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**GEY 402- Micropaleontology and Paleoecology**

**1. Morphological classification of pollens and spores**

**Morphological classification of pollens**

The pollen grains are produced within the anther of the flower. Pollen mother cells originate from the sporogenous tissue of the anther which later divide meiotically to form four pollen grains called tetrad.

The pollen grains do not remain united at maturity, and are dissociated into single pollen grain called monad. Sometimes rarer types like dyads (two pollen grains), Octads (eight pollen grains) and Polyads (many pollen grains) are also observed

Dyads:

Pollen grains which are united in pairs and shed from the anthers as doubles are called dyads. Dyads are present in Scheuchzeria palustris and other members of Podostemonaceae. The dyads are formed due to the incomplete break up of individual grain or monad.

Tetrads:

Four pollen grains are united to form tetrad. Tetrads are the unseparated product of meiosis. Tetrads maybe categorized into different types based on their arrangement.

Tetrahedral tetrad:

Pollen grains are arranged in two different planes. Three grains are in one plane and one lies centrally over the other three. In some cases, the pollen grains are released from the anther in the tetrad condition. These types of tetrads are called obligate or permanent tetrads, viz., Drymis (Winteraceae), Drosera (Droseraceae), Rhododendron Ericaceae).

# Tetragonal tetrad:

All the four pollen grains are arranged in one plane e.g., Typha latifolia (Typhaceae), Hedycaria arborea (Monimiaceae).

# Rhomboidal tetrad:

All pollen grains are arranged in one plane forming rhomboidal shape e.g., Annona muricata (Annonaceae).

# Decussate tetrad:

Pair-wise the pollen grains are at right angle to each other, e.g., Magnolia grandiflora (Magnoliaceae).

# T-Shaped tetrad:

The first division of pollen mother cell is transverse to form a dyad. The upper or lower cell of dyad undergoes a vertical or longitudinal division instead of transverse, yielding either straight or inverted T-shaped configuration, e.g., Aristolochia sp.(Aristolochiaceae), Polyanthes sp; (Amaryllidaceae).

# Linear tetrad:

The first division of pollen mother cell is transverse and a dyad is formed. Each cell of the dyad again divides transversely to form a linear tetrad, e.g., Mimosa pudica.

# Cryptotetrad or Pseudomonad:

Here tetrads are formed without partition walls between the four compartments. One out of the four nuclei develops normally and the rest three obliterate. Thus an apparent monad but homologous to the tetrad is formed e.g., Cyperaceae.

# Polyads:

In most of the Mimosaceae members each of the tetrad cells divides once or twice or more, yielding a group of 8 to 64 cells which remain together after maturity. These compound grains are usually held together in small units and are called polyads e.g., Acacia auriculiformis, Adenanthera pavonina, Calliandra hematocephalla, Samania saman, Albizzia lebbeck.

# Pollinia:

In Orchidaceae and Asclepiadaceae the whole contents of an anther or anther locule which shed as one united mass of pollen are called Pollinia .The pollinium (singular) apparatus is the functional unit of a “corpusculum” with its two attached arms (translator) and Pollinia. e.g., Calotropis sp., Daemia sp., etc., of the Asclepiadaceae and majority of the family Orchidaceae.

**Morphological classification of spores**

Spores are often classified by the structure in which meiosis and spore production occurs. Since fungi are often classified according to their spore-producing structures, these spores are often characteristic of a particular taxon of the fungi.

• Sporangiospores: spores produced by a sporangium in many fungi such as zygomycetes.

• Zygospores: spores produced by a zygosporangium, characteristic of zygomycetes.

• Ascospores: spores produced by an ascus, characteristic of ascomycetes.

• Basidiospores: spores produced by a basidium, characteristic of basidiomycetes.

• Aeciospores: spores produced by an aecium in some fungi such as rusts or smuts.

• Urediniospores: spores produced by a uredinium in some fungi such as rusts or smuts.

• Teliospores: spores produced by a telium in some fungi such as rusts or smuts.

• Oospores: spores produced by an oogonium, characteristic of oomycetes.

Red algae

• Carpospores: spores produced by a carposporophyte, characteristic of red algae.

• Tetraspores: spores produced by a tetrasporophyte, characteristic of red algae.

By function

• Chlamydospores: thick-walled resting spores of fungi produced to survive unfavorable conditions.

• Parasitic fungal spores may be classified into internal spores, which germinate within the host, and external spores, also called environmental spores, released by the host to infest other hosts.

By Origin During Life Cycle

**Meiospores:**

Spores produced by meiosis; they are thus haploid, and give rise to a haploid daughter cell(s) or a haploid individual. Examples are the precursor cells of life wgametophytes of seed plants found in flowers (angiosperms) or cones (gymnosperms), and the zoospores produced from meiosis in the sporophytes of algae such as Ulva.

• Microspores: meiospores that give rise to a male gametophyte, (pollen in seed plants).

• Megaspores (or macrospores): meiospores that give rise to a female gametophyte, (in seed plants the gametophyte forms within the ovule).

• Mitospores (or conidia, conidiospores): spores produced by mitosis; they are characteristic of Ascomycetes. Fungi in which only mitospores are found are called "mitosporic fungi" or "anamorphic fungi"

# By mobility

Spores can be differentiated by whether they can move or not.

• Zoospores: mobile spores that move by means of one or more flagella, and can be found in some algae and fungi.

• Aplanospores: immobile spores that may nevertheless potentially grow flagella.

• Autospores: immobile spores that cannot develop flagella.

• Ballistospores: spores that are forcibly discharged or ejected from the fungal fruiting body as the result of an internal force, such as buildup of pressure. Most basidiospores are also ballistospores, and another notable example is spores of the genus Pilobolus.

* Statismospores: spores that are discharged from the fungal fruiting body as the result of an external force, such as raindrops or a passing animal. Examples are puffballs.

**APPLICATIONS OF POLLENS AND SPORES IN GEOSCIENCES**

1. **Biostratigraphy and geochronology**

Geologists use palynological studies in biostratigraphy to correlate strata and determine the relative age of a given bed, horizon, formation or stratigraphical sequence.

Because the distribution of acritarchs, chitinozoans, dinoflagellate cysts, pollen and spores provides evidence of stratigraphical correlation through biostratigraphy and palaeoenvironmental reconstruction, one common and lucrative application of palynology is in oil and gas exploration.

**2. Paleoecology and climate change**

Palynology can be used to reconstruct past vegetation (land plants) and marine and Freshwater phytoplankton communities, and so infer past environmental (palaeoenvironmental) and palaeoclimatic conditions in an area thousands or millions of years ago, a fundamental part of research into climate change.

**3. Organic palynofacies studies**

Which examine the preservation of the particulate organic matter and palynomorphs provides information on the depositional environment of sediments and depositional palaeoenvironments of sedimentary rocks.

**4. Geothermal alteration studies**

Examine the colour of palynomorphs extracted from rocks to give the thermal alteration and maturation of sedimentary sequences, which provides estimates of maximum palaeotemperatures.

**5. Limnology studies**

Freshwater palynomorphs and animal and plant fragments, including the prasinophytes and desmids (green algae) can be used to study past lake levels and long term climate change.

**6. Taxonomy and evolutionary studies**

Involving the use of pollen morphological characters as source of taxonomic data to delimit plant species under same family or genus. Pollen apertural status is frequently used for differential sorting or finding similarities between species of the same taxa. This is also called Palynotaxonomy.

**7. Forensic palynology**

The study of pollen and other palynomorphs for evidence at a crime scene.

**8. Allergy studies**

Studies of the geographic distribution and seasonal production of pollen, can help sufferers of allergies such as hay fever.

**9. Melissopalynology**

The study of pollen and spores found in honey.

**10. Archaeological palynology**

Examines human uses of plants in the past. This can help determine seasonality of site occupation, presence or absence of agricultural practices or products, and 'plant-related activity areas' within an archaeological context. Bonfire shelter is one such example of this application.

**Stratigraphical and paleoenvironmental application of spores and pollens**

Palynology in the oil industry is a stratigraphic tool especially useful in the study of rocks deposited in continental, coastal, and shallow-marine settings. Palynological analyses are used mainly for chronostratigraphic correlations, paleoenvironmental studies, and the evaluation of potential source rocks. The integration of palynology with other geoscience disciplines, such as sedimentology, geophysics, geochemistry, and petro physics, is needed for geological modeling and petroleum system studies, which in turn are essential for planning and developing better exploration strategies and for optimizing reservoir exploitation . This also will enhance detection of hydrocarbon accumulation in subtle traps and permit better prediction of the lateral variability in quality of reservoir rock than is achievable only with the classical litho-seismic stratigraphic approach, thereby leading to increased oil reserves. The study of fossil flora record of sedimentary rocks has diverse range of applications in geology including biostratigraphy, geochronology (to correlate strata and determine the relative age of a bed, horizon, formation or stratigraphic sequence), paleoecology and climate change, organic palynofacies studies, geothermal alteration studies (to examine the color of palynomorphs extracted from rocks to give the thermal alteration and maturation of sedimentary sequences) .This is especially true because the floristic component of layered rocks occur in high abundance permitting the use of only little amount of sample and statistical analysis .Although a lot of bio stratigraphic studies have been carried out by several workers in the Niger Delta Basin , the information they provide cannot be extrapolated over a long distance because of the very complex nature of stratigraphic architecture occasioned by the numerous synsedimentary faults which mainly deformed and compartmentalized the stratigraphic interval of interest, the Agbada Formation .Furthermore, the findings of some of these studies are kept private by the oil companies that did the research because of the rules of confidentiality and proprietary nature of basic information thereby causing a lacuna in the bio stratigraphic database of the Niger Delta Basin. It is the aim of this present study therefore to use palynology to establish the age, the paleoclimate and the paleodepositional environment of the stratigraphic interval penetrated by GBO-04 well in the western onshore Niger Delta.

Significance of pollens and spores in sedimentary and petroleum geology

The role of palynology in the exploration for oil is essentially comparable to that of any other branch of paleontology. Advantages and limitations of spores, pollen, algae, miscellaneous protistans of uncertain or known affinity, and other similar-sized microfossils utilized in palynology as stratigraphic and paleoecologic indicators are briefly reviewed. The economic value of this relatively modern scientific field to the petroleum industry may be increased and hastened by avoiding some of the pitfalls which plagued micropaleontology in its earlier years of application. Information should be developed simultaneously on the biology, ecology and stratigraphy of these organisms.

Palynologists now being trained should be encouraged to develop their knowledge of both geologic and biologic fundamentals. Research in this field should be sponsored by industry, as well as by universities and government agencies, in both its own research laboratories and in private or university labs. The areas of this research should include: studies of the distribution and preservation of palynomorphs in modern sediments; relative significance of living assemblages or transported entities to other types of organisms with which they are found; development of methods and programs for mechanical classification of these micro-fossils and analysis, evaluation, storage and retrieval of data concerning them; improvement of techniques for separating these fossils from the rocks; development of environmental information by the study of types and conditions of preservation, origin and significance of reworked fossils, relative percentages of spores and pollen to other organisms, and characteristics of their role in sedimentation