Palaeobotany

Introduction

Types

Nomenclature of Fossils

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Paleobotany is the study of fossil plants. A fossil plant is the remains or traces of a once living plant . Fossil plants are generally found buried below ground. Paleobotanical information is used to unravel the evolutionary history of plant taxa, in both time and space. It is employed also as a benchmark in phylogenetic studies for estimating differentiation times of different levels of taxa.

Meaning of Fossil:

The word fossil is derived from the Latin verb 'fodere' which means to dig up. Thus, a fossil refers to anything that is excavated from the

earth and not fashioned by man. Actually, the fossil refers to organic remains taken from the earth. So in common sense, fossils are the traces of the past life forms in the womb of the earth.

The fossils may be categorised in the following types:

Chemical Fossils

These are the remnants of organic compounds p reserved in sediments or in parts of fossilised structures without undergoing any or minimal change. These include amino acids, hydrocarbons, fatty acids, lipids, carbohydrates and the derivatives of other organic compounds.

The chemical composition of Pre-Cambrian rocks is an important criterion to establish the biogenicity of putative unicellular or multicellular organisms present in Pre- Cambrian rocks. The existence of insoluble kerogen is used as proof of biogenicity. Similarly, the occurrence of pristane and phytane, degradable products of chlorophyll molecule, may be used as proof of photosynthesis.

2. Trace Fossils or Ichnofossils:

Sometimes, indications of prior existence of organisms in the sediments of earth may be regarded as trace fossils or Ichnofossils. These include animal tracks or foot print preserved in rocks, burrows of invertebrates, coprolites (fossil excretes), gastroliths (polished stones in the abdomen of dinosaurs), gnawed bones, etc.

3. Microfossils:

Microscopic organisms like bacteria, spores and pollen grains, fungal and algal spores, foraminifera, diatoms, epidermal and wood fragments of plants etc. preserved in the sedimentary deposits are referred to as microfossils. Microfossils are visible only after maceration of sediments.

4. Megafossils:

Large parts of plants like leaf, stem, root, flower, seed, etc. and animal remains as whole organism or in parts, preserved in the sedimentary deposits are called megafossils. These are visible to naked eyes and are the better source of morphological as well as anatomical studies.

The megafossils may be categorised into the following five types on the basis of the nature of fossilisation:

(a) Compressions: These are plant parts, compressed by the vertical pressure of the sediments (Fig. 1.83). The plant fragments like leaves, stem, seeds get flattened and are retained as thin carbonaceous films with outline of external features.

Generally, internal structure is not preserved, however, in rare instances cuticles, stomate, etc. are retained.

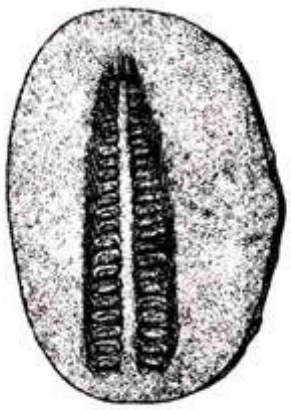

Fig. 1.83 : Compression of *Lepidostrobus* cone

(b) Impressions: Impression may be defined as the negative of a compression. These are just impression of plant parts which do not contain organic matters as in compression (Fig. 1.84). The

sediments containing the flattened plant parts become hardened and when split open shows the negative imprint i.e. impression.

Fig. 1.84 : Impression of *Neuropteris* leaf

(c) Petrifactions:

These are the best, but rarest types of fossil which preserve the external form as well as the internal structures. The cellular details are preserved due to the infiltration of minerals like SiO_2, $CaCO_3$, $MgCO_3$, FeS, etc. into the tissue. The petrified fossils can be cut into small pieces and series of section can be made for anatomical studies (Fig. 1.85).

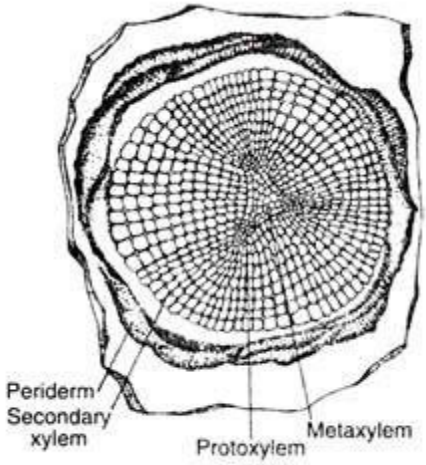

Fig. 1.85 : T.S. of a petrified *Sphenophyllum* stem

(d) Casts or Incrustations and Molds:

In these types, the deposition of iron and carbonate minerals occurs in the form of a hard cast around the plant parts. The internal structure is degraded to form a cavity which is completely filled up by the surrounding sediments. Thus, the external preserved surface of the plant part is called a mold (Fig. 1.86), while the replaced internal structure of the plant part is called a cast.

Stigmarian root system is an example of mold, while the pith cast of a Catamites stem is a common example of incrustation (Fig. 1.87). In these types, only external forms are preserved, while internal cellular details are not preserved.

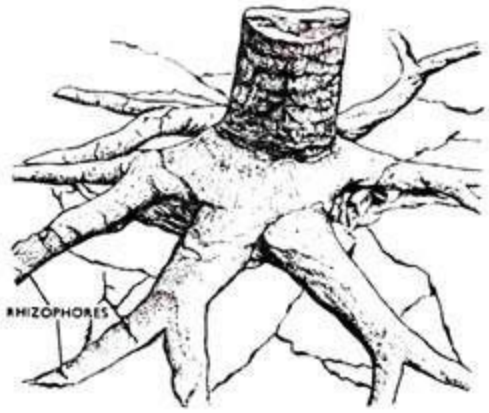

Fig. 1.86 : Mold of *Stigmaria*

Fig. 1.87 : Pith cast of a *Calamites* stem

5. Sub-Fossils:

A certain time period is required for the formation of a fossil. If the plant or animal parts are excavated before they completed their fossilisation process, they are called sub-fossils. Coal is a

compressed fossil, while peat, an early stage of coalification is referred to as sub-fossil.

6. Pseudofossils:

Sometimes inorganic rocks that appear to be fossils are actually mineral deposition. These fake structures are mistaken for plant or animal remains. These are known as pseudofossils.

7. Derived Fossils:

The fossilised organisms that held in a stratum younger or older than the fossil themselves are called derived fossils. These are results of tectonic movement of earth or other geological upheaval.

8. Coal Balls:

The petrified spherical balls containing plant parts are commonly termed coal balls (Fig. 1.88). These spherical balls are formed as a result of infiltration of plant debris in swamps by carbonates of calcium or magnesium, thus restricting the conversion of the debris into coal. Coal balls occur in localised regions and they range in few centimeters to several meters and weigh from a few to several pounds. Coal balls are specifically significant in palaeobotanical studies.

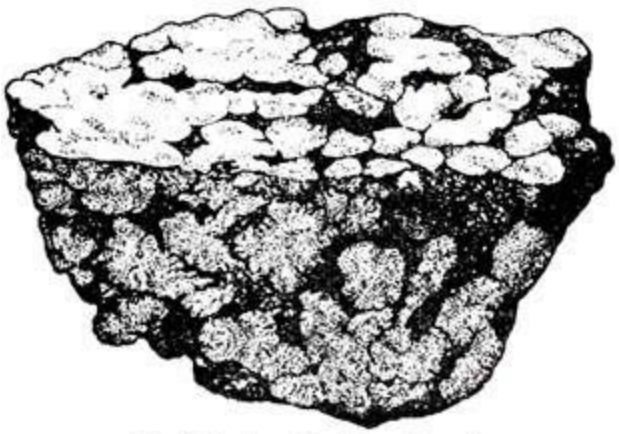

Fig. 1.88: A coal ball (sectioned)

9. Paper Coal:

It consists of thin dead leaves, dispersed in organic matrix. The inner tissues of leaves are destroyed, thus the paper coal consists of layer after layer of cuticles, often with decomposed stems. The carbonaceous lime stone horizon at Tovarkovo, in Toula in Russia, is an example of paper coal.

10. Amber:

The fossilised resin of extinct coniferous trees, Pinus succinifera in particular, is called Amber. The resinous exude flowed due to injury caused by boring insects which eventually accumulated on the forest floor and got hardened forming amber. Insects and flowers are often found preserved in amber. Amber has high economic value and used in jewelllery.

11. Index Fossils:

The organisms that help in dating other fossils found in the same sedimentary layer are called index fossils. Such fossils are found widely distributed geographically, and limited in time span having very distinct characteristic features. Monograptus is an index fossil of Lower Devonian, while Myrepollenites is a marker of Eocene.

Foraminifera, pollen grains, spores etc. are also used as index fossils.

Nomenclature of Fossils:

The whole plant is not preserved, but only detached plant parts like stem, root, cone, leaf, etc. are preserved as fossils. These detached plant parts are being discovered in different times by different authors. Thus, these detached plant parts or organs are given a bionomial (generic and specific name) by the same set of rules under the International Rules of Botanical Nomenclature which have been framed for living plants.

The first valid description of Lepidodendron came into existence from the publication of Sternberg in 1820. Thus, this date has been considered as the starting point of palaeobotanical nomenclature like that of Linnaeus's 'Species Plantarum' in 1753 for the nomenclature of modern vascular plants.

Each detached organs or fragments is given a different name. Each of these names acquires the status of a genus. The generic name in fossils is applicable for only a plant part like root, stem, leaf, cone or other organ, without indicating to what plant it belongs. Thus, the genus is termed form genus or artificial genus in contrast to natural genus for living plants.

A form genus cannot reliably be assigned to a single family, however, it may be assigned to an order or other higher taxonomic rank. For example, Stigmaria is a form genus of the order

Lepidodendrales which cannot be assigned to any one of the three families: Lepidodendraceae, Sigillariaceae or Bothrodendraceae.

When the relationships among different organs like stem, root, leaf and reproductive structures are established and can be assigned to the same family, then the genera can be called organ genera.

For example, stem genus Bucklandia, leaf genus Ptilophyllum, male fructification Weltrichia and female fructification Williamsonia are genetically related and assigned to the same family Williamsoniaceae. Thus, all are considered to be organ genera. However, there is no provision in the International Rules of Botanical Nomenclature for the use of organ genera.

During reconstruction, the palaeobotanists should select the earliest (after 1820) validly published generic name applied to any one of its parts as per Rule of Priority. He or she will use any one of the form genera as the generic name for the whole organism. Say, for

example, the validly published female fructification, Williamsonia has been used for naming the whole plant.

Rules for naming form genera:

A particular suffix is used for naming a form genus which signifies the organ it belongs.

The suffixes applied to different plant parts are:

Suffix	Applied to organ	Examples
Dendron	Stem	*Lepidodendron, Lyginodendron.*
Xylon	Woody part	*Dadoxylon, Cordaixylon, Mesoxylon.*
Phyllum	Leaf	*Ptilophyllum, Nipaniophyllum, Brachyphyllum*
Pteris	Fern-like stem or frond	*Sphenopteris, Lyginopteris, Etapteris, Archaeopteris*
Spermum	Seed	*Corystospermum, Mitrospermum*
Carpon	Seed or seed like	*Lepidocarpon, Mazocarpon, Calamocarpon*
Carpus	seed	*Trigonocarpus, Cardiocarpus*
Stoma	seed	*Lagenostoma, Stamnostoma*
Theca	Microsporangia	*Codonotheca, Aulacotheca, Crossotheca*
Strobus	Cone	*Lepidostrobus, Androstrobus*