The Significance of Palynology In Socio-Economic Development of in Nigeria.

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ABSTRACT

Palynology has become a well-established research tool leading to enormous breakthroughs in the world of science. As a result, Palynology has integrated perfectly into multidisciplinary programmes, such as Melissopalynology, Aeropalynology, Forensic palynology, Agricultural palynology, Fossil palynology, Morphorgraphic palynology (pollen morphology, pollen productivity), Latropalynology, Palaeopalynology including many other areas. Through these multidisciplinary programmes, Palynology has found various applications in Archaeology, Geology, Criminology (Forensic science), Allergology in medicine, Plant taxonomy, Stratigraphy, Paleoecology, Paleobotany and Petroleum industry. The term palynomorph includes both pollen of spermatophytes, spores of fungi, ferns, and bryophytes, as well as other organic-walled microfossils such as dinoflagellates and acritarchs. Pollen grains can be studied for comparative morphological data, clues to unexpected aspects relating to breeding systems, pollination biology and hybridization. This can bring about a better understanding of the whole biology of the group under investigation. Forensic palynology deals with the use of pollen and spores in disproving or proving relationships between people, crime scenes and objects so as to resolve civil or criminal cases. In recent petroleum researches, palynology has become an important tool in resolving many age and facies correlation problems. Palynologists are evolutionarily oriented botanists working ultra-structurally, especially those routinely using Transmission Electron Microscopy (TEM). They are perfectly trained, highly experienced scientists who regularly bring solutions to socio-economic problems. It is in view of this that we present an overview of the various contributions and the significance of palynology, and how it could be further harnessed in bringing about socio-economic development in Nigeria.

Keywords: Melissopalynology, Aeropalynology, Archaeology, Allergology, Paleobotany.

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1. INTRODUCTION

Palynology is the study of microscopic bodies generally known as palynomorphs; pollen and spores and certain other microscopic sized structures, either of plant or of uncertain origin. These other structures include acritarchs, dinoflagellates and their cysts (dinocysts), and algal and fungal spores. The diameters of palynomorphs fall within the range of 5µm-500µm. Thus, "Palynology" can also be defined as the study of organic-walled microfossils (Erdtman, 1969). The term "Palynology" was coined by Hyde and William (1944) and since then, it has become a new sub-division of Botanical science with different applications. At the beginning, Palynology was confined to the morphology of pollen and spore alone. Most people think of pollen only in terms of hay-fever allergies and human health, but its story is really much more interesting. Pollen is the male gametophyte or the microgametophytes of seed plants that produces the male gametes.

Many gymnosperms (e.g., conifers) produce pollen with bilateral air bladders that help during airborne transport of the pollen. Some pollen produced by angiosperms (flowering plants) has characteristic hook-like structures on the exine wall that allows it to become attached to the legs of insect pollinators. Spore is usually a haploid and unicellular structure, which is a unit of sexual or asexual reproduction, produced by seedless plants during meiosis in the sporangium of a diploid sporophyte (Erdtman, 1971). Hence, spores and pollen grains are reproductive propagules and play a paramount role in the life history of land plants. In nonseed plants; ferns, the sporophyte generation produces single-celled spores that give rise to the haploid gametophyte generation. A single type of spore is produced in homosporous plants, whereas two spore types are produced in heterosporous plants. The microspores develop by meiotic division to form microgametophytes, and the megaspores also undergo meiotic division to form the megagametophytes. The gametophytes of most nonseed plants are multicellular and proliferate outside the spore wall during development.

By comparison, all seed plants (gymnosperms and angiosperms) are heterosporous, and pollen represents the microgametophyte. Pollen grains consist of only three to several cells, and these remain contained within the microspore wall, within which they have developed (Osborn, 1997). The study of pollen grain in the light of modern science starts in the 19th century, and as of today, the studies of pollen and spores occupy a focal point due to the fact that unique "morphoform" of their structures have been the fundamental factor that served to shape and widen the scope of Palynology. Erdtman and Gunnar (1921), described pollen as a tool for study of the Quaternary vegetation and climate change. The name 'palynogram' was introduced by Erdtman (1951, 1952) to describe a standardized illustration of the morphology of a pollen grain or spore. Additional insight may be obtained into evolution, from the aspect relating to morphological data of fossil pollen and the fossil record. Analysis of fossil pollen grains is the most important approach to reconstruction of past flora, vegetation and environment (Faegri and Iversen, 1989). Palynology is divided into two broad fields, Paleopalynology and Neopalynology. Paleopalynology deals with the study of palynomorphs (including micro fossils) found in the past environment, while Neopalynology is concerned with extant palynomorphs (including the extant pollen). Palynology is becoming increasingly important in basin analysis worldwide.

Within the past quarter century palynology has become an increasingly important component of archaeological research. Applications have included elucidation of site and room functions, ceremonial and medicinal practices, prehistoric diet and food preparation, correlative construction and chronologies, human modification of the local environment and the nature, magnitude and duration of climatic perturbations, particularly as related to human demography and subsistence strategies (Hevly, 1981).

1.1 Socio-economic Development

Socio-economic development is the relationship between economic activity and social life. The process of social and economic development in a society depends largely on the continuous improvement in the wellbeing and in the standard of living of the people. Everyone agrees that development is necessary, and everyone wants it, for instance; Academicians, politicians and economics all agree that development improves the standard of living people. Development is a process of qualitative change and quantitative growth of the social and economic reality which we can call either society or economy (Jan Drewnowski, 1966). Socio-economic development is Socio-economic thematic area aims to ensure that Africans meet their basic needs that are essential to live a life of dignity. This includes access to quality education, better healthcare, decent housing, safe drinking water and good sanitation, as well as equitable distribution of a nation's wealth. Socio-economic development is measured with indicators such as Gross domestic products (GDP), life expectancy, literacy and levels of employment. Mabogunje (1980) stated that there are four main ways in which the term development has been used: development as economic growth, as modernization, as distributional justice and as socio-economic transformation. Changes in less-tangible factors such as personal safety and freedom from fear of physical harm, and the extent of participation in civil society will also boost socio-economic development in our societies. Hence, new technologies, changes in laws, changes in the physical environment and ecological changes are some of the causes of socio-economic imparts.

1.2 Current State of the Nigerian economy

Vanguard newspaper on 8 May, 2017, described the state of the Nigerian economy at half way marked. From the recent data, it could be observed that the Nigerian economy is weak and very sick. Of course, the cause of this has been attributed to corruption, mismanagement and misappropriation of funds, but truth still remains that Nigeria has been a mono-economic country; more than ninety percent of the nations' gross income is from the oil sector. Nigeria as at present is still being involved in hitherto virtually a mono-economy. The oil sector (oil and gas) provided up to 95% of Nigeria's foreign exchange earnings and 80% of its budgetary revenues.

Due to fall in price of oil in the world market, Nigeria is now experiencing **Economic recession** (Sowunmi, a public lecture, 2016). **Economic recession**: "... slowdown in **economic** activity over the course of a normal business cycle." (Wikipedia); **Economic depression**: "sustained, long-term downturn in *economic* activity ...more severe downturn than an *economic* recession..." (Wikipedia). Now, can we continue to look on while the state of the economy of our "**Dear Nation....NIGERIA**" crashes and pretend that all is well?

1.3 Solutions to this problem

This had always been a major discussion even during the regime of President Goodluck Jonathan, and yet little or no serious effort has been made to avert the situation. President Muhammadu Buhari even promised to change the state of the Nigerian economy, its three years now, promises of change still lies in the air, thus becoming a mirage. But I believe we can always swing into action if we wish to. There must be a shift in Nigerian economy from mono-economy to multi-economic system. Thus, need for diversification of the economy. Diversifying of economy alert sounded as far back as 1975; unheeded until it became imperative now. Essence of diversifying: decrease importation, boost exportation; be self-reliant in what is consumed; increase industries. Result: reduction in level of unemployment; socio-economic development; and enhanced quality of life for average citizen (Sowunmi, 2016). Now, why is **Palynology** significant in socio-economic development?

2. HISTORY OF PALYNOLOGY IN NIGERIA

Palynology began in Nigeria in the 1960s when Sowunmi started pioneering the Paleo-ethnobotanical and environmental archaeological studies in Nigeria. She set up the first Palynology Laboratory in 1968 at the Archaeology Unit of African Studies (now Department of Archaeology and Arthropology). Today the laboratory has over 3000 references pollen slides of present-day Nigerian and other West African plants (Oyelaran *et al.*, 2016). Since then a lot of work has been done in Palynology, particularly the study and the reconstruction of the past vegetation of our environment in Nigeria.

Sowunmi (1973) conducted the first Palynological studies when she described the pollen grains of 150 Nigerian woody plants, comprising over 60% of the recognised climatic indicator species of the forest, i.e. primary and secondary rain forests, and swamp forests, and savanna, i.e. derived forest in the Guinea and Sahel zones, these being the major vegetation zones in Nigeria. Her work was publish in *Grana* 13: 145-186, 1973. The paper is the first in a series on the pollen flora of Nigeria. The plants includes; *Lannea microcarpa*, *Mangifera indica* which are of the family Anacardiaceae, *Dracaena arborea* of the family Agaceae, *Annona senegalensis* of the family Annonaceae and others. She compared her findings with those of earlier investigators and she concluded that Intra-specific variations were observed among the morphological structures of the pollen grains and could be used to provide additional characters for use in plant taxonomy. She stated that the pollen could serve as a reference material for pollen analysis of Quaternary deposits.

Sowunmi (1976) continued her laudable contributions to Palynology when she pioneered the analysis of honey pollen from the forest and savanna zones of Nigeria (Melissopalynological investigation). She conducted the pollen analyses of eight honey samples collected from the Guinea savanna, derived savanna, and the dry lowland rain forest. From the study, Sowunmi was able to ascertain the botanical and the geographical origins of some Nigerian honey samples, alongside with the ecology of the area concerned.
Agwu and Akanbi (1985), as results of their research on Palynological analysis of honey samples, warned that the unscientific and traditional agricultural practices are threatening the flora of several parts of Nigeria with increased uncontrolled and indiscriminate destruction. They gave the warning because they were able to ascertain that the vegetation serves as the source of honey.

Njokuocha (2006) published a work on the presence of airborne pollen grains in Nsukka, Nigeria, from the research he had carried out at two different sampling heights (1.8 m and 15 m) from February 1993 to January 1994. He stated that twenty-six plant families (40 genera) were identified at the lower sampling height, while thirty-eight families (58 genera) were identified at the height of 15 m. it observed from the results that in Nsukka (1) there are differences in the pollen concentration at various source heights; (2) there are three periods of varying pollen abundance, and (3) the period of highest pollen concentration is the late rainy – early dry season/Harmattan (September to December), while the low pollen season is during the rainy period (May to August) (Njokuocha, 2006).

Mbah and Amao (2009) carried out a research on the natural foods and feeding habits of the African honey bee *Apis mellifera adansonii* Latrielle, in Zaria, northern Nigeria. They observed and collected 28 plant species visited by the honeybee *Apis mellifera adansonii* Latrielle, using secateurs and plant presses to cut and preserve the specimens, respectively. They also used digital camera to photograph the honeybees on flowers. The plants includes; *Bauhinia grandifolia*, *Acacia ataxacantha*, *Crotolaria falcate*, *Cosmos sulphurens*, *Parkia biglobosa*, *Guiera senegalensis*, *Sida acuta*, *Tridax procumbens*, *Musa sapientum*, and so on. The plants were categorized into 15 families, including; Leguminosae, Asteraceae, Malvaceae, Combretaceae, Mimosaceae, Rutaceae, Musaceae, Portulaceae, Labiatae, Apocynaceae, Acanthaceae, Caesalpiniaceae, Verbanaceae, and Curcubitaceae. They were able to conclude thatthe categorisation of the plants into 15 families indicates the diverse nature of the natural food sources of these insects (Mbah and Amao, 2009).

Adeonipekun and John (2011) carried out a Palynological investigation of haze dust in Ayetoro-Itele Ota, Southwest Nigeria. The researchers decided to verify the biological contents of the March 2010 hazy dust in Nigeria as a result of the attendant panic it brought to the public. They made use of 3 g of dust deposited on the car bonnet of one of one of them, which was treated chemo-palynologically. The microscopic study of the residue was carried out. It was revealed from their study that the dust was rich in pollen grains, fungal spores and hyphae. There was no record of pteridophyte spore. However, there was record of high proportion of diatoms almost doubling that of the sporomorphs. They concluded that the hazy dust studied contains high proportions of palynomorphs from the Sudan/Guinea and derived savannas as well as lowland rainforest ecozones. Hence, Savanna and derived savanna pollen grains and the Sahara desert freshwater diatoms recovered indicate that the dust was still the harmattan borne by the Northeast Trade winds though coming heavily and lately in March instead of the traditional January (Adeonipekun and John, 2011).

Mbagwu *et al.* (2009) conducted Palynological studies on five species of the family Asteraceae namely *Guternbergia nigritiana*, *Emilia praetemissa*, *Vernonia guineensis*, *Lagera pterodonta* and *Chromolena odorata* was carried out. Results obtained from their investigation showed that the pollen shape is spheroidal in *G. nigritiana*, *E. praetermissa* and *C. odorata* while it is elliptic in *V. guineensis* and *L. pterodonta*. The pollen aperture was found to be porate in all except in *L. pterodonta* where it is elliptic. The pollen wall is echinate in all except in *C.odorata* where it is smooth. They also concluded that the differences and similarities in pollen morphology of the investigated species are significant and could be exploited for biosystematics purposes.

Hence, applying these variations in pollen morphology to the species investigated showed that species in the family with similar pollen characters are more closely related and thus exhibit interspecies relationships suggesting reasons for them to be in the same family while those with different pollen characters are not very closely related and suggest reasons for them to be as distinct species (Mbagwu *et al.*, 2009).

Adebayo *et al.* (2012), conducted a research on the Palynology of Bog-1 Well, Southeastern Niger Delta Basin, Nigeria. They assigned a Late Oligocene-Mid Miocene age to the miospores recovered from the sediments of a section of Bog-1 well in the Niger Delta Basin are, based on the co-occurrence of pantropical stratigraphic markers such as *Zonocostites ramonae*, *Retimonocolpites pluribaculatus*, *Retibrevitricolporites protrudens*, *Psilatricolporites crassus*, *Circatricosisporites dorogensis*, *Retitricolporites irregularis*, *Racemonocolpites hians*, *Pachydermites diederixi*, *Brevicolpororites guinetii* and *Proxapertites cursus*. Moreover, the palynological assemblage was dominated by pollen and spores and a total of 119 palynomorphs were identified out of 152 encountered. Species diversity of above 30 was regarded as rich while that of 30 and below was regarded being poor. There was a general occurrence of high species diversity, except at a few levels. They concluded that the diversity of the angiosperm palynoflora, which forms the bulk of the assemblage, suggests a dense lowland vegetation cover during the deposition of the studied sediments in a tidal swamp mangrove (Adebayo *et al.*, 2012).

Chiaghanam *et al.* (2013) described the Palynology and Paleoenvironmental Study of Early Campanian to Mid-Maastrichtian Deposits of Udi and Environs in the Anambra Basin, South Eastern Nigeria. They made use of the Palynological assemblages, lithofacies and facies association to determine the age and paleoenvironment of the Enugu and Mamu Formations of Udi area of the Anambra Basin, South east Nigeria. Palynological analysis were carried out in over twenty samples which yielded spores and pollen grains alongside with marine Dinoflagelates that are of Early Campanian to Maastrichtian for Enugu shale and middle Maastrichtian for Mamu Formation. According to Chiaghanam *et al.* (2013), the main diagnostic species of spores and pollen recovered includes; *Laevigatosporites ovatus, Leiotriletes adriennis, Echitriporites trianguliformis, Longapertites marginatus and Cyathidites minor*. Among the main diagnostic dinoflagellates are *Operculodinium centrocarpum, Areoligera senoniensis, Spiniferites ramosus, Ceratiopsis spp., Paleocystodinium spp., Dinogymnium accuminatum, Spinferites ramosus and Cordosphaeridium inorders*.

Moreover, they concluded that the Palynological analysis and lithofacies association which was used to determine the age and paleoenvironment of the studied are indicate of a deltaic sedimentation in an Anambra basin of a Campanian maastrichtian sedimentary unit that are characterized with transgressive and regressive events as reflected the Abundance and diversity of Palyonomorph and dinoflagellates that was recorded. The palynomorphs and dinoflagellates distribution in the unit shows that Enugu Shales was deposited in a deeper marine environment than the Mamu Formation and it is an indicative of a drop in sea level, possible saline water and fluvial processes (fresh-water) in a fresh water swamp/upper deltaic plain (Chiaghanam *et al.*, 2013).

Subsequently, Paul *et al.* (2014) described the comparative study of the pollen morphology of some members of Euphorbiaceae family. From their studies, they concluded that most pollen grains of Euphorbiaceae family are isopolar and radially symmetrical. Moreover, the variations and similarities in pollen morphological characters within the genera and species are enough to confirm and throw more light on its taxonomic classifications. They made a recommendation that the studies will be useful for identifying the flora and improve the conservation status of economically important plants as well as acting as a reference guide in identifying various species in their respective families (Paul *et al.*, 2014).

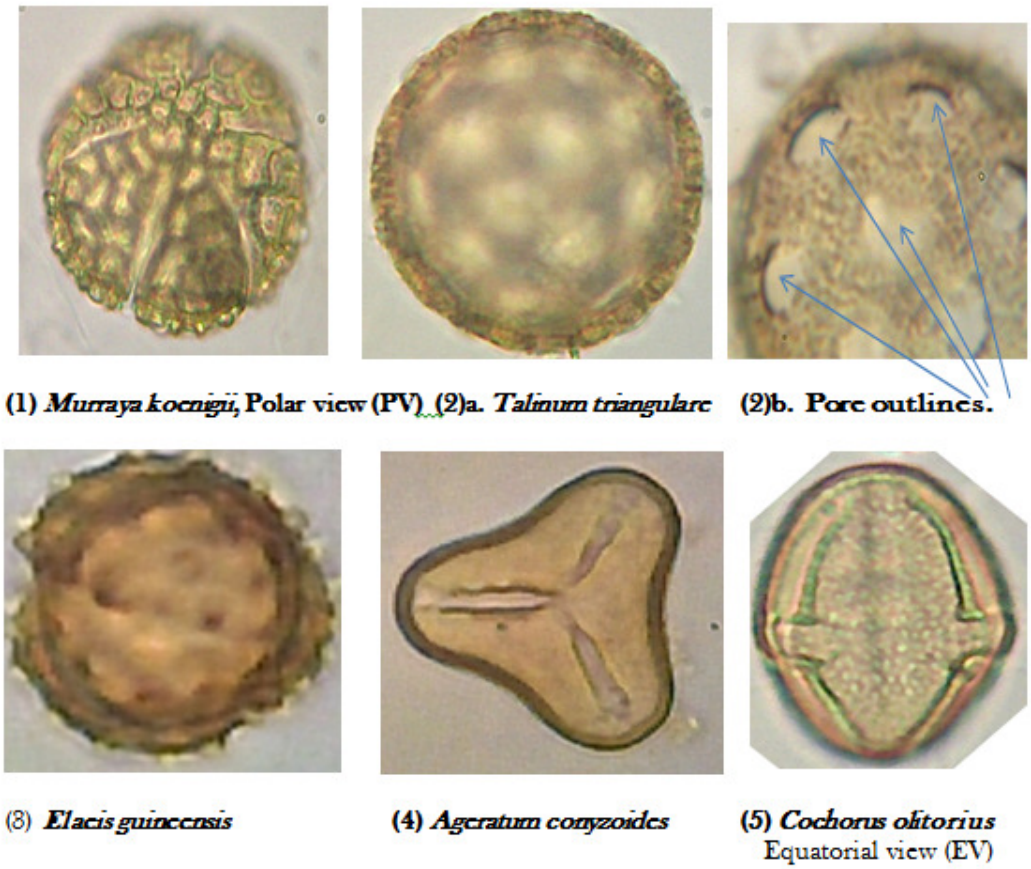

Fig. 1 to 5: Photomicrographs of the pollen grains of some Nigerian plants.

3. BRANCHES OF PALYNOLOGY

3.1 Forensic palynology

Forensic palynology is the application of palynomorph analysis to the law. This activity introduces the science of forensic palynology: the use of microscopic pollen and spores (also called palynomorphs) to solve criminal cases. Pollen and spores are ideal forensic trace materials because the grains are small, highly variable, and found on almost any item that has been exposed to or comes in contact with the air (Milne *et al.*, 2005). There is always transfer of pollen and spores between people, plants, and objects or there may be a combination of contact between these things.

Pollen can be isolated from most items typically submitted for forensic examination. These include: Soil, clothing and fabrics, ropes and twines, air filters, drugs, plant material, and human and animal material, such as hair, fur, and stomach contents (Horrocks 2004; Milne *et al.* 2005). Scientists make use a digital pollen database and Google Earth to link pollen trace evidence to a specific crime scene. The methods presented are based on those used in criminal cases and palynological techniques used by forensic scientists. Forensic science is appealing to students because of its prominence in popular media. Forensic palynology can harness this excitement and focus student attention on subtle aspects of ecosystems such as the role of pollen and spores in plant propagation (Babcock and Warny, 2014). Published case histories of forensic palynology demonstrate its use in crimes such as rape, homicide, genocide, terrorism, drug dealing, robbery, and others (Milne, Bryant, and Mildenhall 2004).

3.2 Aeropalynology

This is the branch of palynology that deals with the study of palynomorphs suspended in the air including those with allergenic effects "hay fever". It is the study of pollen grains and spores that are dispersed into the atmosphere. Studies have shown differences in the pollen concentration at various heights and seasons. Wind-pollinated plants are known to typically produce copious amounts of pollen. The abundance of the pollen in the air help in enhancing successful pollinations. Daily observations of the airborne pollen indicate that pollen grains and fern spores are suspended in air turbulence. They are transported over varied distances away from their sources to other areas of the same or different ecological characteristics (Bringfelt *et al.*, 1982).

Pollen abundance or concentration has always been lower at wet or rainy seasons and higher at dry season or Harmattan (Njokuocha, 2007). For different plants, flowering time and season vary widely, and the release of airborne pollen is typically inhibited by high humidity or rain. Moreover, the abundance of airborne pollen commonly causes allergic reactions in a large proportion of the human population, for example, Pollinosis, Allergin Rhinitis, or Hay fever, which is elicited when allergen-containing pollen makes contact with the mucous membranes lining the nose, trachea, or bronchi and the cornea of the eye. Allergens leach out of the pollen and bind to immunoglobulin E antibodies. The antibodies are linked to mast cells that release histamine and other inflammatory chemicals, producing allergy symptoms. Ironically, the allergens that induce pollinosis include many of the same compatibility-incompatibility, recognition proteins involved in pollination (Osborn, 1997).

In understanding and avoiding hay fever, knowledge of the temporal, seasonal, and environmental aspects of pollen dispersal is also important, and more also, to monitor the risks of pollinosis, the diversity and quantity of various pollen types are assessed by filtering the air throughout the year.

4. APPLICATIONS

4.1 Application in Medicine and Aeropalynology

As stated earlier, the biological contents of the March 2010 hazy dust in Nigeria deserve verification due to the attendant panic it brought to the public (Adeonipekun and John, 2011). Allergenic pollen produce certain chemicals, most important are histamines. Symptoms of pollinosis include: sneezing, conjunctivitis, pneumonia, trachea-bronchitis, sinuses, possibly also migraine headache, uterine pain, dermatitis (small reddish swellings on skin). Possible "culprits" like Zea *mays*, fungal spores e.g. *Cladosporium* sp. Treatment of pollinosis: anti-histamine, susceptible persons keep indoors. Health-promoting pollen tablets because nutritive value, esp. proteins, mineral salts. Pharmaceutical palynology; manufacturing of pollen tablets.

4.2 The role of pollen morphology in plant systematics

Pollen morphology is an expression of part of the genome and like any character be it cryptic or macromorphological it may be useful in some groups for taxonomic studies and less valuable in others (Ferguson, 1985). Comparative pollen morphology has been studied for about 150 years beginning with workers like Mohl (1835) and Hassell (1842). Erdtman (1952) provided the work which is rightly regarded as the corner stone of modern comparative pollen morphology. His work centred around the study of the acid resistant sporopollenin exine. The shape, size, apertures, ornamentation and the stratification of the wall are the characters which proved so useful in distinguishing pollen grains of different species, genera, tribes, families and orders. Pollen morphology is also important in understanding the functional aspects of pollen such as pollination biology and pollen- pistil interaction. In Nigeria, not much work have been done on pollen morphology.

4.3. Application of Palynology in stratigraphy (stratigraphy palynology)

Stratigraphic Palynology is a branch of biostratigraphy that deals with applying geological and evolutionary principals to the understanding of sedimentary sequences and the geological record. The use of Palynomorphs, their identification, distribution, and abundance to correlate among sedimentary sequences of any age, or to provide chronological control for these sedimentary sequences. Typically, stratigraphic palynology is applied to pre-Quaternary sediments but also to sediments of all ages. Stratigraphic Palynology played a prominent role in petroleum exploration during the mid-twentieth century. The available palynological information indicates that it is an extremely significant parameter for generating new geological models and refining hydrocarbon (oil and gas) exploration researches (Mehrotra *et al.*, 2012). From 1965 - 1980 the major North-American petroleum companies hosted large palynology laboratories. The ubiquity of palynomorphs permitted the detailed analysis of subsurface stratigraphy necessary for locating petroleum reservoirs. Analysis of fossil pollen grains is the most important approach to reconstruction of past flora, vegetation and environment (Faegri and Iversen, 1989).

4.4 Application in apiculture (bee-keeping); Melissopalynology

Melissopalynology is a branch of palynology that deals with the study of pollen grains, spores and other microscopic objects contained in honey samples. The term "melissopalynology" was coined from the specific name of honey bees, "*Apis mellifera*", and "palynology". Honey is a viscous, sticky and sweet liquid made from several sweet plant juices, mainly nectar and opened, ripe fruits, as well as honey dew (Crane, 1975). Melissopalynology in Nigeria, also began in 1976 at the Palynology Unit of the Department of Archaeology and Anthropology, University of Ibadan, when Sowunmi carried out the first melissopalynological investigation (Sowunmi, 1976). The melissopalynological analysis helps in determining the botanical and geographical origins of honey samples and ascertaining purity of sample and authenticity of provenance as claimed by marketer.

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