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NAAC ACCREDITED ‘A’ GRADE

Topic:	PALEOBOTANY & PALYNOLOGY
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FOSSILIZATION PROCESS (TAPHONOMY):

THEORIES OF PRESERVATION :

1. **Infiltration theory:**

Infiltration of mineral substance takes place at first which is then followed by precipitation due to interaction ;between soluble mineral salts present in the surrounding water and certain compounds released during partial disintegration of plant cell walls. In this process free carbon is released which reduces the sulphides present in water and leads to formation of carbonates of Ca, Mg , Fe .

2. **Molecule by molecule replacement theory:**

Decomposed material molecules of the plant body are simply replaced by the molecules of mineral substances like lime carbonate , iron pyrites or silica. This theory is not widely accepted.

FACTORS OF FOSSILIZATION:

A. **ENVIRONMENTAL CONDITIONS:**

1. **ANOXIC ENVIRONMENT**: Low O2 concentration repels scavengers. While slowing the rate of bacterial decay.

2. **NO SCAVENGERS OR PREVENTION OF AUTO CATALYTIC ACTIVITY OR MICROBIAL DECOMPOSITION:** As scavengers scatter and destroy remains, stopping fossilization before it starts, so there should be no scavengers or prevention of auto catalytic activity at the field where fossilization takes place.

3. **NO BACTERIA**: bacteria can completely decompose remains, leaving nothing behind to fossilize.

4. **HIGH DECOMPOSITION RATE:** This allows the organism to be buried before scavengers, bacteria, or the environment can take their toll, allowing the fossilization process to begin.

5. **PRESENCE OF SOME KIND OF WATER BODY**: Brackish water , marine or fresh water as it contains particulate matters like sediments , minerals etc that allow fossilization process.

6. **INFILTRATION WITH MINERAL SUBSTANCE OR WITH CHARGED ANTISEPTIC PARTICLES :** Infiltration of mineral substance take place at first which is then followed by precipitation due to interaction ;between soluble mineral salts present in the surrounding water and certain compounds released during partial disintegration of plant cell walls. In this process free carbon is released which reduces the sulphides present in water and leads to formation of carbonates of Ca, Mg , Fe.

7. **PROTECTION AGAINST HIGH WIND VELOCITY**: low wind velocity favours fossilization but high wind velocity becomes a barrier of the fossilization process.

B. ORGANISM FEATURES:

1. **HARD SKELETON**: As soft bodies, decay rapidly (on the order of hours to days) leaving nothing behind.

2. **SIMPLE SKELETON**: As complex, articulated skeletal parts tend to separate, making reconstruction difficult.

3. **HIGH POPULATION NUMBER**: The more organism of a species that exist the greater, the chances that one of them will be fossilized,

4. **BENTHIC INFAUNAL LIFESTYLE**: This means the organism lives in sediment , so it’s already buried.

Modes of Fossil Preservation:

J. M. Schopf (1975) has recognised four distinctly different modes of fossil preservation.

These are:

(a) Cellular permineralization,

(b) Coalified compression,

(c) Authigenic preservation, and

(d) Duripartic preservation.

(a) Cellular Permineralization:

This includes all of the specimens that have previously been called petrifaction fossils. This involves infiltration followed by intracellular and interstitial precipitation of soluble minerals like silicates, carbonates, iron compounds through cell walls. The buried plant part undergoes partial disintegration to release free carbons which interact with the sulphides present in water and lead to the formation of carbonates of Ca, Mg, Fe.

Thus, the soluble minerals like carbonates, silicates etc. are deposited within cell walls through infiltration and precipitation. As mineral deposition continues within plant tissues, water is expelled as a result of compaction of the sediments. This causes the sediments and the buried plant part to solidify, thus completing cellular permineralisation.

Some of the well-known deposits that contain permineralised fossils are Rhynie chert, Gunflint chert, Bitter Spring Formation, petrified forest of Arizona, Deccan Intertrappean bed in India, etc.

Since **cellular permineralization reveals the cellular details of the plant, such as nature of cortical cells, vascular bundle, pit connections, secondary wall thickenings, nature of ray cells etc. — it has served as a tool to unravel the taxonomic dispute**.

(b) Coalified Compression:

Unmineralised parts are deposited in sediment, followed by softening of cell walls and collapse of internal cell spaces. This leads to loss of gas moisture and soluble materials. As a result of pressure exerted by accumulated sediments and water, the residues are altered and consolidated to form a black coaly deposit.

The distortion or compression is directional and only in the vertical plane. The splitting of rocks commonly yields the coalified **compression** on one face and its counterpart i.e. **impression** on the opposite face. On weathering, coaly part is lost or exfoliated, thus an impression may be revealed on the rock.

The extent of compression varies with the degree of hard nature of plant parts. Leaves are commonly retained in their natural form, but cylindrical or rounded organs such as stem, root and seed become dorsiventrally flattened. Most of the fossils recovered as coalified compression are remains of leaves, occasionally stems, roots, flowers, cones and seeds.

Since **a coalified compression reveals leaf form, venation pattern, epidermal characteristics, etc., it has served as a tool in establishing systematic position and affinity of extinct plants.**

(c) Authigenic Preservation or Cementation:

It involves very early cementation in soft sediments by iron and carbonate compounds. The plant material develops an electric charge as soon as it starts to decay. Thus, it attracts oppositely charged ionised particles of sediments. As a result sediments comprising of iron pyrite sphalerite, chalerite, agate, opal, carbonate along with mud and sand accumulate around the plant part.

Later, the sediments become cemented and the plant part is entombed in the sediment. The internal structure is degraded to form a cavity which is completely filled up by the surrounding sediments- After lithification, the external surface of the plant part is preserved as **mold** and the replaced internal structure of the plant part is called a **cast**.

In this process, **the internal cellular details are not preserved**. Lepidodendron stem is a mold, while the pith cast of *Calamites* stem is an example of cast.

(d) Duripartic (Hard Part) Preservation:

Certain hard parts of both plants and animals are resistant to decay and oxidation and also resistant to physical distortion. Preservation of such hard parts without being changed by chemical or physical factors is referred to as duripartic preservation.

Such sites of preservation are abundant in the Phanerozoic epicontinental seas. Skeletal parts of lime-precipitating algae (Dasycladaceae, Characeae), coccoliths, diatom frustules (diatomite) and radiolarian skeletons (radiolarian ooze) are some examples of duripartic preservation.

IMPORTANCE OF FOSSIL STUDY :

Paleontologists learn about how life existed on Earth thousands of years ago by excavating fossils buried deep in the ground and studying them. Fossils — the preserved remains of a once-living plant or animal — offer insight into how the plants, animals, and humans of earlier ages existed. From them, paleontologists can also glean valuable information on how species that exist today survived in eras long past.

Importance of fossil study are given below:

1. Extinct Plants and Animals:

- Fossils help researchers learn about plants and animals that existed long ago, having since faced extinction or evolution to modern species.
- Fossils provide an important record of the species that otherwise may never have been discovered because they died long before people began keeping records.

2. Evolutionary Evidence

- Species evolve over long periods of time, and the change can occur so slowly that it is difficult to know where one species ends and a new species begins. However, fossils help fill in the blanks.
- The study of fossils also can identify some factors that influenced evolutionary change. For example, drastic climate changes may kill some species out entirely, or allow only those that adapted to the new environment to survive.
- Finding similar fossils from different ages can help scientists understand how organisms evolved and changed over millions of years of development.
- Fossils are traces of ancient life. An imprint of a leaf, an insect preserved in amber or a footprint are all examples of different types of fossils. Scientists use fossils to gather information about the lives and evolutionary relationships of organisms, for understanding geological change and even for locating fossil fuel reserves.

3. Climate Change:

- The study of fossils also provides information about climate change. For example, scientists theorized that a comet hit the Earth, an event that dramatically changed the conditions for life and killed off the dinosaurs. Another drastic shift in climate led to the Ice Age, which killed off many species and changed life on Earth.

- Scientists learn this information by determining the age of fossils that are discovered and studying other clues found in the same soil layers where they found the fossils.

4. Tectonic History:

Fossils are very useful to the study of tectonic history. When a fossil of a given species is found on several modern continents, it gives a strong indication that these continents were previously unified.

5. Ancient Cultures:

- Fossils of human remains and of plants and animals provide insight into how people of the past lived.
- Plant and animal fossils from near the remains of old human settlements show what people ate, their tools and their culture.
- If signs of disease are found in plant or animal fossils, scientists can deduce that the people of that era may have suffered the same disease. Understanding what people ate also provides information about how they lived, such as whether they were hunters and had to travel to find food.

6. Structure:

The most basic information a fossil can provide is about what animals and plants looked like. While a complete fossil is best for understanding body structure, even a partial fossil can provide valuable information.

7. Environment:

The condition of a fossil can indicate what type of environment existed at the time. Well-preserved and complete fossils might indicate a bog, whose soft organic matter helped prevent the fossil from deteriorating.

8. Carbon Dating & Dating Layers of the Earth:

The relative depth of fossils can give clues as to when the organisms lived, as the deeper they are buried, the older the fossil. This information can be verified by carbon dating, which can pinpoint a fossil's age.

Fossils aren't used only to understand individual organisms. Geologists also use fossils for what's called **biostratigraphic correlation**, which allows researchers to match layers of rock in different locations by age based on how similar the fossils in each rock layer are. This information can be used to help understand when different layers of rock were formed even when large distances separate them .

9. Geology:

Finding similar fossils in different areas can indicate patterns in the movement of the Earth's crust, scattering the remains of creatures that once lived in a single place.

10. The Facts:

The oldest fossils on Earth are about 3.8 billion years old, or almost a billion years younger than the planet itself. Plants, animals and insects can all leave fossilized remains, but organisms that are completely soft-bodied, such as jellyfish, are less likely to leave fossils when they're gone. Hard body parts like teeth, bone and shell are most likely to be preserved.

11. Peeking into the Past:

Fossil remains can give us insight into how prehistoric plants and animals obtained food, reproduced and even how they behaved. At times fossils can also provide evidence for how or why the fossil organism died.

12. Fossils and Oil:

Fossils also have practical and commercial applications. The oil used in our energy and plastics industries tends to collect in specific types of rock layers. Because fossils can be used to understand the age of different rock layers as described above, studying the fossils that surface when digging oil wells can help workers locate oil and gas reserve .And of course, coal, oil and gas are themselves called **“fossil fuels”** because they’re formed from the organic remains of prehistoric organisms.