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THE TREES PRAYER:

A CLARION CALL BY THE FOREST PATHOLOGIST

AN INAUGURAL LECTURE

By

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Ukoima, H.N., Chukunda, F.A and Onyeizu, U.R (2017a). Effects of Crude Oil polluted soil on substrates quantity on morphological characteristics of *Pleurotus ostrentus* (Jacauin ex Fr. Kummer) and *Pleurotus pulmonarius* (Fries) Quel Fruit bodies. *Delta Agriculturist*. Accepted for publication.

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THE TREE'S PRAYER:

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AN INAUGURAL LECTURE

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WEDNESDAY 29TH NOVEMBER, 2017

Dedication

This work is dedicated to my
lovely parents,
Elder Hudson Francis Ukoima and
Deaconess Gladys Hudson Francis
Ukoima through whom I came into the
world and they taught me how to
appreciate life.

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The Vice Chancellor Sir
Members of the Governing council
Deputy Vice Chancellor
Registrar and other Principal Staff of the University
Provost of the College of Medicine
Dean of Post Graduate School
Deans of Faculties and Directors
Distinguished Professors and Scholars
Heads of Departments
Staff and students of Rivers State University
Ladies and Gentlemen

1.0. PREAMBLE

BACKGROUND STORY OF HOW I DEVELOPED INTEREST IN RESEARCH

I have always had the desire to discover the nature of things in my environment, something we all have; “natural curiosity”. As a child, I always imagined what God was like. Such vivid imagination usually caused me to feel as though I had an encounter with a ghost. My father's bed time stories also influenced me. I grew up thinking of my future, behind all my pictures in primary school, I wrote, “The boy who thinks of his future”. The thought of my future, my affinity for discovery as well as my vivid imagination led me into having passion for words that had the suffix 'logy', meaning 'study of'. Therefore, I had affinity for courses like; Biology, Zoology, Geology, Microbiology and Criminology. I chose to study the later criminology. I gained admission into the University of Indiana, USA in 1980 to study criminology. However, being the only son of

my parents, my Father wanted me to stay back home, so I forfeited the admission. Reluctantly, I wrote the Joint Admission and Matriculation Board Examination the same year and passed. I got admission into the University of Port Harcourt to study Botany; a course that did not have the suffix 'logy'. Little did I know that Botany had lots of loges; Such as Pathology, Plant Physiology, Virology and Bacteriology.

Final year in the University was the most interesting of all years, for my project, I was given the most amazing supervisor, Prof. Bosa E. Okoli, A stern and focused researcher. My project topic was "*Investigation into Apomitic Behaviour and Cytology in Costus lucanusianus Linn (Zingiberaceae)*". This plant was identified along a bushy part at Ogbakiri road in Emohua Local Government Area of Rivers State. It was reportedly used to cure cough, bronchitis and rheumatism (Kay, 1989).

Morphological and Cytological studies in *Aframomum sceptrum* and an unidentified species of *Aframomum* were undertaken with a view to ascertaining the nature of the unusual reproductive behavior observed in *Costus lucanusianus* and its relationship to the other two species. Observations made on inflorescence axes and floral development revealed the presence of facultative apomixes, a situation whereby new plants are produced from parent plants through asexual reproduction (Plates 2 and 3). Cytological studies also showed that species of *Costus lucanusianus* exist in both diploid and triploid forms(Plates 3-13 and Table 1a). The chromosome number in the diploid collection in 2n = 8 and 3x = 27 in the triploid collection. Some irregularities observed included Y-trivalents, high frequency of univalents and abnormally large polyploidy pollen grains. These irregularities were reflected in the high sterility observed in the triploid (11.13%, 7.7% and 17.6%) as opposed to the diploid collection where fertility was high (85.5%).

I am grateful to my sisters; Mrs. Eton Awani, Mrs. Ama James and Dr. (Mrs) Dorcas Eneh. God bless you for your support. Also, thanks to my in-laws; Mr. Alex Awani, Mr. James, Pastor Edet Eneh and my awesome mother In- Law Mrs Sunday Micah and family.

To my wife and a friend, I lack words to thank you. You call me daily to remind me when to close from work. The publications were possible because of the delicious meals, care and encouragement. Thank you so much. I call you "old girl" because your not like most women of this generation. To my lovely children; Kelvin, Atisi, Believe and Victor, you are all rare gifts and have never let me down.

Thanks to everyone who attended this lecture, God bless and grant you journey mercies.

Goodbye

Au revoir

Adios

Okidim, Mr. N. S. Teete, Mr. Nte Iyakute, Mr. Sydney Enyindah, Mr. Desmond Wosu and all staff and students of the Faculty of Agriculture.

I also appreciate the following persons HRH Engr. Goodhead D. Nteogwuijah - Inituk (King of Okorobile), HRH Bartholomew Ikaan (King of Oronija), Chief Arch. Clinton J. Ubulom, Chief Dr. W. J. Ubulom and Chief Anthony Waribo for their support.

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- All My friends and colleagues from the University of Port Harcourt especially Prof Eunice Nwachwukwu, Prof. Hillary Edeoga Former Vice Chancellor, Micheal Opara University of Agriculture, Prof. B. Ndukwu and others too numerous to mention. A big thank you to all of you.

Finally, I am lucky to have my parents who gave me life and taught me how to appreciate it. They are very rare people. They played a vital role in my life. My father paid all my school fees from Primary school to Ph.D level and fed me until I was able to fend for myself. He trained several persons in my community and elsewhere too numerous to mention. My mother, sweet mother for life, Mother like no other. My caring, loving, mentoring mum who sacrificed so much for all her children. Her prayers made us who we are today. Papa and Mama, I thank you from the bottom of my heart. May God continue to preserve you for us.

It was also observed that the chromosomes of *Aframomum sceptrum* Schum, are generally smaller than those of *Costus lucanusianus* and *Aframomum sp* (Ukoima, 1985).The results obtained indicate that polyploidy in *Costus lucanusianus* is a contributory factor to the occurrence of apomixis.

Plate 1: *Costus lucanusianus* (Normal)

Plate 2: Apomixis in *Costus lucanusianus*

Table 1a: Cytology and pollen data in *Costus lucanusianus*

Plant Accession Number	Chromosome N	2n	3n	Number on which pollen estimate was done	Pollen data Pollen % fertility	Locality Emohua Village Wet road side, University of Port Harcourt Permanent site
200	9	18		106	85.5%	
201			27	44	11.36%	
202			27	270	7.7%	-do-
203			27	565	17.6%	-do-

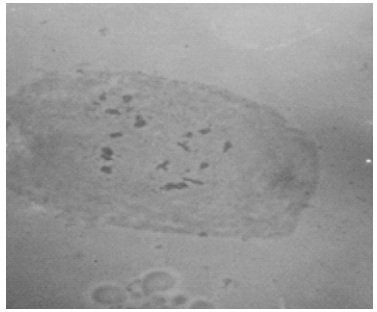

Plate 3: Mitotic metaphase in diploid *C. lucanusianus*, showing 2n=18

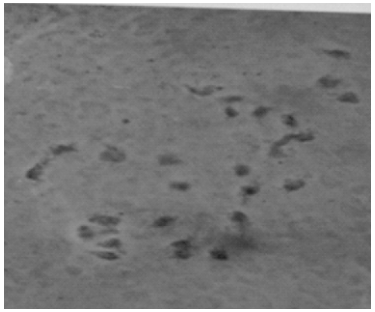

Plate 4: Diakinesis in *C. lucanusianus*, Triploid
2n= 27 (23 univalents + 2 bivalents)

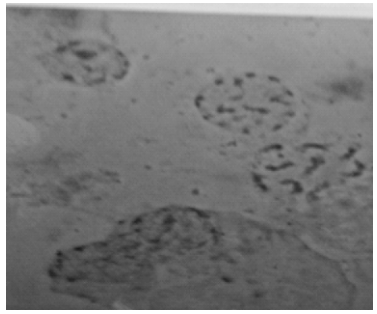

Plate 5: Meiotic prophase 11 in *C. lucanusianus*, diploid, x = 9

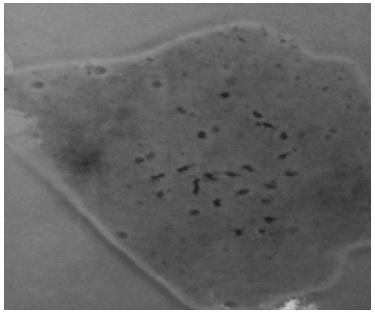

Plate 6: Mitotic metaphase in triploid *C. lucanusianus*2=27

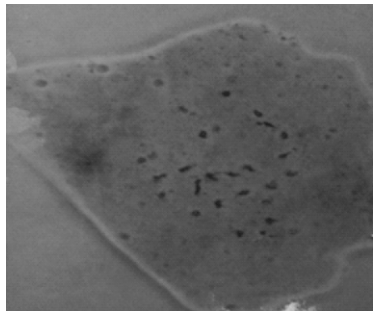

Plate 7: Mitotic metaphase in *Aframomum sceptrum*
Showing, 2n=40

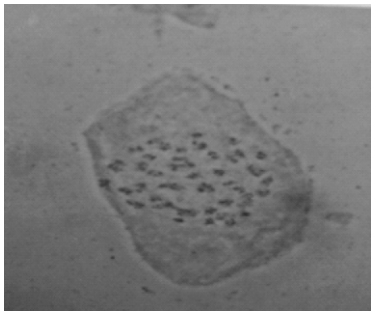

Plate 8: Mitotic metaphase in *A. sceptrum*
showing 2n=50

- Prof. S. Y. Giami, Prof. M. S. Igben, Prof. S. C. Teme, Prof. Wami, Prof. E. E. Opuwaribo, Prof.H.I. Hart, Prof. Agbam, Prof. S. N. Wekhe, Prof. A. Monsi, Prof. T. A. T. Wahua, Prof. J. P. Aalwa, Prof. U. I. Oji, Prof. E. C. Chukwuigwe, Prof. S. A. Amakiri, Prof. W. A. Amaewhule, Prof. M. J. Ayotamuno, Prof. I. K. E. Ekweozor, Prof. M. V Omubo-Pepple, Prof. F. B. Sigalo, Prof. M. J. Ahiakwo, Prof. F. N. Ikpe, Prof. T. T. Epidi, Prof. Seth Accra Jaja Prof. C. O. Ahiakwo, Prof. C. K. Nwachukwu, Prof. G. N. Emah, Prof. A. A. Amakiri, Prof. I. R. Jack, Prof. E. N. Amadi, Prof. S. N. Amadi, Prof. S. A. Amadi, Prof. Davies, Prof. D. I. Hamilton, Prof .G. I. Ken Akaniwor, Prof. S. A. Braide, Rev. Mother, Prof. C. I. Israel-Cookey, Prof. M. P. Eboh, Prof. G. K. Fekarurhobo, Prof. Chioma Opara, Prof. A. O. I. Gabriel, Prof. M. N. Koko, , Prof. M. D. Mepha, Prof. Eme Orlu, , Prof. N. S. Okoroma, Prof. B. O. Green, Prof. I. F. Oruambo, Prof. J. B. Vipene, Prof. O. Owei, Prof. M. Lilly, Prof. Edith Chuku, Prof. S. N. Okogbule, Prof. G. C. Akani, Prof. A. J. Toby, Prof. Gbobo, Prof. Daka, Prof, Ideriah, Prof. B. D. Kiabel, Prof. A. O. Davies, Prof. J. M. J. Jaja, Prof. B. Isiefe, Prof. O. C. Obunwo, Dr. I. I. Kakulu, Dr. I. Zeb-Obipi, Dr. A. B. Nwauzoma, Dr. S. Wemedo, Dr. N. Ebere, Dr. Mrs. O. A. Ojri, Dr. S. N. Deekae, Dr. S. A. Abere, Dr. M. O. Akusu, Dr. F. E. Nlerum, Dr. C. O. Albert, Dr. Eric Amadi, Dr. L. C. Baber, Dr. I. C. Obara, Dr. Kii-kabari David, Dr. N. Boisa, Dr. O. J. Owen, Dr. A. D. George, Dr. J. Osakwe, Dr. I. B. Foby, Dr. A. Tobin-Harry, Dr. D.I. Ekine, Dr. A.I. Nwanouala, Dr. L.D.Gbareneh, Dr. B. A. Ekeke, Dr. S. Nubarido Dr. Ikechi, Dr. Amakiri Dokuboba, Dr. S. O. N. Dimkpa, Mr. K. Dum Peter, Mr. Chukwu Kingsley, Mr. H. H. H. Gunn. Dr. A. A. Nchor, Dr. D. B. Ewubere, Dr. Otene, Benjamin , Dr. N. C. Johnson, Dr. Lenu Fakae, Mr.

from 2004 – 2007. I am also indebted to Prof. B.B. Fakae whom I served as both Acting Head of Department and a substantive Head of Department from 2011 – 2015. Also to late Prof. N. Dienye am highly indebted who employed me at Rivers State College of Education now Ignatius Ajuru University of Education, Port Harcourt, thank you sir.

To my supervisors and Lecturers; Prof. Mrs. M. A. Amakiri, Prof. B. Okoli, Prof. C. I. Umechuruba, Dr. Balafama Wilcox Ewvaraye, late Prof. A. E. Arinze and late Prof. Edith Elewon. I lack words to thank all of you for the awesome training given to me. God bless all of you and your generation to come.

The following colleagues have played a major role in my academic life. Firstly, Prof. Michael Ogburia who recommended me for employment in this University and who later became my friend and also Prof. U. U. Gabriel who encouraged me to come over to the then Rivers State University of Science and Technology.

Secondly, I am also thankful to Mr. Richard Abere, My Primary School classmate and still an awesome friend till date. He has been a friend for five decades. The other friends are my University friend, Mr. Loveday Oruala as well as my late friend Mr. Wilson Ngowerekumo. I appreciate all of you.

My colleagues as well as my students whom I supervised, Prof. Godwin Omokhua, Dr. F. A. Chukunda, Dr. Sarogoro David, Dr. Peace Nnadi, Dr. Glory Pepple, Dr. Onyeizu Uchenna Roland, Late Dr. Ogbonnaya, Mrs. Simbi Wellington, Mr. Morgan Ikata, Mr. ThankGod Nweke, Mr. Osele Eghuan and others too numerous to mention. A big thanks to all of you for supporting and believing in me.

Thanks to my colleagues who have been supportive in one way or the other. Some are;

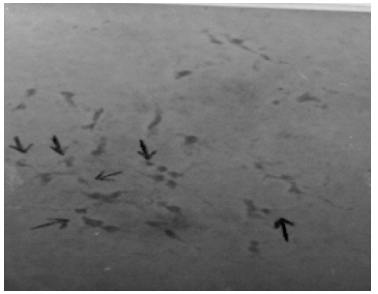

Plate 9:Diplotene in triploid *C. lucanusianus*,2=27
Arrows showing 5 satellite chromosomes

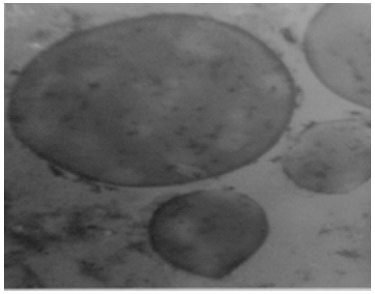

Plate10: Abnormally large polyploid pollen in the triploid collection 2n=27

Plate11: Early Anaphase 1 in *C. lucanusianus*2n=27.
Arrows showing precocious chromosomes at the poles

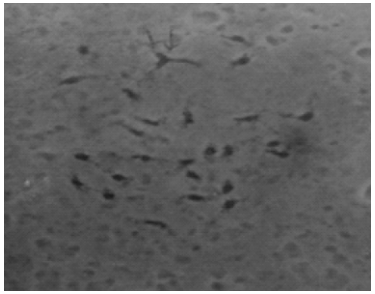

Plate12: Early diakinesis in triploid collection *C. lucanusianus*. Arrow indicates one Y-trivalent.

Note the presence of 24 univalents.

Ladies and Gentlemen, you may wonder why I have taken time to talk about this project. It was indeed how my interest in microscopy began.

My next drive was to go for my Master's degree. University of Nigeria, Nsukka appealed to me to study Plant Breeding and Genetics. Unfortunately, I was not considered for admission because my transcript was not sent on time. I was compelled again

to go back to my beloved and prestigious University, the Unique University of Port Harcourt. Prof. B.E. Okoli was away for his post doctorate programme at the time and I was thrown off balance for a while as I wanted him to be my supervisor again. As fate would have it, I met another interesting lecturer, a father and a mentor, Prof. Pius D.S. Kinako, who re-directed me to my root 'logy'. He advised that I should study plant pathology because of its relevance in all aspects of agriculture and natural sciences. I was asked to work with one of the most revered lecturers in the Department, Prof. C. I. Umechuruba. I found him to be a piece of work. He was a compendium of potential knowledge. His numerous books were hardly given out. Ladies and Gentlemen, it was at this point that I ventured into the mangrove forest. The works of Tea, (1982) on a fungal disease (*Cylindrocapon dydium*) that devastated the Gambian mangrove forest caught my attention (Plate 13) .

Plate 13: *Rhizophora* trees killed by dieback disease (Teas,1982).

18.0. ACKNOWLEDGMENT

Firstly, I thank the Almighty God for all He has done for my family and I. We cannot count the blessings neither can we number them one by one said the song writer.

I appreciate our Vice Chancellor Prof. Blessing Chimezie Didia an awesome administrator, rare to find for giving me the opportunity to present this inaugural lecture. I am also grateful to the Deputy Vice chancellor, Prof. B. M. Oruwari, whom I served under as a Sub Dean, Faculty of Agriculture for two years. He taught me a lot of things too numerous to mention. He kept encouraging most of us to present our inaugural lectures. I am grateful to the Former Registrar, Mrs. Daba Constance Odimabo, who has always played the role of a mother from time to time as well as the present Registrar, Mrs Victoria Jamabo. Thank you the Bursar, Mr. Kenneth and my friend for all the support both in the past and the present. Thanks to Prof. I. K.E. Ekweozor for encouraging me to present this inaugural lecture.

Worthy to be appreciated are; Prof. S.C. Achinewu, Former Vice chancellor of RSUST who approved my employment and whom I served as Acting Head of Department of Forestry and Environment

My understanding of this prayer is in the last line,' HARM ME NOT.' Indeed, this inaugural lecture has proffered solutions from the Forest pathologist angle on how to protect our trees from pest and diseases. It is a call on man to protect plants from destruction caused by MICROBES, INSECTS, PARASITIC PLANTS, FIRE AND EVEN MAN HIMSELF. A CALL FOR PEOPLE TO DEVOTE MORE TIME TO NATURE. TO APPRECIATE AND PROTECT TREES . To use trees in a sustainable way for the benefit of this generation and the future ones. Certainly, this will lead to ECO-TRUST (PEOPLE AND NATURE THRIVING TOGETHER WITHOUT CAUSING HARM TO EACH OTHER). Finally, there will be ECO-SUSTAINABILITY (capacity of the earth to meet the needs of this generation without hindering the future generations from being able to meet their needs). Vice-Chancellor Sir, this is a golden jubilee inaugural lecture and therefore offers a golden information for all to desist from harming the trees. I hope your understanding is in line with mine? If it is not then you are against this tree's prayer and you need to make a U-TURN BECAUSE CLIMATE CHANGE IS REAL. Ladies and gentlemen hope you all said good morning to the plants today? Remember a green life is the panacea to global warming.

This research suggested that fungi and other microbes are potential threats to the mangrove ecosytem. In a bid to help to salvage the mangrove forest trees in Rivers State, South-South, Nigeria, I commenced research on fungi and bacterial diseases as well as pest affecting the mangrove forest trees in Port Harcourt, River State, Nigeria. This work was continued at my Doctoral level under the supervision of an eminent scholar, Professor Mildred Alali Amakiri, at the then Department of Crop/Soil and Forestry, Rivers State University of Science and Technology, Port Harcourt, Nigeria in 1990. My contact with these eminent scholars led to so many publications in International, national and local journals, books, conference proceedings, workshop, seminars, over Ninety five in number (95).

Vice Chancellor Sir, Ladies and Gentlemen, permit me to look into some relevant areas that will give insight into my research contributions.

I am quite aware that the question in your minds is “DO TREES PRAY? We will find out at the end of this lecture. However, because the prayer is coming from the PLANT KINGDOM (PLANTAE) and the Forest Pathologist is involved in the ECO-PROTEST, it means that the subject Forestry is also involved. Therefore, this section will be discussed in the following order;

1. Definition of Forestry
2. History of Forestry
3. Classification of Forestry
4. Importance of Forestry
5. Factors affecting Forest Resources

2.0. DEFINITION OF FORESTRY

Forestry is the science and craft of creating, managing, using, conserving, and repairing forests and associated resources to meet desired goals, needs, and values for human and environment benefits (wikipedia.org,2017). In simple terms, it is the careful and skillful management of natural resources such as animals, trees, soil, microorganisms and minerals for the benefit of humans. Forestry is practiced in plantations and natural stands. The science of forestry has elements that belong to the biological, physical, social, political and managerial sciences (wikipedia.org,2017).A well managed forest will provide services such as;

i. Production through availability of resources such as timber and timber by-products.

ii. Protection and preservation of our environment from hazards such as erosion, global warming, storm etc.

iii. Recreation through preservation of wildlife for recreational purposes.

Modern forestry generally embraces a broad range of concerns, in what is known as multiple-use management, including the protection of forest trees, provision of timber, fuel wood, wildlife habitat, natural water quality management, recreation, landscape and community protection, employment, aesthetically appealing landscapes, biodiversity management, watershed management, erosion control, and preserving forests as 'sinks' for atmospheric carbon dioxide. A practitioner of forestry is known as a forester. The forest ecosystem has come to be seen as the most important component of the biosphere and has become vital technology, applied science and craft(wikipedia.org,2017).

17.0. SUMMARY

In a nutshell, it will be improper to end this lecture without providing an answer to the question, 'DO TREES PRAY'. The Portuguese writer provided the answer one thousand years ago and it is shown below to support my research work.

Portuguese Tree's Prayer

- Ye who would pass by and raise your hand against me, harken ere you harm me.
- Iam the heat of your hearth in the cold winter nights
- The friendly shade screening you from the summer sun
- And my fruits are refreshing draughts, quenching your thirsts as you journey on
- Iam the beam that holds your house
- The board of your table
- The bed on which you lie
- And the timber that builds your boat
- Iam the handle of your hoe
- And the door of your homestead
- The wood of your cradle
- And the shell of your coffin
- Iam the gift of god and the friend of man
- Ye who pass by, listen to my prayer
- Harm, me not.

16.0. RECOMMENDATIONS

1. State and Federal Governments should ensure that gas flaring stops because of its harmful effects on microbial and plant populations. Besides, soot from gas flaring activities has enormous effects on human and animal health.
2. Enforcement of carbon taxation on individuals, companies and government who pollute the environment above 28.32 cubic metres.
3. Eco-friendly methods should be employed in programmes aimed at managing our environment. Such as use of biocides, bio-control methods and in organic fertilizers (Ukoima, 2009h,2009i,2009k and Ukoima and Okah,2006a; Ukoima and Iheanachor, 2006b).
4. Research in the use of mushrooms and other non timber forest products should be encouraged by Universities, Government and private individuals to shift attention from over harvesting of timber.
5. Cultural control methods, such as destroying infected plants, pruning, handpicking of pests should be adopted in controlling the larvae of *E. pulverulenta* in forest plantations.
6. Establishment of the Ministry of Forestry and Tourism to fully harness the potentials of the immense benefits of forest resources endowed this nation.
7. Adequate afforestation programmes to help mitigate effect of climate change.
8. Establishment of functioning biotechnology laboratory with modern equipment and facilities in universities.

3.0. HISTORY OF FORESTRY

The first naturalist or foresters were Adam and Eve followed by the early man and they lived in a quiet and serene environment. The Early man saw the forest as an important part of nature for his keeps as well as renewable resources. Then he suddenly found that the forest can be exploited through fire and hunting. This led to the exploitative phase of the forest. The Early man left wandering and settled and started using forest materials for building and other purposes. This situation was aggravated with the rise in human population and the demand for forest products which increased the demand for forest products.

This stage was followed by the pre-industrial age or the wooden age as dubbed by Werner Sombart and others during the period when timber and firewood were the basic resources for energy, construction and housing. Roman Latifundiae, large agricultural estates, was quite successful in maintaining the large supply of wood that was necessary for the Roman Empire. Large deforestations came after the decline of the Romans. However in the 5th century, monks in the then Byzantine Romagna on the Adriatic coast, were able to establish stone pine plantations to provide fuel, wood and food.

The use and management of many forest resources has a long history in China as well, dating back to the Han Dynasty and taking place under the landowning gentry. A similar approach was used in Japan. In Europe, land usage rights in medieval and early modern times allowed different users to access forests and pastures. Plant litter and resin extraction were important, as pitch (resin) was essential for the caulking of ships and hunting rights, firewood and building, timber gathering in wood pastures, and for grazing animals in forests.

Systematic management of forests for a sustainable yield of timber is said to have begun in the German states in the 14th century, e.g. in Nuremberg, and in 16th-century Japan. The practice of establishing tree plantations in the British Isles began in the mid-19th century. Schools of Forestry were established beginning in the late 18th century in Hesse, Russia, Austria-Hungary, Sweden, France and elsewhere in Europe.

The first dedicated forestry school was established by Georg Ludwig Hartig at Hungen in the Wetterau, Hesse, in 1787 in Germany. In Spain, the first forestry school was the Forest Engineering School of Madrid was founded in 1844.

In South America, the first forestry school was established in Brazil, in Vicosa Minas, in 1962, and moved the next year to become a Faculty at the Federal University of Parana in Curitiba (www.wikipedia.org,2017).In South Africa, Forestry commenced between 1652-1772by Van Riebeck and later Van der Stel (Britton, 2006).

Forestry in Nigeria started around 900-200 B.C when the NOK culture reached its zenith in the middle belt of Jos Plateau. However, organized forestry commenced in 1887 in Lagos colony governed by Sir Alfred Moloney. The Department of Forestry was established in 1897 by the Acting Governor Sir, George Denton (Ekeke, 2014).

4.0. CLASSIFICATION OF FORESTRY

Forestry has been grouped as follows:

1. **Basic Forestry**
2. **Applied Forestry**

10. The study on the cultivation of *Volvariella volvacea* mushroom (Basidiomyceles), a Non-Timber Forest Product (NTFP) on different wastes (palm fibers, rice husk and saw dust) showed that Palm fiber is considered the most suitable farm waste for growing *V. volvaceae.*

11. *Pleurotus ostreatus and P. pulmonarius* are potential remediators of crude oil spilled sites.

moniliforme Sheldon isolated from *Rhizophora mangle, Rhizophora harrisonnii* and *Avicennia Africana* in Port Harcourt, Nigeria showed that the test fungi are acidophiles (pH 3.0-4.0), alkalinophiles (pH 8.0), neutrophiles (pH 7.0) and halophiles (Alkaline in nature).

7. The findings on effect of gas indicated that gas flare has effect on bacteria and plant and fungal populations. This is human factor and a major threat to the existence of trees.

8. Studies on the use of mushrooms will help shift attention from over harvesting of trees. Nutritional, organoleptic and palatability of three edible mushrooms namely; *Volvariella volvacaea, Pleurotus tuber-regium, Pleurotus sajor caju* in Nigeria contained alkanoids (Tannins), a good medicinal property. Nutritional values of these mushrooms showed that *V. volvacaea* was richest in protein and carbohydrate (62 and 3.84%). *Pleurotus tuber-regium* contained more of potassium and calcium (450mg/kg and 25.2mg/kg) while *Pleurotus sajor caju* had more of fibre and ash (4.5 and 2.0%). Basic sensory food evaluation showed that *V. volvacaea* (1.06) was the best in terms of palatability, followed by *P. tuber-regium* (1.01) and the least was *P. sajor caju* . This research will help forest users to shift attention from harvesting of trees for commercial purposes to harvesting of mushrooms.

9. Natural supernatant culture media stimulated higher mycelia growth than synthetic agar culture media employed in the study. Thus *P. sajor caju, P. tuber-regium* and *V. volvaceae* mycelium can be grown culturally on ricebran/soil, cassava peels/soil and palm fibre culture media respectively.

1. Basic Forestry:

Basic Forestry deals with the theory and practice of constitution and management of forests and utilization of their products. Basic Forestry has the following Branches:

a. Silviculture: This refers to certain aspects of theory and practice of raising forest, crops, methods of raising tree, their growth and after-cares up to the time of final harvesting. However, in simple words, it is the cultivation of forest trees.

b. Forest Mensuration: In simple language, it is the measurement of forest produce. However, it is defined as the determination of dimensions (e.g. height, diameter, volume, etc.) from, volume, age and increment of single trees, stands or whole woods, either standing or after felling. It concerns linear area, volume and weight measurements.

c. Forest Management: It is the practical application of science, technique, and the economics to a forest estate for the production of some wanted results. In actual sense, it is the application of business methods to the operation of a forest estate. The Society of American Foresters (SAF) has described it as an application of business methods and technical forestry principles to the operation of a forest property.

d. Forest Utilization: It is a branch of forestry concerned with the harvesting, conversion, disposal and use of forest produce.

e. Forest Law: Law includes any rule of action. The rules and law imposed by the state up on the actions of its citizens for the breach of which they are punishable. Forest law is classified as:

i. Constitutional laws

ii. Public laws

iii. Private laws; Very essential for protection of forest; Some terms - Forest offence / Forest right / Forest settlement

iv. Forest wildlife Act WL (Protection) Act 1972 Animals / birds.

f. Forest Policy: Branch of forestry concerned essentially with social and economic aims underlying forest management and forestry development.

2. Applied Forestry:

This includes those subjects which have the references to other courses but make the essence of forestry

a. Dendrology
b. Forest Ecology
c. Forest Economy
d. Forest Entomology
e. Forest Fire
f. Forest Genetics
g. Forest Pathology
h. Forest Seed technology
i. Forest soils
j. Forest statistics
k. Forests surveying
l. Remote sensing
m. Social Forestry-Social Resent
n. Agroforestry

4. The larvae of *E. pulverulenta* are defoliators and a major threat to the growth and establishment of *T. ivorensis*. This does not conform with the trees prayer and therefore the role of an Entomologists is needed here to monitor this pest so that it does not affect plant population. This is the first report on *E. pulverulenta* invasion of *T. ivorensis* in Rivers State and Nigeria in genera

5. It is important that such infected trees should be treated with extracts of *Jatropha curcas, Aloe-vera barbadense* and *Rhizophora recemosa* as well as bio-control methods. For example *Penicillium citrinum* and *Aspergillus niger* can be used to control *Lasiodiploda theobromae* while *Lasiodiploda theobromae* can be used to control *Paecilomyces lilacinus*. These methods are environmentally friendly and will not alter the environment but enhance plant growth.

6. Other contributions merely involve understanding the physiology of these microbes in order to formulate control measures which will enhance plant growth. Growth studies such as effects of P^H, temperatiure , salt water, sodium chloride and moisture content will enable Phyto-pathologists understand the growth pattern of microbes and therefore determine appropriate control measures of diseases. For instance fungi isolated from the phylloplane of mangrove plants function in high relative humidity of 90% and 100% as well as temperature ranges of 20^0C and 30^0C with best growth at 30^0C. This is an indication that most fungi found in the mangrove forest of Port Harcourt are psychrophiles (12 – 20 °C) and mesophiles (14- 45°C). Studies on effects of pH and sodium chloride (NaCl) on the growth of *Pestalotia dicheata* (Speg) Stepart and *Fusarium*

level of severity and thus prevent the microbes from causing harm on plants.

2. Similar studies on mangrove soil showed that fungi such as *Phytophthora sp, Curvlaria lunata, Fusarium moniliforme, Fusarium solani, Pestalotia sp, Aspergillus niger, Rhizopus stolonifer, Rhizopus sexualis, Penicilium sp and Aspergillus flavus does exist.* Also, Nine bacterial genera occurred on red mangrove plants and include: *Acinetobacter ,Aerococcus*, *Alcaligenes*, *Bacillus*, *Corynebacterium*, *Flavobacterium* and *Pseudomonas*, *Staphylococcus*, *Streptomyces*, *Corynebacterium*. *Corynebacterium, Bacillus and Pseudomonas* . These microbes were found to be ubiquitous and saprophytes playing earlier mentioned roles. The abundance of these microbes in mangrove soil is essential as they may be relevant as a data bank for mangrove and biotechnological studies.

3. The investigation on diversity and abundance of insect visitors to flower of *Irvingia gabonensis* showed that Ricanidae (*Ricania spp*) of the Order; Lepidoptera; insect Order: Odanata (*Anisoptera spp*) and Coleoptera (*Carabidae spp*) are insect visitors of *Irvingia gabonensis*. It is pertinent to emphasize that no empirical study has been done on insect visitors of both *Irvingia gabonensis* and *Moringa oleifera*. This work is pioneering and identifies the roles of insects in plants pollinations/foraging pattern. Therefore, these insects encourage trees to grow healthily and produce fruits to ensure continuous existence of these trees. This is in line with the trees prayer.

o. Forestry Extension
p. Afforestation
q. Recreation Forestry etc.

Some Other Forestry Branches:

1. Aesthetic forestry
2. Commercial Forestry
3. Community Forestry
4. Extensive Forestry
5. Farm Forestry
6. Extensive Forestry
7. Multiple use Forestry.

5.0. IMPORTANCE OF FORESTRY

The benefits of forest to man as well and to its environment are numerous and are shown below:

a. Quantifiable benefits or tangible benefits

b. Unquantifiable benefits

5.1. Quantifiable or Tangible Benefits

This is the economic aspect of the forest, such as timber, building, construction and sale of forest produce.

a. Wood is relevant to any nation and it is the primary product of the forest. It is used for building, construction and fuel. This has led to the rise of several industries such as;

i. Serom wood industries limited, Cross Rivers State, Nigeria.

ii. Calabar Veneer Plywood Industries in Cross Rivers State, Nigeria.

iii. Nigerian Newsprint and Manufacturing Company (NNMC) in Oku Iboku, Akwa Ibom State.

iv. Eastern Match industries

v. Nigerian Romanian Wood Industries Limited in Ondo State.

vi. United Match Company Limited, Illorin, Kwara State

vii. Nigerian Paper Mill, Jebba, Kwara State.

viii. Niger Match Industry Limited, Port Harcourt, Rivers State

ix. Safety Match Manufacturing (Nig.) Ltd, Ikeja, Lagos

x. Star Match Company Limited, Ikeja, Lagos.

xi. Multi million naira Pioneer Wood Industry.

xii. African Timber and Plywood Industries Limited, Sapele, Delta.

b. The other benefits are in the minor products of the forest such as; Vegetables, animals, animal products and minerals.

i. The vegetable products are many, e.g. Ogbono (*Irvingia gabonensis*), Pear (*Dacroydes edulis*) etc. Other products from plants which can generate revenue are bamboos, gums, resins, tannins, dyes, medicinal plants, mushrooms,

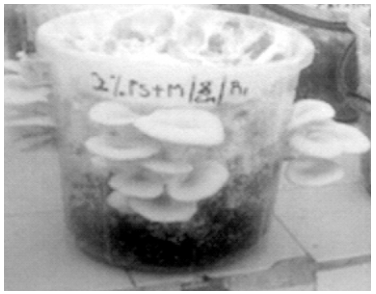

Plate 24: *P. ostreatus*

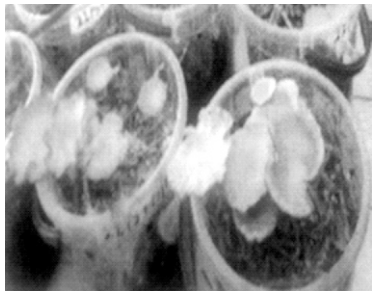

Plate 25: *P. pulmonarius*

15.0. CONCLUSION AND RECOMMENDATIONS

In conclusion, the following solutions have been proffered from the Forest pathological perspective in line with the tree's prayer.

1. The study showed that a total of twelve fungal species were isolated from some mangrove forest trees in Port Harcourt namely; *Pestalotia dichaeta, Collectotrichum gloesporioides, Fusarium moniliforme, Fusarium sp, Botryodiplodia theobromae, Phomopsis sp, Fusarium solani, Aspergillus niger, Penicillium sp, Linderina sp , Rhizopus stolonifer and Aspergillus flavus*. Observations made in the laboratory, field and pathogenicity test suggested that some of these fungi are saprobes which means they help to degrade dead organic matter and thus provide nutrients for plant growth and are said to obey the trees prayer. *Pestalotia dichaeta, Collectotrichum gloesporioides, Fusarium moniliforme, Botryodiplodia theobromae and Phomopsis sp* are pathogenic and thus have the potentials of causing harm on trees. Though their threshold is low which means these have little or no effect on plant population. It is a call on Forest Pathologists to monitor disease dynamics in the forest so as to know their

Table 24: PAH and TPH degradation potential of *P. pulmonarius* across different percentage crude oil pollution and substrate quantities.

2%PS+ M 4CM	0.003	0.010	0.003	0.004	0.003	0.011	0.003.	0.013	0.031	0.004	0.003	0.009	0.009	0.021	0.020	0.016	0.003.	0.012.	0.023	0.00062	0.0042	0.0021	0.028	0.03	0.2715
2%PS+ M 8CM	0.002	0.012	0.003	0.003.	0.004.	0.016	0.002	0.014	0.021	0.004	0.003	0.007	0.009	0.029	0.015	0.017	0.003.	0.012.	0.022	0.00053	0.0038	0.0021	0.026	0.031	0.2582
4%PS+ M 4CM	0.004	0.010	0.003	0.003.	0.006.	0.012	0.002	0.021	0.025	0.005	0.004	0.003	0.007	0.026	0.016	0.018	0.005.	0.013.	0.021	0.00166	0.0042	0.0027	0.027	0.029	0.2735
4%PS+ M 8CM	0.003	0.013	0.002	0.004.	0.004.	0.010.	0.003	0.014	0.022	0.003	0.004	0.006	0.003	0.026	0.012	0.016	0.005.	0.011.	0.020	0.00154	0.0047	0.0022	0.020.	0.031	0.3523
6%PS+ M 4CM	0.003	0.012	0.003	0.002.	0.005.	0.015.	0.003	0.011	0.030	0.005	0.005	0.012	0.006	0.026	0.016	0.018	0.004.	0.014.	0.021	0.00163	0.0046	0.0023	0.021	0.029	0.2702
6%PS+ M 8CM	0.005	0.015	0.002	0.004.	0.003.	0.011.	0.002	0.021	0.029	0.003	0.003	0.009	0.010	0.027	0.018	0.020	0.006.	0.012.	0.020	0.00168	0.0041	0.0026	0.024.	0.028	0.2855

Table 25: PAH and TPH degradation potential of *P. ostreatus* across different percentage crude oil pollution levels and substrate quantities.

2%PS+ M 4CM	0.002	0.010	0.003	0.003.	0.004.	0.011.	0.001.	0.010	0.020	0.002	0.003	0.008	0.004	0.026	0.009	0.010.	0.005	0.014.	0.020.	0.0074.	0.005	0.0042	0.027	0.028	0.2366
2%PS+ M 8CM	0.002	0.010	0.003	0.003.	0.004.	0.012.	0.003.	0.013	0.021	0.002	0.003	0.007	0.005	0.020	0.006	0.012.	0.004	0.013.	0.020.	0.0042	0.0044	0.0031	0.025	0.03	0.2635
4%PS+ M 4CM	0.002	0.009	0.004	0.003.	0.003.	0.012.	0.001.	0.011	0.022	0.002	0.002	0.011	0.003	0.024	0.009	0.014.	0.008	0.012.	0.019.	0.0072	0.0037	0.0035	0.038	0.031	0.2544
4%PS+ M 8CM	0.003	0.011	0.002	0.005.	0.001.	0.013.	0.003.	0.014	0.023	0.003	0.003	0.006	0.006	0.023	0.012	0.019.	0.005	0.007.	0.014.	0.0045	0.0044	0.0027	0.022	0.028	0.2346
6%PS+ M 4CM	0.002	0.012	0.005	0.002	0.002	0.012.	0.001.	0.011	0.027	0.002	0.003	0.010	0.003	0.023	0.011	0.012.	0.005.	0.012.	0.020.	0.0061	0.0041	0.0024	0.031	0.033	0.2516
6%PS+ M 8CM	0.002	0.012	0.002	0.003.	0.004.	0.012	0.002	0.018	0.032	0.002	0.004	0.011	0.005	0.021	0.012	0.016.	0.006.	0.011.	0.018.	0.0068	0.0036	0.0025	0.029	0.029	0.2409

snails etc. The products of the minor forest are responsible for 40% of the total revenue generated from the forest. The animal products; are bush meat, ivory, elephant tusks, bee wax, honey, and fish.

iii. The minerals include; Iron ore, diamond, gold, stone, sand and gravel

c. Nypa palm

Nypa palm is one of the most productive mangrove plants. It provides leaves for making thatches, hats and brooms. It also provides juice making sugar, alcohol and aromatic tea. The nuts are edible and shell is used to make earrings, necklaces and bangles.

5.2. Unquantifiable or Intangible Benefits of the Forest

These are forest resources that cannot be quantified in monetary terms but are very important. Examples are; Influence of forest on climate, Preservation of wildlife and erosion control.

5.2.1. Influence of forest on climate:

a. Carbon sequestration/climate change mitigation

Without the forests, earth would be uninhabitable. Forests provide water storage, dictate weather patterns and act as the planet's lungs by absorbing carbon dioxide and releasing oxygen into the atmosphere through photosynthesis. Some of the carbon dioxide absorbed by the trees in this process, however, remains stored in their leaves, trunks and roots. Scientists have long known the mechanics of this process; the only

mystery is precisely how much carbon is stored in the biomass of trees. Knowing the exact amount of carbon stored in the world's forests is necessary for a number of reasons. Firstly, measuring emissions caused by global deforestation and secondly designing appropriate compensation for REDD+ programs. Carbon credits are a key component of national and international emissions trading schemes that have been devised to reduce the consequence and effects of greenhouse gas emissions. Credits can be exchanged between investors or bought and sold in international markets at the prevailing market price. Carbon credits are then used to finance carbon reduction projects.

A new study out of the Woods Hole Research Center takes a step towards providing that greater accuracy, using Light Detection and Ranging (LiDAR) technology, researchers have created the first "wall to wall" map of carbon storage in global tropical forests. Their work helps to advance understanding of how deforestation contributes to global emissions as well and it highlights the importance that LiDAR and other remotely sensed data will play in a global REDD+ program (Gina, 2017 and Tracy *et al,* 2009).

According to the study, the world's tropical forests contain 228.7 PgC stored in their biomass. Putting this number in perspective, the sum total of carbon released from the combustion of fossil fuels since 1850 is around 212 PgC. There is no risk of rapidly releasing all of this stored carbon; these numbers merely highlight the importance of tropical forests in the Earth's carbon cycle by highlighting their immense capacity for carbon storage.

The study indicated that the mushrooms used for this study namely; *Volvariella volvacaea, Pleurotus tuber-regium, Pleurotus sajor caju* are endowed with chemical properties suitable for humans. *P. sajor caju, P. tuber-regium* and *V. volvaceae* mycelium can be grown culturally on ricebran/soil, cassava peels/soil and palm fibre culture media respectively. The highest yield of *Volvariella volvacea* was recorded on palm fiber, followed by rice husk and sawdust. It is suggested that mushrooms can be cultivated on these substrates. Adenipekun and Lawal (2012), Assan and Mpofu (2014), Oyeizu *et al*, (2017a), Ukoima, *et al* 2009b, 2009f, 2009g) have made contributions supporting this work. This is still an attempt to shift attention of forest users to NTFPs.

14.4. REMEDIATION OF CRUDE OIL POLLUTED SOIL USING TWO OYSTER MUSHROOMS *(P. ostreatus and P. pulmonarius).*

The Results of this research indicated that *P. ostreatus* had more PAHs reduction potentials than *P. pulmonarius* (Ukoima and Onyeizu, 2017d*)*. The high rate of PAH degradation effect observed in *P. ostreatus* could have come from lignolytic enzyme secretion presented elsewhere in this study. This research is supported by works of Onyeizu *et al* (2017) and Eggan (1999) who reported that many factors influence the effectiveness of fungal soil remediation including enzymes. In conclusion, *P. ostreatus* is more viable mushroom for myco-remediation than *P. pulmonarius*, even though both oyster mushrooms reduced PAHs concentration far below U.S.A EPA priority pollutant of 16mg/100g (Eggan and Vaclav, 2002) (Tables 24, 25 and Plates 24 - 25).

River State, Nigeria (Ukoima *et al,* 2009c). The aim of this study was to investigate the influence of selected farm wastes on the growth of *V. volvacea* so as to organically utilize these farm wastes and minimize the environmental nuisance caused by their burning (incineration). The highest yield of 345g was recorded from palm fiber, followed by 231g from rice husk and 146g from sawdust. Palm fiber is considered the most suitable farm waste for growing *V. volvacea*. The chemical properties of the various substrates combined to influence the chemical endowment and growth of *V. volvacea*(Fig 13). The findings of Nwoko *et al* (2017b) and Chukunda *et al* (2017) and Ukoima *et al*(2017b) are in line with this research.

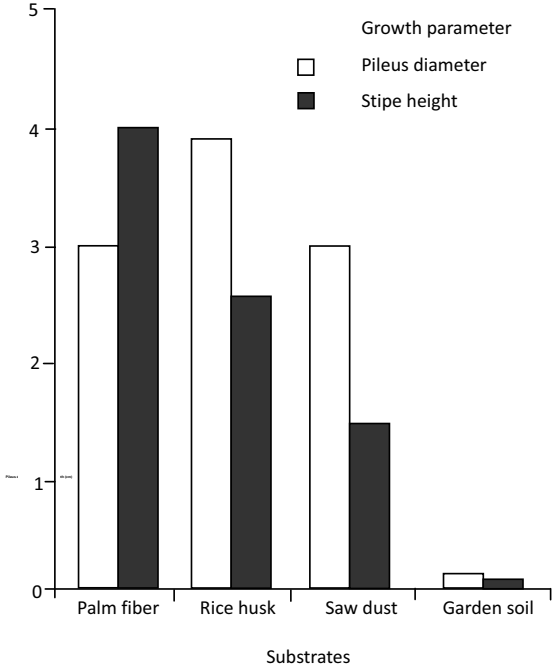

Fig 13: Growth performance of *V. volvacea* on different farm wastes

The America's tropical rainforests, including the Amazon, store 51.4% of this carbon. Africa's forests store 28.4% of the total, and Indonesia's store 18.4%. Not all forests store carbon equally, however; in most of the Americas, including the Amazon, most of the carbon is stored in "thick forest," but in Africa and Asia, scrublands, shrub and savannas store almost as much carbon as forests do. This discovery has important implications for how REDD+ programs are structured (Gina, 2017 and Tracy *et a*l, 2009).

Therefore, plants help to reduce global warming because it takes in all the carbon and other chemicals that help to wear off the ozone layer. That's why afforestation programmes are necessary to mitigate effects of climate change.

a. Forest trees reduce the speed of wind and as such protect farmlands and buildings from destruction

b. Forest cover also regulates temperature. This is common in the rainforest where it is neither too cold nor hot in the wet season. Whereas, in the North especially in Maiduguri with scanty vegetation, the temperature is very high.

5.2.2. Influence on Water Supply

a. The source of water supply is usually found in the watershed

b. The water shed require protection in order to regulate stream flow all the year round.

c. If the forest cover is removed, erosion takes place especially in hilly areas and is followed by

evaporation. This may lead to streams drying up in the dry season.

d. However, if there is adequate forest cover excessive evaporation will be checked and the litter on the forest floor will encourage percolation.

5.2.3. Wildlife Preservation

The forest is a good place or environment for animals, birds and other living things to live survive and reproduce.

a. In areas where the forest is burnt by man, some animal species move from their natural habitat or homes and are caught and killed by hunters. In some cases some animal species have become extinct (disappear).

b. It was because of this reason, that an international conference for the protection of fauna and flora in Africa was held in London in 1993.

c. This resulted in the establishment of national parks and nature reserves as homes for these animals

d. There are a total of 37 gazetted game reserves in Nigeria

e. However, only two are functioning;

   i. Yankari Game Reserve, Bauchi

   ii. Kainji Lake National Park in Kwara State.

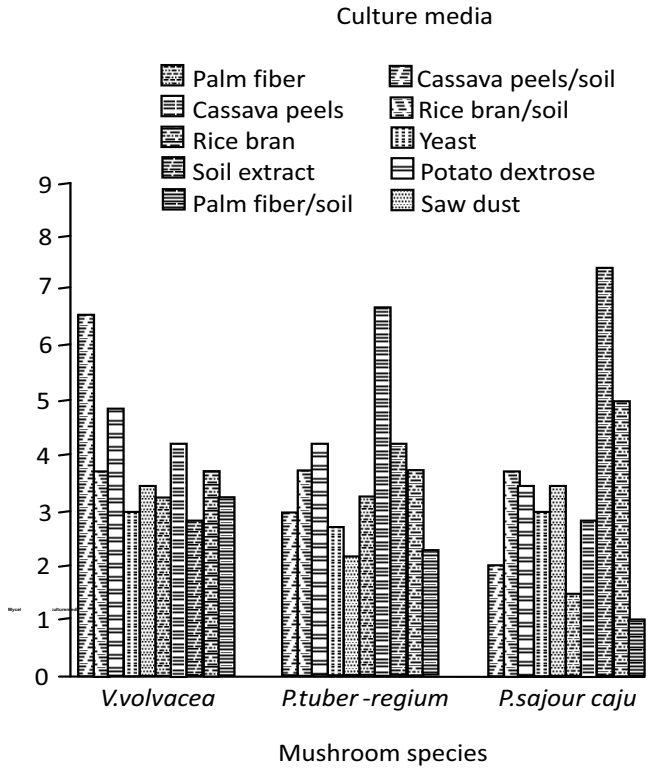

Fig.12: Response of selected edible mushrooms to different culture media

14.3 CULTIVATION OF MUSHROOM *(Volvariella volvacea)* ON VARIOUS FARM WASTES IN OBUBRA LOCAL GOVERNMENT OF CROSS RIVER STATE, NIGERIA.

A study on the cultivation of *Volvariella volvacea* mushroom (Basidiomyceles), a Non-Timber Forest Product (NTFP) on different wastes (palm fibers, rice husk and saw dust) was conducted at CRUTECH, Obubra Campus, Cross

14.2 CULTURAL STUDIES OF MYCELIA OF *Volvariella volvaceae, Pleurotus tuber-regium* and *Pleurotus sajor-caju* ON DIFFERENT CULTURE MEDIA.

Various agar culture media were investigated for culturing the mycelia of *Pleurotus tuber-regium, Pleurotus sajor caju* and *Volvariella volvaceae* edible mushrooms (Ukoima *et al*, 2009b). The study was conducted at Cross River University of Technology, Calabar Campus, Nigeria. Selected mushroom species were cultured to source for low input, cheap and other method of growing active mycelia, for the production of viable mushroom spawn (seeds). The results revealed that *P. sajor caju* had the highest mycelia growth (7.8cm) on rice bran/soil culture media while *P. tuber regium* had the highest mycelia growth (5.8cm) on cassava/soil culture media. *V. volvaceae* had the highest mycelia growth (7.1cm) on palm fibre culture medium. The least mycelia growth (1.5-4.4cm) was observed on potato dextrose agar culture media and yeast agar culture media. Therefore, natural supernatant culture media stimulated higher mycelia growth than synthetic agar culture media employed in the study. Thus it is recommended that *P. sajor caju, P. tuber-regium* and *V. volvaceae* mycelium can be grown culturally on ricebran/soil, cassava peels/soil and palm fibre culture media respectively (Fig. 12). This research will help to shift attention from cutting down of trees to other Non Timber Forest Products such as Mushroom.

5.2.4. Erosion

Forest trees reduce the direct effect of rain splash on the soil as well as surface run off, thereby reducing the washing off of the top soil. Forest cover also protects the soil from the direct effect of sunlight thereby reducing evaporation.

It also adds nutrients to the soil through litter.

5.2.5. Resource Base

The mangrove is a resource base for local inhabitants. It is a place they live and derive their means of livelihood.

5.2.6 Spanning grounds

Mangroves are spawning grounds for fish and other marine organisms. Mangroves are nurseries for brooding fishes, crustacean and mollusks.

5.2.7. Energy Inputs

Fallen leaves and stems act as source of food for estuarine and near shore fisheries. Mangroves provide a link between marine and terrestrial ecosystem. There is an import of nutrients from the land to the mangrove and export of nutrients from the mangrove to the sea.

5.2.8. Mangrove trap silt and filter run-off

Mangroves enhance siltation of flowing water and this enhances the growth of some plants which would have been affected by turbid water.

5.2.9. Reduction of estuarine pollution.

Mangroves absorb and trap pollutants in the soil

5.2.10. Science and Education

Wetlands provide important locations for scientific research and also play an important role in educating people about biodiversity.

6.0. IMPORTANCE OF FORESTRY IN NATIONAL ECONOMY

Forestry is a very important component of our national economy. This is shown below;

6.1. Revenue generation

Timber, animal, animal by product, vegetables and minerals are sources of revenue generation in the country. These products are sold both locally, nationally and internationally.

6.2. Employment

There are several employment opportunities in the Forestry unit:

i. Oil company and oil servicing companies as environmentalist

ii. Ministry of Agriculture (Forestry Unit at the State and Federal levels)

iii. Consultancy; as consultant to Government, Companies, NGO's (Non-Governmental Organizations)

iv. Companies such as Nigerian News Print Manufacturing Company Limited. Etc.

v. Work in the University

14.1. Nutritional, Organoleptic and Palatability studies of selected edible mushrooms in Nigeria.

Studies on the nutritional, organoleptic and palatability of three edible mushrooms namely; *Volvariella volvacaea, Pleurotus tuber-regium, Pleurotus sajor caju* in Nigeria were conducted to determine the best mushroom for human consumption (Ukoima *et al*, 2009a). Associations of official agricultural methods, basic sensory methods or food evaluation and Hedonic tests to measure likeness were measured for this research. Organoleptic analysis showed that the mushroom species contained alkanoids (Tannins), a good medicinal property. Nutritional values of these mushrooms showed that *V. volvacaea* was richest in protein and carbohydrate (62 and 3.84%). *Pleurotus tuber-regium* contained more of potassium and calcium (450mg/kg and 25.2mg/kg) while *Pleurotus sajor caju* had more of fibre and ash (4.5 and 2.0%). Basic sensory food evaluation showed that *V. volvacaea* (1.06) was the best in terms of palatability, followed by *P. tuber-regium* (1.01) and the least was *P. sajor caju* (0.5) (Tables 22-23).

Table 22: Nutritional values of edible mushrooms studied

S/N	Samples	Moisture %	Ash %	CHO %	Liquid %	Protein %	Fiber %	Ca	P	Fe	Mg	K	Na	C	A	E
1	*Volvariella volvacaea*	95.0	1.30	3.84	4.0	62.5	2.12	12.1	160	0.5	0.5	251	51.3	3.20	0.0	0.00
2	*Pleurotus tuber-regium*	90.0	1.40	1.05	1.0	40.16	2.51	25.2	300	1.5	1.0	450	23.15	0.01	0.0	0.00
3	*Pleurotus sajor caju*	85.0	2.0	3.00	0.60	29.5	4.5	15.3	7.3	0.85	0.5	310	17.2	0.0	0.001	0.00

Table 23: Category Scores for Palatablilty Test

Mushroom varieties	A	B	C
	V. volvacaea	*P. tuber regium*	***P. sajor caju***
Treatment means	3.4	2.1	1.5

Table 21: Effect of *J. curcas* seed extracts on fungal growth (cm)

S/N	Fungal Isolates	Seed Extracts (ml)			
		0	2	4	5
1	*Fusarium Oxysporium*	6.86[a]	5.88[a]	3.02[a]	1.02[b]
2	*Rhizopus stolonifer*	5.29[b]	4.53[b]	3.26[a]	1.00[b]
3	*Penicillium sp*	4.62[b]	3.51[c]	3.31[a]	2.11[a]
4	*Aspergillus niger*	3.81[c]	1.95[d]	1.42[b]	1.90[a]

Mean values with similar letter per column are not significantly different ($P<0.05$) by DMRT

14.0 NON TIMBER FOREST PRODUCTS (NTFPs) (MUSHROOMS)

Mushrooms are becoming accepted because of their high nutritional composition in protein, carbohydrate, mineral and vitamins. Besides, mushrooms have low cholesterol. Therefore consumption by humans is on the increase. More so, myco-remediation is an economically and environmentally sound alternative to extracting, transporting and storing toxic waste. It also restores value to depleted land. The current method of removing toxic waste by burning or burying the waste does not restore the ecology but helps to cripple and make the ecosystem lifeless. Besides, there is the urgent need to shift attention from cutting down of trees to Non Timber Forest Products (NTFPs) which is becoming very lucrative. Mushroom is one of them. Therefore, the under-listed studies were conducted with the intention of contributing to the **ECO- SOLUTIONS** in the area of mushroom production and remediation.

vi. Private ownership; such as fuel wood trading, hunting, chewing stick, cane industry, snail, mushroom and Bee farming

6.3. Provision of raw materials

Forest provides raw materials such as pulp for paper production. Construction Purposes. Mangrove species such as *Rhizophora spp* are used to make poles, beams and scaffolds for construction purposes.

6.4. Boat building

Mangrove trees such as *Exoecaria agallocha* is used to make boats for fishing purposes. Production of tool handles. Handles for farm tools and furniture are made from mangrove trees. Bark of *Rhizophora spp* and *Bruguiera, Ceriop spp* are used for tannin production to tan leather and other products. Some mangrove species have medicinal and pharmaceutical values. For instance, some members of Avicenna species are as astringents to treat ulcers while the barks and roots are used as aphrodisiac and maturative poultice.

6.5. Supply of fuel wood

About 70% of Nigerians are rural dwellers and depend on fire wood and charcoal for cooking, heating and ironing. Fuel wood such as *Avicennia* and *Rhizophora* are the preferred genera for domestic wood fuel in the Niger Delta of Nigeria. Income generated from wood extraction in Calabar South between 1991 and 2011 accrued to N13,633,144.00 – N27,591,120.00 from cutting down of timber harvest N130,724,000.00.

6.7. Supply of protein

A major source of meat supply comes from the forest as what is popularly called bush meat. Some agriculturists nowadays are involved in domestication (rearing) of animals, for example;-

i. Snails (*Archatina marginata*)

ii. Giant rat (*Cricetomys africana*)

iii. Guinea fowl (*Numdi melegiris*)

iv. Cane rat (*Thryonomys swindler*)

6.8. Foreign Exchange

Wood, animal and animals products and crude oil can be exported and can serve as foreign exchange for some countries.

6.9. Protection of life and property

Lions, tigers and bees are used as security for the protection of lives and properties.

6.10. Building

6.11. Landscaping and Beautification

6.12. Tourism

Most coastal and inland wetlands are used for tourism and recreational activities such as swimming, boating, fishing, camping and bird watching.

6.13. Sites for Education and Research

Research is done by Institutes, Colleges, Universities and Companies in the mangrove forest. It therefore helps to increase the knowledge especially about the mangrove ecosystem.

Table 18: Phytochemical Screening of *Aloe vera, Jatropha curcas* and bark of *Rhizophora racemosa*

Phytochemical	*Aloe vera*	*Jatropha curcas*	Bark of *Rhizophora racemosa*
Saponins	+	-	+
Terpenoids	-	-	+
Quinones	+	-	-

+ = presence, - = absence

Table 19: Weight (%) of Bioactive Secondary Compounds in bark of *Rhizophora racemosa, Aloe vera* and *Jatropha curcas* (Mean ± SE)

Plants	Saponins	Quinone	Terpenoid
Rhizophora racemosa	0.08 ± 0.10	0.00	18.12 ± 0.18
Jatropha curcas (mg/g)	0.02 ± 0.01	0.00	0.00
Aloe vera (mg/g)	0.04 ± 0.01	20.10 ± 0.12	0.00

Table 20: Effect of leaf extracts of *J. curcas* on fungal growth

S/N	Fungal Isolates	Leaf Extracts (ml)			
		0	2	4	5
1	*Fusarium Oxysporium*	6.24^{b}	5.41^{b}	1.35^{d}	1.03^{c}
2	*Rhizopus stolonifer*	7.02^{a}	4.88^{c}	2.26^{c}	1.20^{c}
3	*Penicillium sp*	6.29^{b}	6.08^{a}	3.10^{b}	2.82^{b}
4	*Aspergillus niger*	7.89^{a}	6.47^{a}	4.23^{a}	3.45^{a}

Mean values with similar letter per column are not significantly different ($P<0.05$) by DMRT

botanicals as an alternative means of protecting our plants from pathogen invasion particularly our leafy vegetables.

Table 15: Effect of *Aloe vera* Extracts on *Lasiodiploda theobromae* growth (g)

%*Aloe vera* concentration	**Inhibition**
20	0.5332
40	0.6352[a]
60	0.2990[b]
80	0.5654[a]
100	0.1645[b]
0 (Control)	3.7532[c]

Values in each column with the same superscript are not significantly different at P>0.05 using DMRT.

Table 16: Effect of *Jatropha curcas* extracts on *Lasidiploda theobromae* growth (g)

%*Jatropha curcas* concentration	**Inhibition**
20	1.4346[a]
40	1.3381[a]
60	1.0305[a]
80	0.8610[b]
100	0.9118[b]
0 (Control)	3.9491[c]

Values in each column with the same superscript are not significantly different at P>0.05 using DMRT.

Table 17: Effect of *Rhizophora racemosa* extracts on *Lasidiploda theobromae* growth (g)

%*Rhizophora racemosa* concentration	**Inhibition**
20	0.9009[a]
40	0.8425[a]
60	0.4126[b]
80	0.5208[b]
100	0.2946[c]
0 (Control)	4.4120[c]

Values in each column with the same superscript are not significantly different at P>0.05 using DMRT.

7.0. FACTORS AFFECTING FOREST CONSERVATION/ FOREST RESOURCES

7.1. Agriculture

Agriculture directly competes with forests for land to feed the growing population. The area under cultivation is increasing leaving its toll on the forest.

7.2. Livestock

Dependency on forests for grazing livestock negatively affects forests. Roughly 90 percent of the rural households own livestock. Livestock are an important part of the farming system and support agriculture through provision of manure for fertilizer and draught power. The value of livestock as a source of cash income is increasing with better sales of butter, cheese and meat. In fact in some areas in Northern Nigeria the forest is burnt for greener pastures to emerge for grazing cattle. Cattle appear to be preferred to humans. The clash between cattle grazers and natives is on the increase with attendant high death rates.

7.3. Pollution

Gas flare, crude oil, industrial chemicals can destroy plants, animals, fishes and humans. (Plate 14)

7.4. Lack of conservation ethics

A lot of persons believe that trees grow naturally; therefore harvesting them will have no effect on the forest. According to them all trees grow naturally and unassisted and so will continue to grow without man's assistance.

7.5. Civil service approach to forest management

Forest reserves are owned by Government under the Forestry Department, unfortunately funds are not made available to maintain these reserves. Even when funds are available it takes time before getting to the Departments.

7.6. Poverty

The rate poverty is very high in the country as such people fall back on the forest for timber and other exploitation and other products.

7.7. Unemployment

The rate of unemployment is also high. Several persons are jobless. They have no choice but to fall on the forest by exploiting it without authority from government.

7.8. Illegal trade

Commercial values of some wild animals such as elephant, tigers, eagle and others are on the increase. These animals are hunted without considering the law. This has led to depletion of the wildlife population.

Vice chancellor Sir, Distinguished Ladies and Gentle Men this inaugural lecture emphasizes on Tree's prayer and the Forest Pathologists strong and clear request for people to listen to this prayer. It is simply an 'ECO-PLEA'. This call can only be conveyed by the Forest Pathologist who is the plant Doctor. At this point it is imperative to understand the concept, Forest protection and Forest pathology since the Forest Pathologist is part of this discussion.

Mycoflora diseases in the Department of Forestry and Environment Laboratory (Pathology Unit) (Chukunda and Ukoima, 2013). The following fungi were isolated from the diseased leaves of *Gnetum africanum: Aspergillus niger* (60.7%), *Cercospora sp* (20.5%) and *Cladosporum sp* (16.4%). The effect of leaf extract of *Azadirachta indica* on condiospore germination, mycelia extension of the isolated fungi showed that an increased antifungal activity was noticed with a corresponding increase in concentration of the aqueous extract whereby a 100% concentration completely inhibited condial germination (P=0.05). Ascorbic acid at 150mg dosage also inhibited the growth of test fungi significantly. *A. niger* (4.50 – 0.95cm), *Cladosporum sp* (6.0 – 0.70cm) and *Cercospora sp* (8.25 – 1.20cm). This work agrees with the findings of (Chukunda *et al*, 2015 and Ukoima *et al*, 2012), who demonstrated that neem leaf extract of varying concentrations significantly reduced ($P \leqslant 0.05$) the growth of test fungi of castor bean seeds. In another experiment conducted by (Pepple, *et al.,* 2017), Moringa (*Moringa oliefera*) leaf extracts of 0ppm, 20ppm, 40ppm, 80ppm was applied to control some predominant fungi found on *Dalium guineense* Wild namely; *D. guineense* were *Aspergillus niger Van Tieghn, Rhizopus microsporus var. microsporus* Stephen & Mondo, *Penicillium purpureum* Stolk & Samson and *Penicillium minioluteum* Dierekx . The use of Moringa leaf extracts significantly ($P \leqslant 0.05$) reduced the growth of test fungi when compared to PDA (0%ppm) without leaf extract. It is recommended that neem is effective, cheap and ECOFRIENDLY in the control of seed-borne mycoflora of plants. This research work holds promise for the use of

tested fungus (0.9118g mycelia dry weight). Biochemical test showed that quinone, terpenoid and saponin from *Aloe vera*, bark of *Rhizophora racemosa* and *Jatropha curcas* respectively were suspected to account for the inhibition of the tested fungus (*Lasiodiploda theobromae*) (Tables 15-19). This study has revealed that plant extracts of *Jatropha curcas, Aloe-vera barbadense* and *Rhizophora recemosa* can be used to control *Lasdiplodia theobromae*. Ariole and Akinduyite (2016),

Ukoima and Okah (2006a)and Chukunda (2014) have also observed that plant extracts also called Biocides are eco-friendly and can be used to control fungi. Biocides cannot alter our environment.

Laboratory studies on biocidal effect of leaves and seeds of *J. curcas* were carried out on the predominant fungal isolates. 0ml, 3ml, 4ml and 5ml concentrations of *Jaropha curcas* seeds and leaves were tested on the predominant fungi which occurred on leaves and seed of *J. curcas,Fusarium oxysporium, Rhizopus stolonifer, Penicilium sp*. and *Aspergillus niger* (Ukoima, *et al*, 2012*)*. 5ml concentration of Jatropha leaf and seed extracts had the highest inhibitory effect on the isolated fungi (Tables 20 - 21). This study therefore, suggests that control of these fungi is possible through the use of plant leaf and seed extracts of *J. curcas*. The method is cheap, environmental friendly and affordable to local farmers. The works of Ukoima and Okah, (2006a) and Chukunda *et al* (2013) and Lazzeri *et al,*(2004) gives credence to this study.

In a similar experiment, leaves of Okazi (*Gnetum africanum Welw*) were collected from Egbeda forest in Emohua Local Government Area, Rivers State, Nigeria and tested for

Plate 14 : Gas flare exuding thick emission in Port Harcourt

8.0. WHAT IS FOREST PROTECTION AND FOREST PATHOLOGY?

Forest protection therefore, is the preservation or improvement of a forest threatened or affected by natural or man- made causes.

Thus forest protection also has a legal status and rather than protection from only people damaging the forests is seen to be broader and include FOREST PATHOLOGY too.

The types of man induced abuse that forest protection seeks to prevent include:

- Aggressive or unsustainable farming and logging
- Pollution of soil on which forests grow
- Expanding city development caused by population explosion and the resulting urban sprawl
- Fire occurrences

8.1. Forest pathology

Forest pathology, is part of the broader approach of forest protection which is the research of both biotic and abiotic maladies affecting the health of a forest ecosystem, primarily fungal pathogens and their insect vectors. It is a subfield of forestry and plant pathology. Pathologist may be called **Phytiatricians** according to Prof Arinze because they deal with diseases of plants. However, because plants do not complain less attention is paid to them unlike humans who are handled by popular **Pediatricians (Physicians)**and animals by Veterinary Doctors. That is why the trees are cut down every day without pity.

There are a number of abiotic factors which affect the health of a forest, such as moisture issues like drought, winter-drying, water logging resulting from over-abundance or lack of precipitation such as hail, snow and rain.

Wind is also an important abiotic factor. The uprooting or breaking of trees due to high winds causes an obvious and direct loss of stability to a forest or its trees. Abiotic factors and biotic factors can affect a forest at the same time. For example, if wind speed is 150 km per hour, many trees which have root rot caused by a pathogen are likely to be pulled down. Wind speeds can damage healthier trees. Fire, whether caused by humans or lightning and related abiotic

Table 14: *In-vitro* Evaluation of Microbial Antagonist on *Lasiodiploda theobromae* using *Paecilomyces lilacinus*

Days of Incubation	Diameter of *P.lilacinus* (cm)	Diameter of *L. theobromae*(cm)	Hole (cm)	Control (cm)
3	2.81	3.48	1.6	7.68
6	2.99	3.89	0.25	7.95
9	3.11	3.99	0.0	8.9

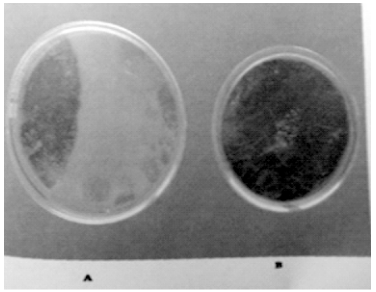

Plate 22: *A. niger* inhibiting *L. theobromae*

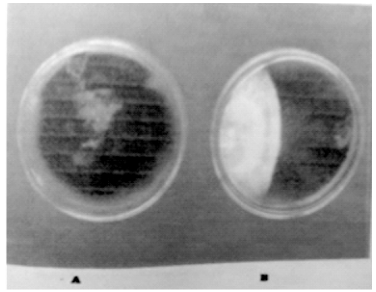

Plate 23: *L. theobromae* inhibiting *P.lilacinus*

13.2. Control of *lasiodiplodia theobromae* (Pat) on *Rhizophora racemosa* and *Gnetum africanum* using plant extracts

Ukoima *et al* (2013b) carried out studies on the control of *L. theobromae* using plant extracts. Different concentrations ranging from (20%, 40%, 60%, 80% and 100%) of extracts derived from the bark of *Rhizophora racemosa*, leaves of *Aloe vera* and *Jatropha curcas* were tested on the isolated fungi. *Aloe vera* and the bark of *Rhizophora racemosa* were inhibitory at 100% on *Lasiodiploda theobromae* (0.1645g and 0.2946g mycelia dry weight respectively). *Jatropha curcas* had less inhibitory effect at 80% concentration on the

Colony diameter of the pathogen and the test organism were measured every 3 days for 9 days. Bio control results indicated that *Penicilium citrinum* (4.61cm) was antagonistic on *Lasiodiplodia theobromae*, followed by *Aspergillus niger* (3.91cm). Whereas, *Lasiodiploda theobromae* (3.99cm) was inhibitory to *Paecilomyces lilacinus* (3.11cm). These results showed that *Penicillium citrinum* and *Aspergillus niger* could be used to control *Lasodiploda theobromae* while *Lasodiploda theobromae* can be used to control *Paecilomyces lilacinus*(Tables 12 -14 and Plates 22 - 23). Cook (2000), Larkin *et al*, (1998) and Madi,(1997) demonstrated that phytogenetically diverse microbes can act as natural antagonists of various plant pathogens.

Table 12: *In - vitro* Evaluation of Microbial Antagonist on *Lasiodiploda theobromae* using *A.niger*

Days of Incubation	Diameter of *A. niger* (cm)	Diameter of *L. theobromae*(cm)	Hole (cm)	Control (cm)
3	3.30	2.30	1.73	3.80
6	3.73	2.74	0.95	6.13
9	3.91	2.98	0.23	8.69

Table 13: *In-vitro* Evaluation of Microbial Antagonist on *Lasiodiploda theobromae* using *Penicillium citrinum*

Days of Incubation	Diameter of *P. citrinum* (cm)	Diameter of *L. theobromae*(cm)	Hole (cm)	Control (cm)
3	4.61	2.36	0	9
6	4.61	2.36	0	9
9	4.61	2.36	0	9

factors also affect the health of forest. The effects of man often alter a forest's predisposition to damage from both abiotic and biotic effects. For example soil properties may be altered by heavy machinery.

8.2. Other abiotic factors

Nutrient imbalances: deficiencies, chemicals (toxic salts, herbicides, air pollutants), stem flow which can concentrate dry deposits which via soil acidification can kill surrounding plants as well as temperature can affect the growth of trees.

8.3. Biotic factors

Fungi: Ascomycota, Basidiomycota and Fungi imperfecti, Oomycota: Phytophthora, Bacteria, Phytoplasmas, Viruses and Insects can destroy plants.

8.4. Parasitic flowering plants

Many plants can parasitize trees via root to root contact. example is the dodder plant.

8.5 Animals

Nematodes, insects especially bark beetles, mammals may browse and destroy plants.

Part of forest pathology is forest entomology. Forest entomology includes the study of all insects and arthropods, such as mites, centipedes and millipedes, which live in and interact in forest ecosystems. Forest entomology also includes the management of insect pests that cause the degrading, defoliation, crown die-back or death of trees.

Vice Chancellor, Distinguished Ladies and Gentlemen, why the Clarion Call by the Forest Pathologist to obey the Trees?

Sir, this is the 50th and indeed the golden jubilee inaugural lecture of this great University. It is apt as the world including our great country Nigeria is facing a lot of environmental challenges, caused by human and pathological activities such as gas flaring, crude oil spillage, felling of trees, diseases and pest. It is important to point out that the Nigeria forest which covers about 9.6 million hectares is reducing rapidly over the past decades. The deforestation rate is estimated at 3.7% and it's one of the highest in the world (REDD+ Rediness programme, 2012).

The Nigerian forest cover has moved from 17,234 to 9041 between 1990 - 2010. Between 2000 - 2005 the country has lost 55.5% of its primary forest (FA0, 2010).

Majorly this has led to climate change which has caused flooding; examples are abound in Florida, Los Angeles, Houston Texas, Caribbean Islands. Back home in Obio-Akpor Local Government Area of Rivers State Nigeria, Markudi in Benue State , Kogi State just to mention a few (Source : Social media) (Plate 15b-e) . Loss of human and properties are immeasurable. It has also caused erosion, loss of biodiversity, loss of wildlife, and socio-economic issues.

Plate 15a : Flooding in Benue state

Plate 15b : Flooding in Port Harcourt

13.0 RESEARCH ON MYCOPARASITISM AND THE USE OF BIOCIDES

Pesticides are potent biocides and in some cases adversely affect the physiology of forest plants. Any change in the physiology of a forest plants may result either in making the plant more resistant or more susceptible to attack by its parasites or predators. Since forest plants which are not physiologically stressed are generally more effective in resisting parasites and predator attack, any chemical that alters normal physiology is likely to increase susceptibility of the crop plant (Cherre and Sagar, 1976). Therefore, the under-listed studies were carried out to apply environmentally or Eco-Friendly and sustainable procedures in managing and controlling disease and pest out breaks.

13.1. Mycoparasitism on some fungal isolates of *Rhizophora racemosaLinn*

Ukoima and Ikata (2013a) conducted an *in-vitro* experiment to control *Lasiodiploda theobromae* and other fungal isolates of *Rhizophora racemosa* using fungal antagonists. The need to have an alternative control measure that is environmentally friendly, useful to the resource – poor, educationally poor rural dwellers that use mangrove in their daily needs. Besides, bio control of these fungi has not been tried for Niger Delta mangrove phylloplane diseases. Fungal pathogens were isolated by cutting the infected portions of the leaves and aseptically placed in glass Petri-dishes for 7days. A dual culture plate assay of 5mm diameter inoculums disc of *Lasiodiplodia theobromae* was placed near the edge of a Petri dish containing PDA medium. A similar inoculums disc of the test fungus was placed at the opposite end of the same Petri dish. The experiment was replicated thrice. Petri dishes containing antagonist fungus were incubated 28 ± 2^{0}C at room temperature for 7 days.

abundant (30%) followed by the insect Order: Odanata (*Anisoptera spp*) 15% and Coleoptera (*Carabidae spp*) 9%. This variation in abundance was observed within 10 weeks.

It is pertinent to emphasis that no empirical study has been done on insect visitors of both *Irvingia gabonensis* and *Moringa oleifera*. This work is pioneering and identifies the roles of insects in plants pollinations/foraging pattern. There was no significant difference (P>0.05) between the insect visitors to the flowers of *Irvingia gabonensis*(Figs 10-11) in the morning and afternoon. Chukunda *et al* (2016) also worked on insect visitors of *Moringa oleifera* at the Forestry and Environment Arboretum, Rivers State University of Science and Technology, Port Harcourt, Nigeria. The result of this study showed that *Scotia dutia* and *Xylocopa virginica* were most abundant and therefore suspected as the major pollinators of *M. oleifera.*

Insects play a vital role in tree growth and related activities. It is important that Eco-Friendly fumigation programmes should be carefully done in order not to destroy the useful insects involved in pollination of our trees. Moreso, bush burning should be discouraged because most of these insects are killed in the process. This can cause ripple effects including low yield just to mention a few.

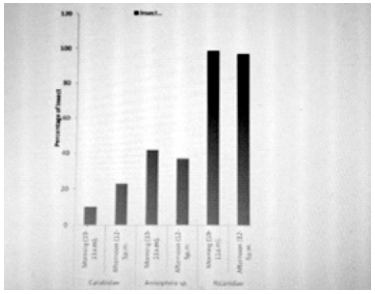

Fig. 10: Simpson Index of insect species in time

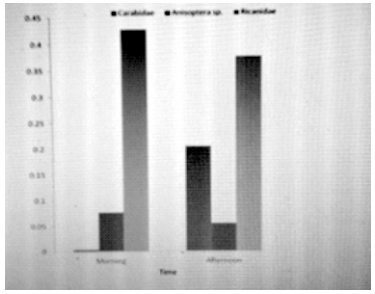

Fig. 11: Percentage of insects in number of weeks

Hobby Airport in Houston

Plate 15c: Flooding in Port Harcourt

Plate 15d : Flooding in Houston

According to the United States Agency for International Development (USAID, 2013), the IUCN Red list of threatened species due to habitat loss in Nigeria currently includes, 128 animals and 172 plants threatened; 14 animals and 16 plants critically endangered; 36 animals and 18 plants endangered and 78 animals and 138 plants vulnerable. Nigeria's wildlife biodiversity of 899 species of birds, 274 mammals, 154 reptiles, 53 amphibians and 4715 species of plants are decreasing daily due to deforestation and habitat loss. It is pertinent to point out that no microbes were mentioned in this list. Infact, there are 9 categories of threatened species; unknown, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated, it is very glaring that there are no sufficient data in all categories mentioned above as it concerns microbes

Unfortunately little or nothing is mentioned about fungi and bacteria, nematodes, virus and other microbes which control important processes on which the tropical forest depends on (Hawksworth and Colwell,1992). The role of microorganisms in ecosystem functioning which could be positive or negative, include; decomposition of organic matter, nitrogen fixation, food sources for other organisms, regulate plant population and

mycorrhizal association and pathogenicity have been broadly discussed (Odiwe *et al*, 2015; Allsop *et al*,1995). It is pertinent to note that fungi apart from those affecting humans are poorly unknown than insects, however by extrapolation, there are about 1-1.5 million species of fungi on earth (Hawksworth,1991 and 1993) and perhaps 3 million bacteria yet to be cultured (Trupper,1992).

According to Hammon (1992), even though such large figures for bacteria currently meet with uncertainty, two conclusions appear obvious;

1. 90-95% of the earth's microbiota is yet to be identified and characterized.
2. Microbiota constitutes at least 15% of all species on earth, compared to3-0.5% of plants and invertebrates respectively. More so, little is known of the biology, genetics,ecology, host range, Biochemistry and distribution of perhaps 40% of the 72,000 fungi (Hawksworth, *et al*,1995). However, what is relevant in this inaugural lecture is that anthropogenic and microbial activities can be detrimental to the growth of trees. Moreso, the role of the forest pathologist and even the microbes in ecosystem management is undermined by government and private individuals. It is in respect of this that necessitated the choice of the topic of this lecture, **'THE TREE'S PRAYER: CLARION CALL BY THE FOREST PATHOLOGIST.'**

Plate 18:*Epicerura pulverulenta*

Plate 19*: Epicerura pulverulenta*

Plate 20: E*arly infestation of Epicerura pulverulenta on T. ivorensis*

Plate 21: *Defoliation of T. ivorensis by Epicerura pulverulenta* (later invasion)

12.2. *Irvingia gabonensis*

Field experiment was conducted at the Department of Forestry & Environment Arboretum, Rivers State University of Science and Technology, Port Harcourt between March – May 2015 to investigate the diversity and abundance of insect visitors to flower of *Irvingia gabonensis* (Ukoima, *et al*, 2016d). Simple sampling method was used in collecting the insects twice weekly, using hand netting technique at interval between March 16th – May 27th, 2015. Results showed that Ricanidae (*Ricania spp*) of the Order; Lepidoptera was found to be the most

12.0. STUDIES ON SOME IMPORTANT TIMBER PESTS

12.1. *Terminalia ivorensis*

Terminalia ivorensis (Idigbo or black afara) is a useful hardwood of the humid tropics of Africa. It is currently under threat due to over exploitation as well as poor regeneration. Qualitative studies were carried out in a mixed population of *T. ivorensis* and some fruit and medicinal trees at the Forestry and Environment Arboretum,Rivers State University of Science and Technology,Port Harcourt(Ukoima *et a*l,2016g). Data presentation was done visually and pictorially. It was observed that the larvae of *Epicerura pulverulenta* with a diameter of 1.5cm and length of 7.1cm (Plates 18-21) are aggressive defoliators of *T. ivorensis*. Defoliation of entire plant stand occurred less than 7 days. It was noticed that defoliation was selective as other plants were not affected.

This is the first report on *E. pulverulenta* invasion of *T. ivorensis* in Rivers State and Nigeria in general. Conclusively, the larvae of *E. pulverulenta* are a major threat to the growth and establishment of *T. ivorensis*. This finding is in tandem with the works of (kanga and Fediere 1991) who reported about the pest in Ghana. It was suggested by these authors that *E. pulverulenta* is a major defoliator of *T. ivorensis* in plantation stands in Ghana and that adequate control measures should be applied in severe cases of infestation. Eco-Friendly procedures in pest and disease control should be adopted and these include cultural practices, such as early detection of pests, handpicking of pests, destroying debris around the plantation and others (Ukoima, 2000c and Ukoima, 2016h).

9.0. CONTRIBUTIONS TO KNOWLEDGE IN FOREST PATHOLOGY

Over 95 publications of the under-listed research contributions were selected in tandem with the tree's prayer. These are;

a. Microbial identifications in the mangrove forest
b. Microbial physiology of the mangrove forest
c. Important timber/fruit tree pests
d. Mycoparasitism/ use of biocides
e. Non-Timber Forest Products (NTFPS), mushroom studies.

i Microbial Identification in the Mangrove Forest

ii. Survey of bacteria and fungi on some red and white mangrove forest trees in Rivers State, Nigeria

Research question: Are there beneficial bacteria in the mangrove?

Mangroves are important in tannin, pulp and paper manufacture, medicine, habitat for some commercially exploited marine organisms such as fish, oysters and crabs (Ukoima, 2000a and Tomlison,1986). Similarly, Bacteria are useful in various ways, especially in nitrogen fixation in the soil. This enhances soil fertility for example cyanobacteria (Anabaena), Azotobacter, Azospirillum. Some bacterial such as cornebacterium are pathogenic on plants (Allsop *et al*, 1995). Ukoima *et al*, (2009a) investigated into the Bacterial pathogens of red mangrove (*Rhizophora mangle*). 50 samples each of leaves and seed (healthy and diseased) were randomly collected and used for

the analysis. Procedures for bacterial isolation and identification was adopted (Buchana and Gibbons,1974). Standard Mean bacterial counts obtained were: healthy and diseases leaves; 8.26 x 10^3 and 5.91 x 10^3 cfu/ml respectively; healthy seeds 7.96 x 10^3 cfu/ml and diseased seeds 1.14 x 10^4 cfu/ml. The bacterial populations of the healthy and diseased leaves and seeds showed no significant difference at $P > 0.05$ (F- cal = 4.69; F- tab = 4.76). Nine bacterial genera isolated include: *Acinetobacter* (7.69%), *Aerococcus* and *Alcaligenes* (3.84%), *Bacillus* (19.23%), *Corynebacterium* (34.61%), *Flavobacterium* and *Pseudomonas* (3.84%), *Staphylococcus* (7.69%) and *Streptomyces* (15.38%). *Corynebacterium* had the highest percentage occurrence and was isolated from both healthy and diseased samples. (Tables 1b, 2, 3 and Figure 1).Some of the bacterial species such *Corynebacterium, Bacillus, Pseudomonas* are known pathogens of plants and were implicated as pathogens of red mangrove. This is in support of the works of (Asadu *et al* 2015; Adedunta and Adeyinka,2012 and Ukoima *et al*, 2007b).

In another study (Ukoima *et al* 2009c) did a survey on the fungi found on *R. mangle, R. racemosa, R. harisonii* (Red mangrove) and *A. africana* (White mangrove) in Rivers State, Nigeria. The wet blotter paper method was adopted for fungal isolation and identification using stereo-binocular and compound microscopes (Barnett and Hunter,1972). The study showed that a total of twelve fungal species were isolated from some mangrove forest trees in Port Harcourt namely; *Pestalotia dichaeta, Collectotrichum gloesporioides, Fusarium moniliforme, Fusarium sp, Botryodiplodia theobromae, Phomopsis sp, Fusarium*

Table 10: Counts of Fungi isolated from the flared site

S/N	Distance from the flared site	Total fungi (cfu/ml)
1	50m	0.03 x 10^5
2	100m	0.35 x 10^5
3	150m	0.41 x 10^5
4	1km	0.15 x 10^5

M (meters) and Km (kilometers)

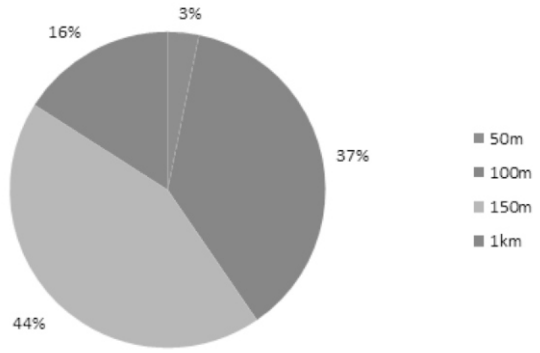

Fig 9: Counts of Fungi isolated from the flared site

Table 11: Effect of gas flare on vegetation at Oloma

Distance from the flared site (meter/km)	Common plants	Species richness
50	*Papsulum jaminance*	+
	Sporobolus pyramidalis	+
	Euphorbia hirta	+
100	*Elaesis guineensis*	++
	Nypa fruticans	+
	Acrosticum aereum	+++
	Rhizophora mangle	++++
150	*Euphorbia hirta*	+
	Sporobolus pyramidalis	++
	Nypa fruticans	+++
	Rhizophora mangle	++++
1k	*Nypa fruticans*	+++
	Rhizophora mangle	++++

products. *Aspergillus niger* (fungus) is used to produce citric acid. Whereas, bacteria such as *acetobacter aceti* are used to make acetic acid, *Clostridium butylicum* is used to produce butyric acid and lactobacillus, lactic acid. To avoid losing these useful microbes anti – ecofriendly activities such as gas flaring should be discouraged. This research agrees with the reports of (Abere and Ukoima, 2014; Atuma and Ojeh, 2013 and Alakpodia, 2000).

Table 9: Counts of heterotrophic bacteria isolated from the flared site

S/N	Distance from the flared site	Total heterotrophic bacteria (cfu/ml)
1	50m	2.4×10^5
2	100m	4.7×10^5
3	150m	5.8×10^5
4	1km	3.0×10^5

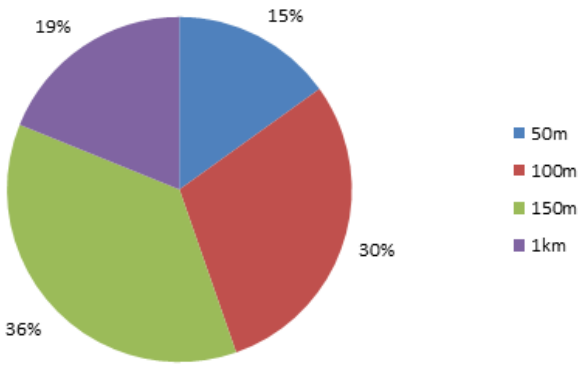

Fig 8: Counts of heterotrophic bacteria isolated from the flared site

solani, Aspergillus niger, Penicillium sp, Linderina sp , Rhizopus stolonifer and Aspergillus flavus. Observations made in the laboratory, field and pathogenicity test suggested that some of these fungi are saprobes *except Pestalotia dichaeta, Collectotrichum gloesporioides, Fusarium moniliforme, Botryodiplodia theobromae and Phomopsis sp*are pathogenic, (Tables 4, 5, Figure 2 and Plates 16 -17). Many authors (Ukoima and Umechuruba, 2009d; Umechuruba, 2005; Ukoima, 2000b; Ukoima *et al*; Akpan and Solomon, 2012; Maxwell, 1968; Kohlmeyer, 1971; Lee &Baker, 1972; Fell *et al*., 1975; Newell, 1976) have reported on fungi associated with mangrove forest in Nigeria, Australia and elsewhere.

Similarly laboratory studies were undertaken to determine the percentage frequency of fungi in the mangrove soil in two sites namely Creek Road Waterside and Eagle Island Waterside in Port Harcourt, Rivers State, Nigeria (Ukoima and Amakiri, 2009j and 2007a). Serial dilution technique was used for isolation of fungi. The results obtained showed that the fungi isolated from the mangrove soil were *Phytophthora sp, Curvlaria lunata, Fusarium moniliforme, Fusarium solani, Pestalotia sp, Aspergillus niger, Rhizopus stolonifer, Rhizopus sexualis, Penicilium sp and Aspergillus flavus*. These fungi were found to be ubiquitous. At Creek Road Waterside the fungus with the highest frequency at the upper zone was *Fusarium sp,* (62%) and at the middle and shore line zones *A. flavus,* (54% and 77%) respectively. At Eagle Island waterside, the fungus with the highest frequency at the upper zone was *Penicilium sp* (67%) at the middle zone *C. lunata (62%)* and at the shore line zone *Penicilium sp* (77%) (Tables 6-7 and Figures 9-15). These findings are in line with the works of (Adeduntan and

Adeyinka, 2012; Akpan and Solomon, 2012; Adeduntan, 2009; Asowata and Ukoima, 2006; Follosco and Uyenco, 1984; Garg, 1982). In another research which aligns with the above findings Ukoima *et al*, (2008) reported on the microbial population in soil and other parts of *Nypa fruticans* The bacteria isolated were: *Bacillus spp, Corynebacterium spp, Alcaligenes spp, Clostridium spp, Staphylococcus spp, Acinetobacter spp, Acromonas spp, Serratia spp, Flavobacterium spp and Micrococcus spp* while the fungi isolated include; *Aspergillus flavus, Aspergillus niger, Aspergillus ochralecus, Aspergillus restrictus, Penicillium spp, Rhizopus spp*, *Mucor spp, Fusarium spp, Saccharomyces spp* and *yeast*. Bacteria population was higher than the fungal population perhaps because the Nypa environment was conducive for their growth. These results were significant at $P<0.05$. These results on the isolation of fungi and bacteria on phylloplane, rhizosphere and rhizoplane of mangrove plants demonstrated that there are beneficial microbes that are abound on Nypa palm which will enhance research in the areas of bio-remediation, molecular biology, Bio-control, fermentation processes and medicine. Research in various aspects of Nypa palm has been documented (Ukoima,1998; 2001; 2002a,c,d; 2004b,c,d; Ukoima 2016d; Nwisuator *et al*, 2008; David *et al*, 2008; Whitmore, 1972 and Zeven,1963).

11.0 INVESTIGATION INTO CHANGES IN BACTERIA, PLANT AND FUNGAL POPULATION IN THE MANGROVE FOREST FOLLOWING GAS FLARE

This study investigated changes in bacteria, plant nutrients and plant population following gas flare in Oloma community, Rivers State, Nigeria (Ukoima *et al*, 2016 a&b). Standard procedures were used for plant analysis and determination of plant population. Bacterial populations were ascertained using conventional methods such as serial dilution. The result on bacteria showed that counts of heterotrophic bacteria were lowest at 50 meters (2.4×10^5 cfu/ml) while total heterotrophic bacteria was however highest (5.8×10^5 cfu/ml) at 150 meters. However, at 1 kilometer there was a reduction (3.0×10^5 cfu/ml) in bacteria population (Table 9 and Fig 8). The result on fungal population showed that counts of heterotrophic fungi were highest (0.41×10^5 cfu/ml) at 150 meters and lowest 0.03×10^5 cfu/ml) at 50 meters. The most prevalent fungi which occurred at the vicinity of flare were: *Fusarium moniliforme* (2), *Rhizopus stolonifer* (7), *Penicillium sp* (6), *Aspergillus niger* (3) and *Candida sp* (1). *Rhizopus stolonifer* was the most prevalent fungus. *R. stolonifer* had the highest percentage occurrence (36.8%) followed by *A. niger* (33.3%)(Table 10 and Fig 9). *Paspulum jaminance, Sporobolus pyramidalis, Euphorbia hirta, Acrosticum aereum, Nypa fruticans,* and *Elaesis guineensis* were less common around the flared site (+ and ++) at 50m – 1km (Table 11). These findings demonstrated that gas flare has effect on bacteria and plant and fungal population. It is very important to stress that fungi and bacteria are part of the mangrove ecosystem and are relevant in mycorrihzal activities in absorbing phosphorus and passing on to plants. Some fungus such as *Rhizobium* is involved in fixing nitrogen in the plants. *Sacchromyces cerevisiae* (yeast) which is a fungus is used to produce ethanol and other

researches conducted by Ukoima *and* Umechuruba, *(*2006c); Ukoima and Umechuruba, (2004a);Ukoima and Umechuruba (2003); Follosco and Uyenco (1984) supports this result.

The implication of these studies is that the test fungi are acidophiles, alkalinophiles, neutrophiles and halophiles. This is in conformity with studies carryout by other researchers (Ukoima and Umechuruba,2009e; Ukoima and Umechuruba, 2004a; Umechuruba and Ukoima 2003).

Table 7: Effect of pH on the growth of *P. dichaeta* and *F.moniliforme* isolated from Mangrove forest trees

Treatment	Mycelia dry weight	
P^H	*P. dichaeta*	*F. moniliforme*
0 (Control)	0.330b,c	0.435b
3	0.522a,b,c	0.050a
4	0.927d	0.311b
5	0.424	0.342b
6	0.265a,b	0.338b
7	0.245a,b	1.121d
8	0.121a	1.363d

A,b,c,d means with different letters the horizontal column are significantly different (p<05)

Table 8: Effect of Sodium Chloride (NaCl) on the growth of *P. dichaeta* and *F.moniliforme* isolated from Mangrove forest trees

Treatment	Mycelia dry weight	
NaCl (%)	*P. dichaeta*	*F. moniliforme*
0 % NaCl	0.364a	0.344a
10 % NaCl	0.479a	0.544a
20 % NaCl	1.487c	0.618b
30 % NaCl	1.352b	1.123b
40 % NaCl	1.233b,c	0.604a
50 % NaCl	0.620a	0.549a

Means values with different letters (a,b,c) at the horizontal column are significantly different (p<05)

Table 1b: Bacterial populations of leaves and seeds (healthy and unhealthy) of *R. mangle*

Types of sample	Bacterial Counts (cfu/ml) Replicate samples Average			
	I	II	III	IV
Healthy leaves	3.8×10^2	2.4×10^3	2.2×10^4	8.2×10^3
Diseased Leaves	1.34×10^3	4.4×10^3	1.2×10^4	5.91×10^3
Healthy seeds	2.7×10^2	1.6×10^3	2.2×10^4	7.96×10^3
Diseased seeds	1.58×10^3	1.7×10^4	2.1×10^4	1.14×10^4

Table 2: Bacterial types isolated from leaves and seeds (healthy and diseased) of *R. mangle*

Bacterial type	Leaves		Seeds	
	Healthy	Diseased	Healthy	Diseased
Acinetobacter	+	+	-	-
Aerococcus	-	-	-	+
Alcaligenes	+	-	-	-
Bacillus	+	-	+	+
Corynebacterium	+	+	+	+
Flavobacterium	-	-	-	+
Pseudomonas	-	-	-	+
Staphylococcus	-	-	-	+
Streptomyces	-	+	+	+

+ = Bacterial type isolated, - = Bacterial type not isolated

Table 3: Percentage frequency of bacteria isolated from healthy and diseased leaves and seed of *R. mangle*

Bacteria type	Frequency	%Frequency
Acinetobacter	2	7.69
Aerococcus	1	3.84
Alcaligenes	1	3.84
Bacillus	5	19.23
Corynebacterium	9	34.61
Flavobacterium	1	3.84
Pseudomonas	1	3.84
Staphylococcus	2	7.69
Streptomyces	4	15.38

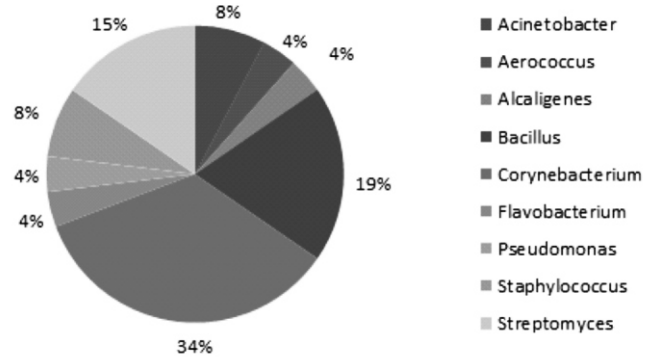

Figure 1: Percentage frequency of bacteria isolated from healthy and diseased leaves and seed of *R. mangle*

Table 4: Fungi isolated from mangrove forest trees at creek road waterside, Port Harcourt

Plant Type	Organism	Plant parts where fungi were recovered							
		Diseased Plant Parts				Healthy Plant Parts			
		SMS	LVS	SDS	FLS	SMS	LVS	SDS	FLS
R. mangle	*Pestalotia dichaeta*	X	X	X					
	Fusarium sp					X	X		
	A. niger					X	X		
	Linderina sp	X				X			
R. harrisonii	*Pestalotia sp*	X							
A. Africana	*Fusarium sp*	X		X					
	Penicillium sp					X	X		
	Linderina sp	X	X	X		X			
	P. dichaeta	X							
	F. monilifomre	X			X				
	Phomopsis sp	X	X	X					

SMS–Stems; LVS–Leaves; SDS–Seeds; FLS – Flowers; x - presence

Table 6: Effect of Temperature on the Growth of Fungi (cm)

Temp (°C)	*F. moniliforme*	*Phomopsis sp*	*Rhizopus sp*	*B. theobromae*	*F. solani*	*Pestalotia sp*
10	-	-	-	-	-	-
20	1.3	1.8	1.7	2.1	0.8	1.5
30	3.5	4.1	3.6	3.8	1.8	2.9
40	-	-	-	-	-	-
50		-	-		-	-

10.2. Effects of pH, and sodium chloride on fungi isolated from the mangrove forest

Laboratory studies were conducted to determine the effects of pH and sodium chloride (NaCl) on the growth of *Pestalotia dichaeta* (Speg) Stepart and *Fusarium moniliforme* Sheldon isolated from *Rhizophora mangle, Rhizophora harrisonnii* and *Avicennia africana* in Port Harcourt, Nigeria. The results obtained showed that the pH range for the growth of *P. dichaeta* was pH 4.0 (with mycelial dry weight of 0.927g). The least growth was in pH 3.0 (0.121g), while the best range for the growth of *F. moniliforme* was pH 8.0 (mycelia dry weight 1.363g) and the least pH which enhanced growth of the fungus was pH 3.0 (mycelia dry weight 0.050g) (Table 7). The best sodium chloride (NaCl) concentration that increased the growth of *P. dichaeta* was 20%NaCl (mycelia dry weight 1.482g) and the least growth was obtained in 0%NaCl (mycelia dry weight 0.344g) (Tables 8). These results were significant at ($P<0.05$). Related studies were conducted on fungi isolated from mangrove soil. fungi which grew on petroleum hydrocarbon were: *A. niger, A. flavus, Thielaviopsis basicola, Penicillium* sp and *Fusarium sp*. Similar

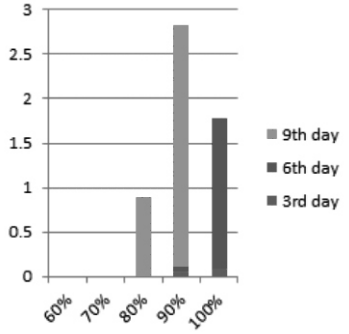

Fig 4a: Effect of RH on growth of *R.sexualis*

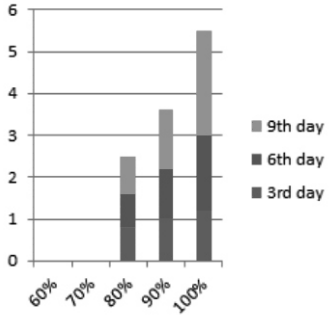

Fig 4b: Effect of RH on growth of *B.theobromae*

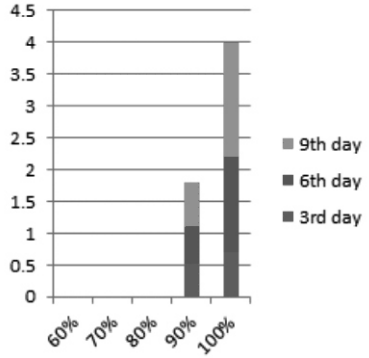

Fig 5: Effect of RH on growth of *C.gleosporioides*

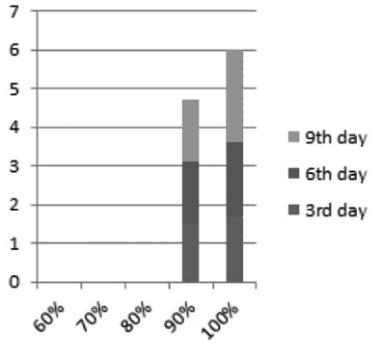

Fig 6:Effect of RH on growth of *F. solani*

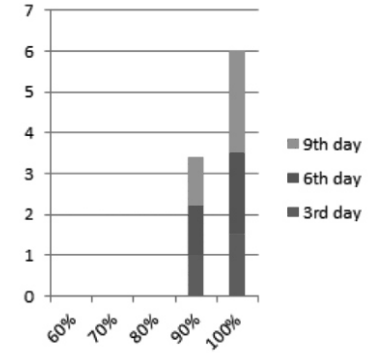

Fig 7:Effect of RH on growth of *Pestalotia sp*

Table 5: Fungi isolated from mangrove forest trees at Eagle Island waterside, Port Harcourt

Plant Type	Organism isolated	Plant parts where fungi were recovered							
		Diseased Plant Parts				Healthy Plant Parts			
		SMS	LVS	SDS	FLS	SMS	LVS	SDS	FLS
R. racemosa	*C. gloesporoides*				X				
	B. theobromae					X			
	R. stolonifer					X			
	Phomopsis sp						X	X	
	P. dichaeta	X	X						
	Penicilium sp					X		X	X
R. mangle	*Pestalotia dichaeta*	X	X						
	B. theobromae	X				X		X	
	Aspergillus sp							X	
R. harrisonii	*Penicilium sp*							X	
	B. theobromae	X						X	
A. Africana	*B. theobromae*			X		X			
	R. stolonifer							X	
	F. solani				X				

SMS – stem; LVS; SDS; FLS - Flowers

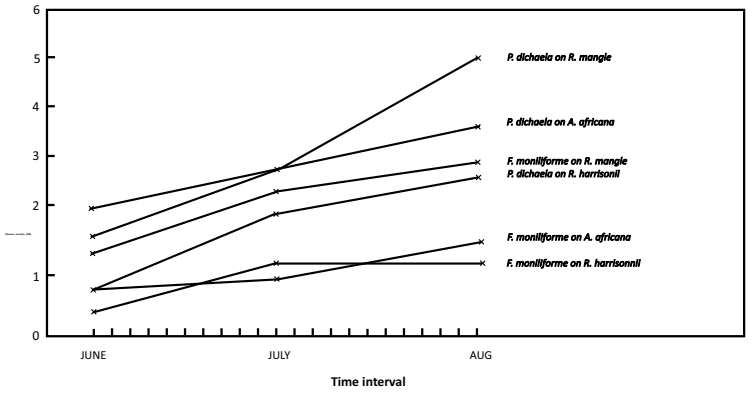

Fig 2: Disease severity on some mangrove plants in the screen house

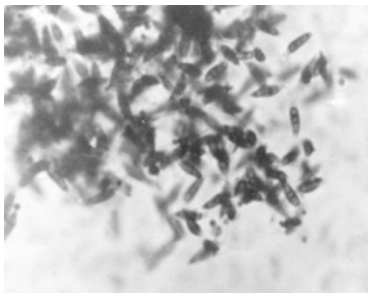

Plate 16: *Pestalotia dichaeta* from mangrove phylloplane

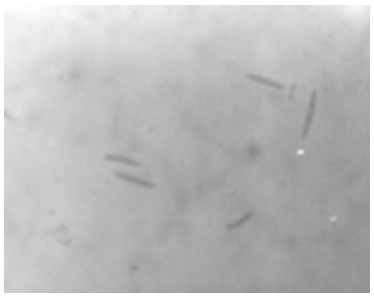

Plate 17*: Fusarium sp* from mangrove phylloplane

10.0. MICROBIAL PHYSIOLOGY OF THE MANGROVE FOREST IN RIVERS STATE

Microbial physiology is concerned with the study of the interaction between an organism and its environment and more particularly with attempts to bring to limelight the relationship between metabolic potentials and changes in the environment in which the organism exists, either in a growing or non-growing state. Its role in biotechnology involves the ability of microorganisms to control their cell structure, chemistry and functions. The phenotypic and genotypic characteristics of microbes are important in disease management. The under listed studies were undertaken to elucidate the physiological components of microbes in the mangrove ecosystem for easy application in biotechnological studies.

10.1. Studies on effects of relative humidity and temperature on fungi isolated from the mangrove forest

Ukoima and Umechuruba (2009e) investigated the effect of relative humidity and temperature on fungi isolated from marine habitats in Port Harcourt. In vitro studies involving relative humidity of 60%, 70%, 80%, 90% and 100% as well as

temperature range of 10°C, 20°C and 50°C were tested on the growth rate of some fungi isolated from marine creeks. The fungi tested were: *Fusarium moniliforme*, *Colletotrichum gloesporoides, Pestalotia spp.*, *Botrydipladia theobromae, Fusarium solani, Phomopsis sp* and *Rhizopus sexualis*. The results showed that all the fungi grew very well at 90% and 100% relative humidity. None of the fungi grew at 60%, 70% and 80% except *B. theobromae*, which showed slight growth at 80% relative humidity (Figures 3a, b & 7). The implication is that these organisms function in high relative humidity. Also, all the fungi grew at 20°C and 30°C with best growth at 30°C. None of the fungi grew at 10°C and 40°C. This is an indication that most fungi found in the mangrove forest of Port Harcourt are psychrophiles (12 – 20 °C) and mesophiles (14 - 45 °C). These results were highly significant at $P < 0.05$. (Table 6).

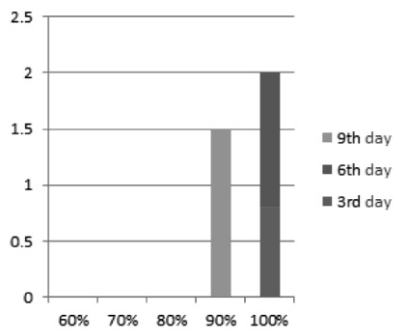

Fig 3a*:* Effect of RH on growth of *F.moniliforme*

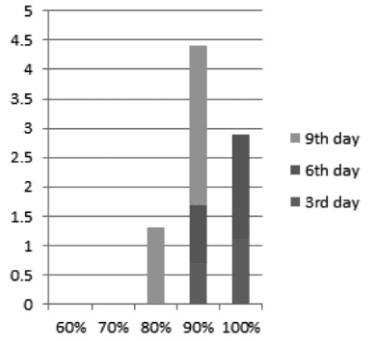

Fig 3b:Effect of RH on growth of *Phomopsis sp*