These ants are mutually exclusive with *Oecophylla longinodo* (Strickland, 1951) and appear to be less capsid predators that *Oecophylla* (Leston, 1960). Here again, mistletoes would seem to be indirectly conducive to capsid pocket formation. The Crematogaster ants provided with food by the mistletoes are the same species which have been implicated in the transmission os swollen shoot virus by tending and possibly carrying the vector mealybugs (Strickland, 1951). In this way, the mistletoe is conducive to the spread of swollen shoot virus.

Considering the above direct and indirect effects, the mistletoes fit well into Tinsley4'§. (1964) cocoa degeneration syndrome concept^ (Fig. 2), and must be considered established pests of cocoa and cola in particular. Now. that[v] they have become established on these important tree crops, they are bound to assume increasing economic importance. They may well become as Important -as the mistletoes described by Kuijt „ (1964; [4]1965) as major pests of cocoa in' Costa Rica or as the mistletoes *Arteuthobium spp.,_* now recogni-zed to be destructive pajasit^s on commercially important forest trees in the United States of America. While'accurate quantifications of the^pest status of these mistletoes are extremely difficult because of the complexity of their ecological rQj£#ii£:is clear that-the damaging effects; of a heavy infestation (up to 50[1a]W^m6re[rt]^"i^TSfoe3, per frefe 'fiaW Wel^ui^e^
i n N
i g e p i £ ' ,
^ ' b m the death of the young actively photosynthesizing branches distal to the points

2*

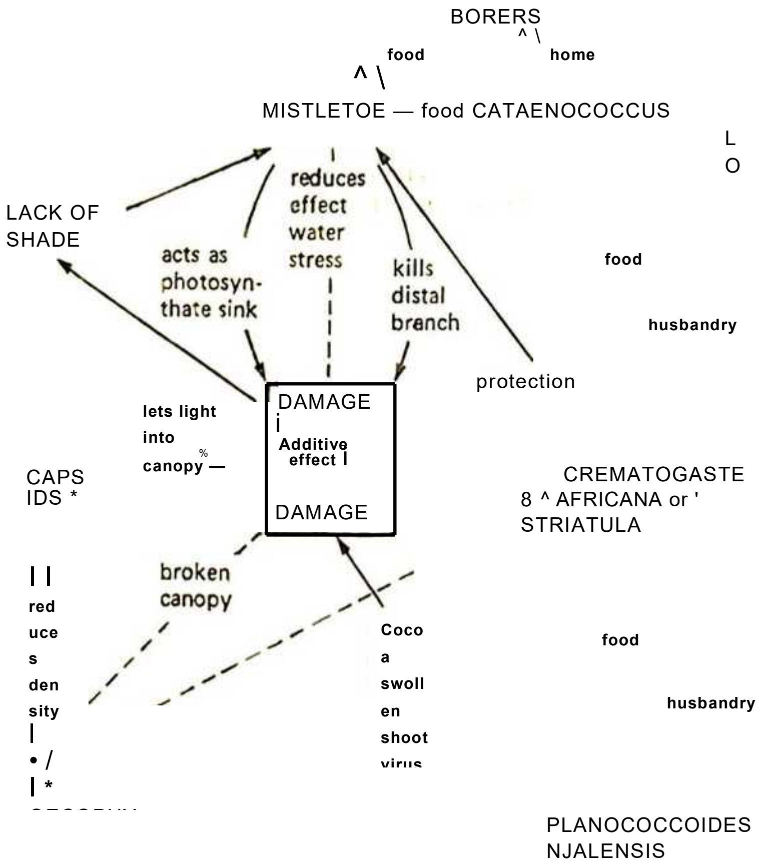


Fig. 2 *Suggested role 7*. bang wens is in cocoa canopy degeneration.*

------------------------- > conducive to, -----------------------------> antagonistic to.

sufficiently low that cutting out once every two years should give acceptable control.

%

of infection are appreciable and control would seem desirable if serious economic hazards are to be avoided. The maintenance of a top shade to prevent mistletoe germination is a long term measure. The present practice of manual cutting of the infected branch can be utilized effectively if done at the flowering peaks and at periods when the ;urmers are not involved in harvesting. This would preferably be in

July-August, when the plants are easily seen. In the case of heavy infestation, manual cutting out particularly when uncontrolled leads to virtual killing of the host tree. Undoubtedly, effective control would have to be sought through the development of specific herbicides as has been done for *Amyemo pendula,* a mistletoe growing on several specie^ of *Eucalyptus* by injecting a solution of triethanolamine salt of 2.4 - D into the host tree (Greenham and Brown, 1957). However, although the host range of the parasite is very wide, the reproductive rate is sufficiently low to allow manual cutting out once every 2-3 years to give acceptable control.

The studies have shown that mistletoes are a potential danger to cocoa and cola, and other tree crops of economic importance. These studies have enabled us to:

i. understand the biology of the parasite;

ii. know their host range;

iii. know and assess the damages they cause and the danger they pose to economic crops;

iv. have required baseline data for planning control measures;

v. develop new approaches to the study of host parasite relationship.

I will now proceed to summarize my research activities in the fields of enzyme histochemistry, growth physiology and stress physiology; point out the main thrust of the research, show the contributions made to knowledge and enrichment of botanical research and assess the practical applications of such contributions, if any, to human affairs as well as their relevance to the advancement of our subject matter "Botany in human affairs".

The aim of enzyme histochemical methodology (Microscopic enzyme histochemistry) is to localize enzymes or enzyme catalyzed reactions within tissues and cells. In general, biochemical analysis of enzymatic activity involves homogenization techniques in which the cells are ruptured. A tissue is made up of a heteregenous population of cells and, definitive studies on one particular cell type is almost impossible using normal biochemical methods. One of the serious disadvantages is the destruction of ultra-structure . upon which normal biochemical function is dependent. By contrast, microscopic histochemical techniques utilize sections the morphology of which is not grossly disturbed and employ known chemical reactions to produce insoluble chromogenic precipitates precisely at the cytological sites associated with specific enzyme activities. Thus localization of a variety of enzymes may be accomplished at the cytological level, and even of greater importance, sites of enzyme activity may be delineated to one or a few specific cells in a relatively large heterogeneous sample. The microscopic histochemist must, therefore, combine successfully the fields of physiology, biochemistry and histology (Onofeghara, 1969).

The procedures usually employed in microscopic histochemical techniques include:

i. processing the tissue for the test;

ii. application of the test;

iii. observation, evaluation and interpretation * of results.

The methods and techniques used in

histochemistry are diverse, and it is necessary that some of them are modified in accordance with the particular tissues under study. Infact, the following discovery of the alkaline phosphatase method by Gomori (1939), Takamatsu (1939), the azo-dye method for alkaline phosphatase by Menten, Junge and Green (1944), the application of tetrazolium salts as biological redox-indicators by Kuhn & Terchel (1941 as cited by Burstone, 1962), the Gomori (1941) lead phosphate methods pf pre-treating tissues for histochemical-enzyme localization, to modify where necessary, conventional histochemical techniques for the localization of acid phosphatase and to evaluate the azo-dye and metal-salt techniques at./the optical level (Onofeghara, 1972). , : ojc.iv.: :<\ Hi-;

io v In my work on localization of enzymes in *Topinanthus bangwensis* (Onofeghara, 1972),, many of the then known conventional histochemical methods were subjected to critical analysis and modifications and the rewarding efforts of the modifications were_ vivid, clear and comprehensible localizations. According to Onofeghara (1969), the three basic points to bear in mind, when employing a histochemical test are; . • ; \0 ..

i. the specificity of the test;' "f

ii. 'the sensitivity of the test; vnvrno vM

r>- • • .■*i-.ii o/i1 //

iii. the validity of the localization (that is whether the picture of the enzyme distribution produced simulates the. true

V)UL distributional pattern - *ihwivo);* m ,

' • •• '■ - • julg Q

io2ft).">rfq<iOdq

- n: To achieve this, adequate.controls must be ro run by: n 'inoirifi tnrlJ <5rioftrsriJauol io

. -'onr^ns

i. exclusion of substrate from the incubation medium;

,/u ■

ii. addition of specific inhibitors;

iii. addition of competitive inhibitors;

iv. enzyme denaturing through immersion of tissue sections in boiling water for five minutes prior to incubation.

It must be established that any resultant positive reaction is produced by the particular enzyme being tested for and by nothing else. If a negative reaction is produced by a test, it is also necessary to establish that such a reaction is due to the absence of enzyme and not due to lack of sensitivity of the test employed. In most enzyme histochemical techniques, the basic principle is that the enzyme is presented with a substrate on which it acts, liberating either an end-product or the diffusion stain precussor of Holt (1956). Histochemical techniques are classified into two categories - the metal-salt techniques initiated by Gomori (1939), and the azo-dye techniques initiated by Menten, Junge and Green (1944). The former depends on the precipitation of an insoluble metallic salt and the latter on an insoluble dye at the sites of enzyme activity for ready visualization. Both groups of methods have undergone series of modifications in the last 40-45 years.

My enzyme histochemical studies details of which have been published (Onofeghara, 1972a, b, 1973; Onofeghara and Koroma, 1974a, b; Onofeghara and Kaikai, 1975), have centred on the localization of three groups of enzymes namely, acid, phosphatase, alkaline and phosphatase and B-glucosidase in a wide variety of plants (Table IIJ. It is clear from the series of localizations that histochemical localization of enzymes;

i. makes it possible to corelate structure and function;

Bryophyllum cranatum 17	++ or +++ Mainly phloem, less in xylem, cortex and epidermis.	Not Tested	Not Tested
Plectranthus micranthus 18	+++ or ++++ epidermis especially epidermal hairs, cortex, phloem and xylem.	Not Tested	Not Tested

LEGEND: + Low; ++ Moderate; +++ High; ++++ Very high.

* - Only Roots and Root Nodules Used.

1 - 3 Cucurbitaceae

4 - 12 Papilionaceae

13 - 14 Sterculiaceae

15 - Caesalpiniaceae.

16 - Loranthaceae

17 - Crassulaceae

18 - Labiatae

ii. reveals the types of tissues associated with particular enzymes;

iii. gives a clue as to the probable physiological or biochemical role of that tissue in the general metabolism or functioning of the plant as a whole:

iv. makes it possible to have an insight into the various centres of activity of the* processes or reactions catalyzed by enzymes;

v. offers a procedure for tissue characterization and elucidation of enzymes in the primary developing tissues since the formation of specific enzyme systems and their localization in ontogeny are parts of, if not primary forces in the process of differentiation;

vi. provides evidence for the possible classification of tissues on the fundamental principle of homology;

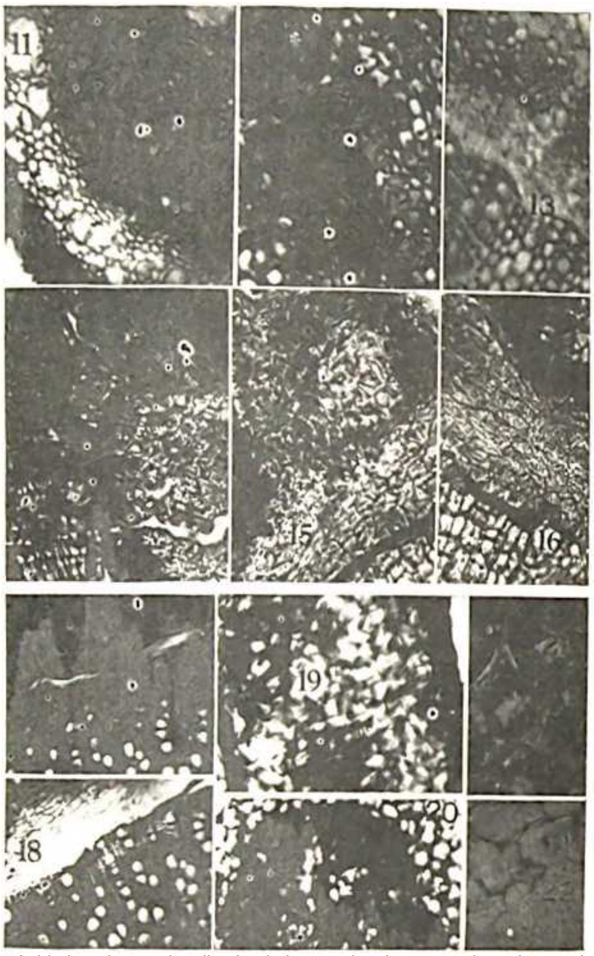
vii. may reveal the basis of tissue function, and observations may be made which aid in adducing the inherent integrity of structure and function;

viii. may provide an additional tool for the resolution of taxonomic problems; it may provide for example, valuable evidence for the confirmation or review of the taxonomic status of certain genera, species or sub-species;

ix. provides possible evidence for the analysis of hybridization situations, especially where the morphological features of the species and hybrids are difficult to interprete or where there is a large degree of back-crossing.

A few specific examples from my published works will serve to illustrate the above point. The successful localization and pattern or distribution of acid phosphatase, alkaline phosphatase and B-glucosidase in the tissues of the angiosperm parasite, *Tapinanthus bangwensis* and its hosts including parasite and host stems, host-parasite unions and parasite haustoria (Onofeghara, 1972, 1973, Plate 5); pointed unequivocally to the involvement of acid and alkaline phosphatases in differentiation and maturation and energy transfer reactions by making available phosphate groups through hydrolysis of suitable substrates, carbohydrate transformations taking place at critical stages in morp ho- genesis, intercellular transport of materials between host and parasite, cell wall formation and in the mechanism of penetration of host by parasite haustorium. The localizations have also shown B-glucosidase involvement in oxidative reactions in plant cells. Glucosidases are usually involved in the hydrolysis of oligosaccharides and glycosides. Hydrolysis of glycosides yields aglycones. In general metabolism, glycosides serve as food reserves and the aglycones resulting from their hydrolysis are oxygen acceptors (Boiteau, 1947). Glucosidases have been shown to be involved in transglycosidation in which the glycosidically bound sugar residue is transferred to other appropriate molecules with hydroxyl groups, a process that is important in polysaccharide synthesis (Karlson, 1965). The parasite, therefore, like many other plants in which B-Glucosidase is found may draw upon its pool of reserve carbohydrates in the form of glycosides either for synthesis of other carbohydrates or as sources of oxygen acceptors in some oxidative reactions. Similar conclusions were drawn from my work on the localization of these same enzymes in the cucurbitaceare (pumpkin or [f]ugu[f] family)

Plate 5



Acid phosphatase localization in host steins, host parasite union, and parasite haustoria - 11. Activity (blackened areas) demonstrated by the technique of Gahan and McLean in epidermis, cortex, phloem, and xylera of Theobroraa cacao. X 100. - 12. Localization in Cola nitida by the metal-salt technique of Barka and Anderson - 13. Control section of Cola nitida incubated with 10"' M NaF. X 175 - 14-16. Localization in host-parasite union (Tapinanthus bangwensis on Theobroma cacao) by the metal-salt technique of Gomori, Jensen, x 100 - 17. Localization in host-parasite union (Tapinanthus bangwensis on Cola nitida) by the metal-salt technique of Gomori, Jensen - 18. Control section of T. bangwensis on Cola nitida, incubated with 10"' M NaF. x 100 19, 20. Acid phosphatase localization in parasite haustoria by the azo-dye technique of Barka and Anderson X 500 - 22. Control section, heat-inactivated x 425 - (11-13, 19-22, fresh frozen; 14 - 18, acetone fixed frozen)

(Onofeghara and Koroma, 1974a, b) and in the leguminosae (the groundnuts group of plants) where the seeds, germinating seeds, stems and roots of seedlings of varying ages were used for enzyme localization. Almost all the plants used in these localizations have provided primary data for a better understanding of the growth, development and metabolism of the plants concerned.

With reference to my sojourn in the solar systems of growth and hormone physiology, I have been involved in a series of studies on the effects of natural and synthetic hormones and other growth substances on the flowering and fruiting of a number of vegetable and crop plants, including *Lycopersicon esculentum* (tomato), *Vigna unguiculata* (Cowpea), *Synedrella nodi flora, Sorghum vulgare,* (okra), *Abelmoschus esculentus, Amaranthus sp.* (green), *Celosia argentea* (soko), *lea mays, Arachis hypogaea, Capsicum frutescens, Corchorus olitorius, Buchnera hispida* and *Cuscuta* sp. Hormones used include Gibbercellic acid (GA3) Kinetin, Indoleacetic Acid (IAA), Naphthalene Acetic Acid (NAA) 2,4-Dichlorophe- noxy Acetic Acid (2, 4-D) and Indolebutyric Acid (IBA)).

For the purposes of this lecture, I will illustrate the significance of these studies by reference to my published work on the Effects of Growth Substances on the Flowering and Fruiting of Tomato and Cowpea (Onofeghara, 1981). Homones play a vital role in plant growth, development and reproduction. The effect of hormones on reproduction was reported as early as 1942 by Zimmerman & Hitchcock who sprayed triiodebenzoic acid on tomatoes and found that flower clusters appeared in the place of buds. Prominent among the hormones that have found application in the flowering and fruiting of various plants are gibberellins and synthetic auxins.

Investigations on the effects of different concentrations of exogenous growth substances, gibberellic acid ($GA3$), 2,4-D and NAA on the flowering and fruiting of *L. esculentum* and *Vigna unguiculato* showed that $GA3$ enhanced vegetative growth and promoted flower primordia production. Most $GA3$ doses induced heavy fruiting in *Vigna unguiculata.* The results indicated that $GA3$ could play a positive role in the control of premature abscission of cowpea fruits, a problem that had been reported previously by some workers (Ojehomon and Sanyaolu, 1970). This deduction is derived from the fact that all the concentrations of $GA3$ used in the study (25, 50, 25, 250, 500 and 1,000 p.p.m.) promoted flower primordia production and development of mature flowers and fruits. The implication of the finding is the fact that gibberellic acid can be used to arrest the premature abscission of flowers and immature fruits and in so doing, improve significantly, the yield. The work also showed that some of the concentrations of NAA used (25, 50 and 125 p.p.m) significantly increased the production of flower primodia and fruits in *L. esculentum.* All the concentrations of $GA3$ used promoted flower primordia and fruit production in *L. esculentum.* All who have tried without success, will appreciate the difficulty in raising tomatoes. It is, therefore, a relief to find that the use of appropriate concentrations of $GA3$ can promote growth and reproduction of this important vegetable. One wishes to add, however, that the cost of $GA3$ puts its use out of the reach of the majority of people.

Recently, Nwalozie and Onofeghara (Unpublished), using water extracts of *Cassia alata* were able to achieve earliness in *Arachis hypogoea* (groundnut) reducing the period of flowering from 105 days to 42 days, using 10% and 20% water extract. In *V. unguiculata,* 10% and 20% acidic portion of the extract induced earliness, causing flowering after 64 days as against 150 days in the control. Similarly, 20% of the basic fraction caused early flowering in 76 days. Higher concentrations of the water extract 50%, 75% and 100%) caused early flowering of K. *unguiculata* in 95 days. Results, such as these hold great promise as the plant material is readily available. Promotion of earliness reduces essentially the reproductive cycle of that plant. Work is still in progress.

I cannot conclude this inaugural address without bringing to light the work we are doing in the field of stress physiology, one of the recent branches of plant physiology. Our emphasis has been on the effects of water stress and oil poolution on the germination, growth flowering and fruiting of a number of vegetable and crop plants. These include *Abelmoschus esculentus* (okra), *Arachis hypogaea* (groundnut) *A ma ran thus caudatus* (green) *Celosia argentea* (soko), *Capsicum frutescens* (pepper) *Corchorus olitorius* (ewedu), *Eupatorium odoratum, Citrullus lanatus* (Egusi), *Luffa cylindrica, Lycopersicon esculentum* (tomato) *Oryza sativn* (rice), *Panicum milliaceum, Synedrella nodiflora, Solanum melongena* (garden egg), *TelfaiNa accidentalis* (ugu) and *Vigna unguiculata* (cowpea). Studies on the effects of water stress (with-holding of water, application of different quanitites of water, use of varying water regimes) were designed to:

i. screen the plants for hardiness or drought resistance;

ii. screen the plants for tolerance of high water tables;

iii. assess their survival capabilities at various stages of their growth and development;

iv. assess the effects of the treatments on their productivity with a view to maximizing beneficial effects for increased productivity.

The results so far (Rogers-Halliday and Onofeghara, Nwosu and Onofeghara, Onwugbuta and Onofeghara, unpublished) indicate varying degrees of resistance to drought. Of all the plants tested so far, *Abelmoschus esculentus* (Okra) can be regarded as drought resistant. Watering once a week or once in 3 weeks, supported good growth. In order of decreasing resistance to drought, the plants tested can be grouped as follows: *A esculentus* > *Capsicum frutescens* > *Telfairia occidental is* > *Amoranthus caudatus* > *Lycopersicon esculentum*. Infact L. *esculentum* was found to perform significantly better under high water regimes. The information is of practical importance to growers of such crops. As you would probably have found, okra performs least during continuous heavy rain.

Within the area of stress physiology, our work on oil pollution is of greater importance as it is more relevant to a topical national issue. My interest in this area not only derives from the fact of the location of this University, but also, and more importantly, from the fact that there is a dearth of information on oil pollution arising from systematic experimental investigations of the effects of oil pollution on flora and fauna in Nigeria. A network of oil pipelines covering several thousands of kilometres traverse arable farmland and human settlements to connect oil fields, flow stations, terminals, refineries and jetties. In the Niger Delta, the hub of Nigeria's oil industry, crude oil pollution is a regular occurence. Oil spills, leakages and blowouts have occurred around oil installations and new exploration sites causing untold damage to crops and arable land in the past 30 years. The Bomu II oil spillage (19 July-Mid August, 1970) covered an area of approximately 108 ha. Another major spill occurred on 22 November 1978 and at least 60,000 bbl of crude oil was spilled. On 5 May 1979, another spill occurred at Bomu flow station involving an estimated 7000 bbl. Since then, more than 20 separate spillages have been reported. In spite of this, very little had been done or documented. Infact at the time the work was started (1979) only the work of Odu (1972) on the effects of oil pollution on the microbiological properties of some agricultural soils had been reported. Later, while the work was going on (and is still going on), Kinako (1981) reported on the effects of oil pollution on species number and productivity of a simple terrestial ecosystem.

Our own work, (Onofeghara, Amakiri, Marioghae, Green, Osuagwu, Maduba, and Ihejieto) which was directed at crops commonly grown in farms in the Niger Delta and involved the use of crude oil and its distillates (Straight Run Gasoline S.R.G.), Automative Gas Oil (A.G.O.), Naphthalene, reformate and kerosene) was aimed at answering the following questions:

i. What effects through sequential monitoring have^ crude oil and its distillates on the germination, growth, flowering and fruiting of crops?

ii. In the event of a spill, for how long can submerged seeds remain viable and germinable?

iii. Do the crops show resistance to spill at any stage in their life cycle? If so, which, and at what stage is the resistance most or least pronounced?

iv. What are the comparative effects of a spill (leakage on the ground only) and a spray (oil sprayed on the crops directly)?

v. How long does a soil spilled with oil take to recover? Can a soil spilled with oil become useful again?

vi. What control or abatement measures are available?

The results of the experiments on the effects of crude oil on the germination of the seeds of *Abelmoschus esculentus* (Okra) *Arochis hypogoea* (groundnut) *A ma ran thus caudatus* (green), *Capsicum frutescens* (pepper), *Corchorus olitorius* (Ewedu), *Eupatorium odoratun* (a weed), *Citrullus lanatus* (Egusi), *Luffa cylindrica, Lycopersicon esculentum* (tomato), *Oryza sativa, Panicum miliaceum, Solanum melongena* (garden egg), *Synedrella nodiflora,* and *Vigna unguiculata* showed that while there were varying degrees of susceptibility/resistance to crude oil pollution, there was significant decrease in the percentage germination of most of the seed types after varying periods of pre-soaking in crude oil, the degree of decrease being generally proportional to the period of pre-soaking. The lag phase preceeding germination was found to increase with increase in the period of pre-soaking. It is noteworthy that a few of the seed types obtained 100% germination even after 32-52 weeks of pre-soaking in crude oil. For example, Amakiri and Onofeghara (1983) reported that *Capsicum frutescens* (local pepper) retained 100% viability and germinability after one year of pre-soaking in crude oil. Onofeghara and

Marioghae (unpublished) found that L. *esculentum* showed almost 100% germination after 36 weeks of pre-soaking in crude oil. After 12 weeks of pre-soaking in crude oil, *Arachis hypogaeo* showed 40% germination, *Eupotorium odoratum,* 50% *Celosia argentea,* 60% and *Synedrella nodiflora,* 44%. It is significant that the seeds of these plants can still germinate reasonably well even after being submerged in crude oil for three months or longer. Among the more susceptible plants are *Vigna unguiculata* which failed to germinate after being pre-soaked for 24-48 hours. Others are *Citrullus lanatus* (only 30% germination after 10 weeks pre-soaking), *Corchorus olitorius* (16% after 12 weeks of pre-soaking), *Amaranthus caudatus* (32% after 12 weeks of pre-soaking), *Luffa aegyptiaca* (8% after 12 weeks of pre-soaking), and P. *miliaceum* (12% after only 23 hours of pre-soaking). When a spill occurs soon after planting and oil covers the farmland, no germination occurs for as long as the seeds are submerged in oil. For seeds which remain viable after a long time of submergence, if a spill occurs at the time of harvest, the farmer can expect to utilize these seeds again.

Experiments carried out on the seedlings and subsequent phases of growth showed drastic effects of crude oil, SRG, A.G.O., naphthalene, reformate and kerosene on these plants (Amakiri and Onofehara, 1983, Onofeghara and Marioghae, unpublished), *lea moys* seedlings and *Capsicum frutescens* plants were most susceptible to crude oil spillage at the intensity of 3L m~2. Similar effects were observed for *Lycopersicon esculentum, Citrullus lanatus* and *Eupatorium odoratum* (Onofeghara and Marioghae, unpublished) spilled with crude oil and its distillates. Mature Z. *may* and *Abelmoschus esculentus* were fiarly tolerant to crude oil spillate in doses of 3 L m and 6 L m"^. In the spraying experiments, crude oil and its distillates were found to be potent contant herbicides. Z. *mays* and *Abelmoschus esculentus* sprayed with crude oil were destroyed in one or two weeks by death and maceration of tissues or by defoliation. *L. esculentum,* C. *lanatus* and £. *odoratum* sprayed with crude oil and its distillates died within one hour to four weeks. *Capsicum frutescens* sprayed with crude oil rapidly recovered from defoliation with a flush of leaves and branches three weeks after oil treatment. This constituted the first report of recovery of this important hot spice of tropical Africa (Amakiri and Onofeghara, 1983). Similarly, *Solanum melongena* (garden egg) was found to show recovery by regeneration of new leaves when it was sprayed at the age of 5-8 weeks. *Oryza sativa* (rice) seedlings between the ages of 5-10 weeks were also found to recover after spraying. Such findings provide a guide to possible predictions in case of a mild oil spray incidence (such as often occurs in Nigeria), spraying crude oil on a local mixed farmland from a small easily controllable leakage along a crude oil pipeline.

These researches are providing primary or baseline data that are indispensable towards evolving a scientific and effective approach to the formulation of strategies for dealing with a problem of national concern - that of oil pollution. It is our aim, through training of personnel and publications of results or original research to work towards the establishment of an oil pollution Research Institute (OPRI) or Oil Pollution Research Centre (OPRC) as comprehensive studies on the effects of oil pollution on flora involves not only physiologists, but also anatomists, morphologists, phytochemists, organic-chemists, physicists, microbiologists, geologists, biochemists, chemical engineers, etc. The University of Port Harcourt is well positioned to make impact in this field.

Careers in Botany and Plant Physiology

There are many opportunities for employment in botanical fields and in fields where botanical training is necessary. Commercial enterprises are finding more and more the need for trained botanists on their staff. The research explorations and advice of Botanists aid in developing better method and in expanding their potentialities. Among these enterprises are the large food growing and food-processing companies and government parastatals, pharmaceutical companies, and laboratories that produce various chemical products such as insecticides, fertilizers and growth substances. Federal and state parastatals and research institutes also offer many opportunities to botanists in various fields. Botanists are knowledgeable enough in the ways of plants to go into farming business or landscaping in partnership with landscape architects. The botanist may be pre-occupied with propagation and distribution of plants ,on a commercial scale. Of course, one cannot over look teaching, a satisfying, interesting and challenging vocation.

Plant physiologists are employed in universities, agricultural colleges, agricultural research institutes, ministries of agriculture, department of defence, industry, especially, chemical and agricultural industries, and in all fields of applied botany, agronomy, agriculture, forestry, horticulture, landscape gardening, plant breeding, plant pathology or pharmacognosy.

Manpower Development in the Department

The Department of Botany here has contributed to the production of manpower. It has in the five years of graduation produced a total of 94 first degree (honours) holders in Botany with 17 in two-one, 54 in two-two and 13 in 3rd class. All of them, to my knowledge are employed in Universities and other institutions of higher learning, in research institutes, secondary schools, government ministries and private companies. Eight holders of the M.Sc. Plant Physiology degree have also been turned out, all gainfully employed. Since two years ago, the Department has started graduate programmes in Mycology/Plant Pathology, and Plant Taxonomy/Bicosystematics. On a national basis, it is one of the most viable departments of Botany available in the country today, given the quality of its staff, the relevance of its academic programmes, and the annual output of first degree graduates.

CONCLUSIONS AND RECOMMENDATIONS

In this brief survey, I have been able to draw attention to the role of plants and the science of Botany in human affairs, the place of plant physiology in human affairs and in other aspects of applied Botany, my sojourn, in the fields of mistletoe parasitism, *in vitro* culture, enzyme histochemistry, growth and hormone physiology and stress physiology, my contributions and those of some of my colleagues in these fields, and the contributions of the Department of Botany to manpower development.

Man, throughout his history, has been dependent entirely upon plants. Humans depend upon plants for food, and drinks, certain drugs and medicines for health, shelter, clothing, industry, fuel, light, environmental quality, recreation, expression of deepest sympathy in times of sickness and sorrow, expression of our love for one another in times of joy, and in some way or another almost every other human endeavour. Plants determine where and how aniifials live since animals can scarcely live where plants or plant remains are entirely absent. The kind of plant life has often determined the type of animal life and its consequent development. It is pertinent to draw attention to the significance of plants in controlling future world population, as producers of oxygen, purifiers of waste water, and by their role in the water cycle, erosion control and other natural phenomena. Plants are clearly a tremendous asset to man. Botany (the study of plant life) offers a powerful tool for increasing the welfare and happiness of all people.

Quite apart from the theoretical significance of plant physiology in Mping man to understand the world in which he lives, plant physiology serves as the foundation for the numerous recent advances in agriculture, horticulture, forestry, floriculture, plant breeding, plant pathology, pharmocology, pharmacognosy and other aspects of applied Botany. There are many aspects of practical agriculture which can be benefitted by some research efforts in plant physiology. The following examples are but some of them. The efficiency of photosynthetic conversion of solar radiation in the production of food nutrients that are acceptable to human diets can be increased. Better ways to utilize information regarding biological nitrogen fixation will result in increased utilization of nitrogen by plants. Techniques of tissue culture developed during the past several years by plant physiologists can be refined to decrease the time required to produce desirable strains of crops. Crop yields can be increased by learning how and when the application of plant growth regulators to plants is more effective. Losses of water from plants by transpiration can be minimized by increasing the efficiency of water use. The growth and development of certain crops can be regulated by artificial means of irradiation. The quantity of human food nutrients in field and vegetable crops ,can be regulated through suitable micronutrient additions to soils. The exact growth conditions necessary for optimum yields of crops can be determined precisely by growing them in controlled environments. Once useless weeds and jungle plants can be converted to high quality animal food by the addition of fats and proteins produced through large-scale culture of algal and yeasts cells.

I have in the course of my brief research sojourn been able to:

a) carry out and report on the first detailed study on the biology of *Tapinanthus bangwensis* and *Phragmanthera incana,* mistletoe parasites of economic crops by:

   i. establishing the pattern of development and establishment on their hotsts *in vivo,* including the manner of haustorial penetration and development and the location of vascular connection between host and parasite;

   ii. determining the host range, showing systematically, the effects of parasitism on the gross structure and distribution of host tissues and pointing to their pests status;

iii. establishing cultural conditions for the growth of the parasite *in vitro;*

iv. establishing the nutritional requirements of the parasite through *in vitro* culture.

b) Successfully characterize histochemically, enzymes (hydrolases principally) in a wide range of plants of economic importance and shown for the first time, the use of histochemical methodology for the study of host parasite relations among the mistletoe family.

c) Report on the use of growth substances, notably GA 3 to prevent pre-mature abscission of flowers and fruits of *Vigna unguiculata* and the use of water extracts of *Cassia alata* to promote earliness of *Arachis hypogaea* and *Vigna unguiculata.*

d) Draw attention to the work a group of us are doing in the area of stress physiology, notably, water stress and oil pollution and show how we have been able to screen a few crop plants for drought hardiness and monitor the germination and growth response to pollution by crude oil and its distillates and so providing primary data for an understanding of the problem of pollution. Systematic primary data on effects of pollution on crop plants are provided for the first time in the Nigerian situation.

Mr. Vice-Chancellor,
Distinguished Ladies and Gentlemen,

If I have succeeded in this short span of time in initiating or extending your appreciation of the role of plants and the study of plant life in human affairs and to draw your attention to what I profess, then, this lecture would largely have served its purpose. I hope that you will see plants and plant scientists as your allies and that you will be more concerned and appreciative of plant life. Plants are a *sine qua non* to man's existnece. A callous or indifferent attitude to plant life is, therefore, not only untenable and inexcusable, but also suicidal. Universities must continue to educate people knowledgeable in the ways of plants, just as they train specialists in space, medicine, law and social theory. Quite obviously, without plants, life as we know it on earth could not exist.

It is in the light of the indispensable services rendered to man by plants that I call on the University of Port Harcourt, State Governments, and the Federal Government as appropriate to explore the possibility of establishing the following as a matter of utmost urgency to encourage greater interest in plants and the study of plant life:

a. A University Herbarium.

b. A befitting Botanical Garden for the University of Port Harcourt.

c. A National Botanical Garden.

d. A National Herbarium.

e. National Parks in all the states of the Federation.

f. An oil Pollution Research Institute.

There is no doubt that "All Flesh is grass". Botany can make it possible for us to have our plants and the appreciation of these plants can be our key to continued existence, God willing. My task is done.

Thank you for your attention and God bless.

ACKNOWLEDGEMENT

I wish to place on record my gratitude to Professor S.N.C. Okonkwo for initiating my interest in host-parasite physiology in general and mistletoe parasitism in particular. I am grateful to the Late Dr. J.R.S.L. Lawton, who supervised the work; to Drs, W.A.L. Evans, and I.D. Bowen for asistance in histochemical methodology.

I acknowledge the inputs of Dr. J. 0. Amakiri, Mrs. Beatrice Rogers-Halliday, Mrs. Joy E. Marioghae, Miss A.L. Nwosu, Miss J.A. Onwugbuta, and Mr. Macellus C. Nwalozie.

1 am grateful to Messrs Fred S. Alasia and Meshack N.N. Karanwi, and Mrs. Carol S. Braide for asistance in the preparation of illustrations and video coverage.

I am grateful to Dr. B.H.R. Wilcox-Evwaraye and Mr. J.O. Opayemi for assistance in the collection of plant specimens.

I owe immense gratitude to my wife, Bridget Diatachekor Onofeghara, whose constant love, devotion, patience, understanding and encouragement has sustained my research endeavours.

Finally, I wish to express my gratitude to Miss Caroline C. Amaike for secretarial assistance.

PROFESSOR FRANCIS A. ONOFEGHARA

REFERENCES

AMAKIRI, J.O. & ONOFEGHARA, F.A. 1983: Effects of Crude Oil Pollution on the growth of *Zea mays, Abelmoschus esculentus* and *Capsicum Frutescens.*

1984: Effects of Crude Oil Pollution ___________________ on the germination of *Zea mays* and *Capsicum frutescens.* Environ. Pollut. 35: 159-167.

BALLE, S. 1958: West African Loranthaceae Kew Bui. 1: 168.

BALLE, S. & BALLE, N. 1961. *Kirabtgaceae di la Cote d'1 voire",* Adansonia I: 208-265.

BOITEAU, P. 1947: Contributions *a l'etude du role des glucosides dans le metabolisme de la plant* _ Bull. Soc. Chim. Biol. Paris, 29: 451-453.

BONNER, J. & GALSTON, A. W. 1952: *Principles Of Plant Physiology,* W. H. Freeman & Co. San Francisco.

BURSTONE, M. S. 1962: *Enzyme Histochemistry and its application in the study of neoplasms.* Academic Press, Inc., New York.

GAUTHERET, R. J., 1959: *Sur la possibilite de realizer la culture indefinite de tissus de tubercules de carrota.* Cor. Acad. Sci. 20: 118-120.

GOMORI, G. 1941: Distribution of acid phosphatase in the tissues under normal and pathologic conditions. Arch. Path. 32: 189-199.

GREENHAM, C. G. & BROWN, A. G. 1957: The Control of Mistletoe by trunk injection. Ast. Inst. Agric. Sci. Hour. 23: 308-318.

HILL, A. F. 1952: *Economic Botany* McGraw-Hill Book Co. New York.

HOLT, S. J. 1956: The Value of Fundamental Studies of Staining reactions in enzyme histochemistry with reference to indoxyl methods for esterases. J. Histochem. Cytochem. 4: 541-554.

KARLSON, P. 1865: *Introduction to modern biochemistry.* Academic Press, N.Y.

KINAK0, P.D.S. 1981: Short Term Effects of Oil Pollution on species numbers and productivity of a simple terrestial ecosystem. Environ. Pollut. 26: 87-91.

KUIJT, J. 1964: Critical observations on the parasitism of new world mistletoes. Can. J. Bot. 42: 1243-1278.

KUIJT, J. 1865: On the nature and action of santalalean haustorium as exemplified by *Phthirusa* and Antidaphne (Loranthaceae) Acta Bot. neerl.% 14: 278-307.

LESTON, D. 1969: Ants, Capsids and Swollen-shoot in Ghana; interactions and implications. Proc. 3rd Int. cocoa Press Conf. Accra.

MENTEN, M. L., JUNGE, J. & GREEN, M. H. 1944: A couping histochemical azo-dye test for alkaline phosphatase in kidney J. Biol. Chem. 153: 471-477.

National Academy of Sciences, Washington 1976: Making Aquatic Weeds Useful: Some perspectives for Developing countries.

NORSTOG, K. & LONG, R. w. 1976: *Plant Biology.* W.B. Saunders & Co.

ODU, C.T.I. 1972: Microbiology of soil contaminated with petroleum hydrocarbons I Extent of contamination and some soil and microbial properties after contamination. J. Inst. Petrol. 562: 201-208.

OKONKWO, S.N.C. 1966: Studies on *Striga senegalensis IV* In Vitro Culture of Seedlings. Effect of Various Sugars and glutamine. Am. J. Bot. 53: 678-693.

ONOFEGHARA, F. A. 1969: Studies on the develops nutrition and histochemistry of *Tapinan bangwensis,* Ph.D. Thesis, University of Ibadan, Nigeria.

1971a: Studies on the development — *Tapinanthus bangwensis* (Engler and K. Krause) Danser Ann. Bot. 35: 729-743.

1971b: Establishment of *in vitro cw* of *Tapinanthus bangewnsis* (Engler and Krause) Danser, and the Effects of sue on growth. Ann. Bot. 35: 1113-1129.

ONOFEGHARA, F.A. 1972: Histochemical local: of enzymes in *Tapinanthus bangwensis:* Acid phosphatase. Am. J. Bot. 59: 549-5~

1973: Histochemical localization — enzymes in *Tapinanthus bangwensis* a its hosts: Alkaline phosphatase and B-Glucosidase. Bot. Gaz. 134: 39-46.

1981: The effects of growth si on the flowering and fruiting of Lyco, *esculentum* and *Vigna unguiculata* Pyt 107-116.

1982: Studies on the Developme nutrition of *Phragmanthera incana*. vS Afric. J. Sci. (In Press).

& KOROMA, S.A. 1974a: Histochc localization of enzymes in the cucurl Acid phosphatases. Ann. Bot. 38: 477-4

ONOFEGHARA, F. A. & KOROMA, S.A. 1974b: Histochemical localization of Alkalin Phosphatases and B-glucosidases in c ceae. Ann. Bot. 38: 705.

& KAIKAI, M.A. 1975: Histoch* localization of enzymes in the Legu Ghana. J. Sci. 15: 45-57.

STRICKLAND, A.A. 1951; The entomology of shoot of cocoa II. The binomics and of the species involved. Bull. Ant. Res. 42: 65-103.

TAKAMATSU, H. 1939: Histologische and biochemische studies Uben die phosphatase Histochemische Untersuchungs raethodick der phosphatase und deren verteilung in verschidenen Organen und Creweben Trans'. Soc. Pathol. Jap. 29: 492-498.

TINSLEY, T.W. 1964: The ecological approach to pest disease problems of cocoa in West Africa. Trop. Sci. 6: 3846.

WILLIAMS, G.A. 1953: Field observations on the Cacao mirids *Sahlbergella singular is* and *Distantiella theobromae* in the Gold Coast I Mirid damage Bull. Ent. Res. 44: 101-119.

WILLIAMS, C.N. 1963: Development of *Tapinanthus bangwensis* (Englen and K. Krause) Danser Contact with the host. Ann. Bot. 27: 641-646.

ZIMMERMAN, P.W. & HITCHNOCK, A.E. 1942: Substituted Phenoxy and benzoic acid growth substances and the relation of structure to physiological activity Contr. Boyce Thompson Inst. 12: 321-343.