SECTION 4

LECTURE 8

8.0 PAST LIFE AND PRESERVATION OF FOSSILS

8.1 INTRODUCTION

WELCOME to lecture 8. Have you ever wondered how, when, and where life came from? Have you ever thought about ancient life? A curious mind must have asked these questions. Ancient life-forms are mostly found “buried’ inside rocks – sedimentary rocks generally. In lecture 6, we saw that sedimentary rocks form when sand and mud become compressed and “harden into stone”. What happens if the bones and other remains of ancient animals and plants are caught up in the sand and mud when they become transformed into sedimentary rocks? The answer is that these remains of ancient life may become fossils, provided that the correct conditions for preservation occur. Fossils are our window to the past. This being the case, I welcome you so as to examine together through this window the elementary concepts about fossils, their preservation, importance and uses. A more detailed study of fossils as a subject shall be covered in another unit - SGL 103: Introduction to Paleontology- that runs parallel with the present unit.

OBJECTIVES

By the end of this lecture you should be able to:

a). Define the terms paleontology and fossils

b). Outline the requirements for fossilization to take place

c). Describe the preservation of original soft, hard and altered parts of organisms

d). Give examples of trace fossils

e). Explain what is the Geological Time Scale and how fossils have been used in its construction.

e). Outline the importance and uses of fossils.

8.2 PALAEONTOLOGY DEFINED

Palaeontology – the study of fossil plant and animal remains - is the Earth science that examines prehistoric life on Earth. Palaeontologists use this knowledge about past types of creatures (e.g. the dinosaurs in Fig. 8.1) and plants to understand past environments and climates. Predictions about future climates and environments are then possible.

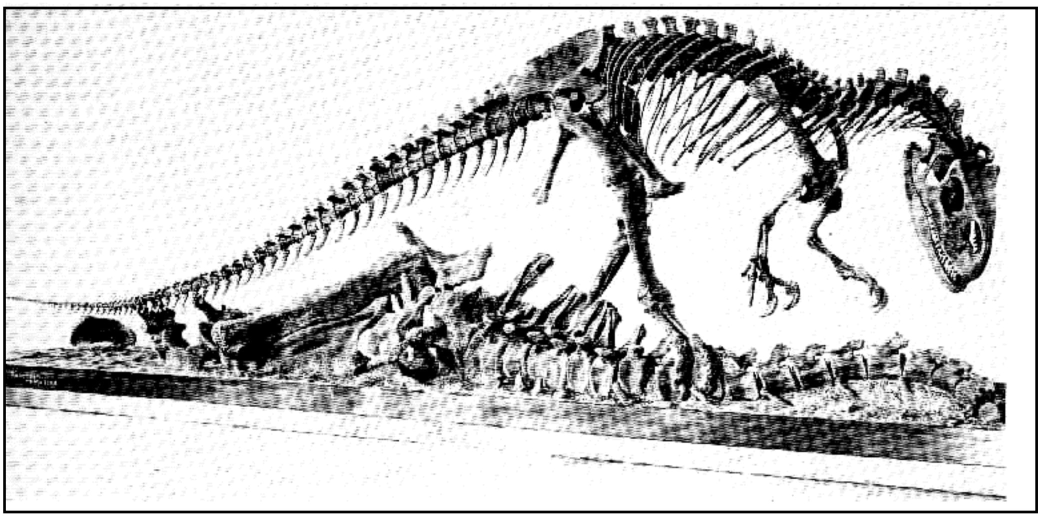

Figure 8.1 The reconstruction of dinosaur skeletons tells us much about these now extinct reptiles.

Because fossils represent the remains of such a diversity of organisms, paleontologists (earth scientists who specialize in the study of fossils) have found it helpful to establish four main divisions within their science. These main divisions include:

- **Paleobotany** - this deals with the **study of fossil plants** and the record of changes which have undergone since they first appeared on earth more than 3 billion years ago.
- **Invertebrate paleontology** – is a study of **fossil animals that did not posses a backbone or spinal column**. Fossils of this type include such forms as protozoans (tiny one-celled animals), clams, snails, starfish, and worms; and they commonly represent the remains of animals that lived in prehistoric seas. They are typically referred to as **invertebrate fossils.**

- **Vertebrate paleontology** is the **study of the fossilized remains of animals that had a backbone or spinal column**. Included in this branch is the study of the remains of fish, amphibians, reptiles, birds, and mammals. Fossils of this type are called **vertebrate fossils**.
- **Micropaleontology** – is the **study of fossils so small that they are best studied with a microscope.** These tiny remains are called **microfossils**, and usually represent the shells or parts of minute plants or animals. Because of their small size, microfossils can be recovered from wells without being damaged by the mechanics of coring or drilling. For this reason, microfossils are especially valuable to the **petroleum geologist**, for they enable him to identify rock formations that are hundreds of meters below the surface.

8.3 FOSSILS

What are fossils?

Fossils are the remains and traces of ancient plants and animals. Fossils are formed when ancient plant and animal remains become hardened and fixed within sedimentary rock or sometimes volcanic ash. Some of the most interesting fossils are formed when huge tree stumps, perfectly formed pollen grains, shells, or the bones of ancient fishes (see Fig. 8.2), reptiles or mammals, become saturated and hardened with minerals such as silica or calcite, and in this way are “transformed into stone”

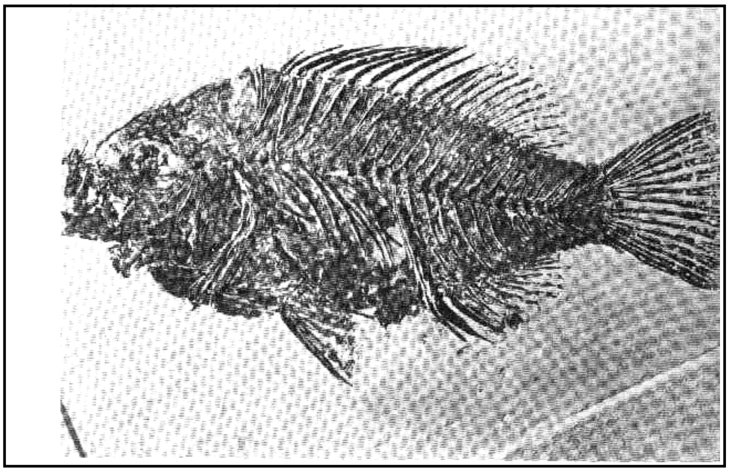

Figure 8.2 A fossil fish found in rocks of the Tertiary Age in Wyoming, USA.

8.4 REQUIREMENTS FOR FOSSILIZATION

In order for fossilization to take place, the following conditions must be fulfilled:

- The organism should posses hard parts e.g. bones, teeth, shells or woody tissue of plant. However, even though the hard parts are normally required, under unusually favorable conditions of preservation, such fragile objects such as e.g. jellyfish and insects have become fossilized.
- The organic remains must escape immediate destruction after death. If the hard parts of an organism should be crushed, eroded or otherwise greatly changed, this could result in the alteration or complete destruction of the fossil record of that plant or animal.
- Rapid burial must take place in a material capable of retarding decomposition.

In general the type of material in which the remains are buried usually depends on where the organisms lived e.g. the bones and shells of marine animals are common as fossils because they fell on the ocean floor after death. Under such conditions they were covered by soft mud which later hardened to shales and limestone of later geologic time. The soft muds are less likely to damage the organism (organic remains). Certain fine-grained rocks e.g. limestone have faithfully preserved delicate specimens as birds, insects and jelly fishes.

8.5 THE DIFFERENT KINDS OF FOSSIL PRESERVATION

Plants and animals may become fossilized in a number of different ways. However, most paleontologists recognize four major types of preservation. In general, the way in which an organism is ultimately preserved will depend upon the composition of the organic remains or the changes which have undergone since their burial.

8.5.1 The Original Soft Parts of Organisms

These type of preservation is among the most spectacular – and rarest – of fossils. This type of preservation requires that the organism must be buried in a material capable of **retarding decomposition** of the soft parts**.** Among materials known to have produced this type of fossilization are frozen soil or ice, oil-saturated soils and **amber** (fossil resin). Under proper conditions, it is also possible for organic remains to become so dried out that a **natural mummy** is formed. This normally occurs only in arid or desert regions and in places where the remains have been protected from destruction by scavengers and predators.

By far the best-known examples of preserved soft parts of prehistoric animals have been discovered in Alaska and Siberia. In these areas, the frozen tundra has yielded the remains of large numbers of frozen elephant-like creatures called mammoths. The bodies of these now-extinct creatures, many of which have been buried for as long as 25,000 years, are exposed as the frozen earth begins to thaw. Many of these giant carcasses have been found in such an excellent state of preservation that their flesh has been eaten by dogs and their tusks sold by ivory traders!

Preservation in amber is another interesting and somewhat unusual form of fossilization. This process takes place when ancient insects became trapped in the sticky gum that oozed out of certain **coniferous** (or cone-bearing) trees such as the spruce or pine. With the passing of time this **resin** hardened, leaving the insect encased in a tomb of amber. Some of these insects have been so well preserved that even fine hairs and muscle tissues may be studied under the microscope.

Although the preservation of original soft parts has produced some useful and spectacular fossils, this type of fossilization is relatively rare.

8.5.2 The Original Hard Parts of Organisms

Most plants and animals have some type of hard part that may become fossilized. For example, they may consist of the shell material of clams, oysters, or snails, the teeth or bones of vertebrates, the **exoskeleton** (outer body coverings) of crabs, or the woody tissues of plants. These hard parts are composed of various materials which are capable of resisting weathering and chemical action, and fossils of this nature are relatively common.

8.5.3 Altered Hard Parts of Organisms

When an organism dies and is buried, its hard parts undergo considerable changes. The type of alteration is usually determined by the composition of the hard parts and where the organism lived. For example, certain types of organic material may be preserved by:

- **Carbonization** and **distillation** – this process takes place as the **organic material slowly decays** after burial. During the process of decomposition, the organic matter gradually loses its gases and liquids, leaving behind a **thin film of carbon**. This is the process by which coal is formed, and carbonized plant fossils are commonly found in many coal deposits. In addition, the remains of fish, graptolites, and reptiles have been preserved by carbonization.
- **Petrification** or **permineralization** – this type of fossilization takes place when **mineral-bearing ground waters infiltrate porous bone, shell, or plant material**. With the passing of time, these underground waters will deposit their mineral content in the empty spaces of the hard parts, thus making them heavier and more resistant to weathering.
- **Replacement** or **mineralization** – this occurs when the original hard parts of an organism are removed after being dissolved by circulating groundwater. **As the hard parts are dissolved** there is almost a **simultaneous deposition of other mineral substances in the resulting voids**. In some replaced fossils the original structure will have been destroyed by the replacing minerals. However, in others, as in the case of certain mineralized tree trunks, the remains may be preserved in minute detail.

8.5.4 Traces of Organisms

These are remains of traces or imprints of once living organisms. Examples include **molds** and **casts** of organisms. If for instance a shell had been pressed down into the ocean bottom before the sediment had hardened into rock, it may have left the impression of the exterior of the shell. This impression is called a **mold**. If at some later time this mold should become filled with another material, this might produce a **cast**. A cast formed in this manner will show the original external features of the shell. Objects of this type are called **external molds** if they show the external features of the hard parts, and **internal molds** if the nature of the inner parts is revealed.

The **tracks, trails** and **burrows** can be among the most useful – and puzzling – of all fossils. Some of these, especially footprints, may indicate not only the type of animal that left them but may also furnish information about how and where the animal lived. For example, the study of a series of the dinosaur tracks would not only indicate the size and shape of the dinosaur's foot, but might also give indication as to the weight and length of the animal. In addition, the type of rock containing the tracks would probably help to determine the conditions under which the animal had lived.

8.6 FOSSILS AND THE GEOLOGICAL TIME SCALE

The need for detailed geological mapping of the rocks and minerals in the Earth and the matching-up or correlation of rock layers, are vital to the search and discovery of economically important minerals. To do this, rock units have to be described and the same sort of layers recognized worldwide. Fossils are often used to help match up rock layers all over the world. Sedimentary rock units are frequently recognized by their unique or distinctive fossils. These important layers of sedimentary rocks are used to make up the **Geological Time Scale**. The Geological Time Scale divides the millions of years of Earth history into units or periods. The Geological Time Scale is accepted worldwide as a result of an international agreement among scientists.

What is the Geological Time scale?

The Geological Time Scale is a calendar which divides the Earth's history into Geological Time Periods. This type of "earth calendar" is based on evidence from rocks formed as long ago as 4 billion years (4,000 million years).

8.7 THE IMPORTANCE AND USES OF FOSSILS

What is the importance and uses of fossils?

Fossils reveal much useful information. Among the most important uses of fossils are:

- Tracing the development of the plants and animals of our planet earth.
- For purposes of correlation to determine the distribution of geologic units of similar age
- By studying fossils, paleontologists can tell us more about the lives of ancient plants and creatures, and thus provide information about modern types of life forms.
- Fossils reveal information about ancient environments and climates.
- Fossils can give the age of certain rocks. This allows geologists to match up or correlate rock layers from all over the world, often leading to the discovery of new mineral deposits of economic importance.
- Fossils are used to make geological maps. They help the geologists to work out the correct sequence of deposition of the sedimentary rocks, i.e., which rock layers are oldest and which are youngest.
- There are other types of fossils known as fossil fuels, such as oil and coal, which are used every day. Coal is formed from ancient plant remains, and is used to generate power. Oil is formed from the bodies of millions of tiny sea creatures which have been compressed over millions of years to form oil.

- Fossils have also been used to give proof of **Continental Drift** or **Plate Tectonics**.

Summary

Fossils are the remains and traces of ancient plants and animals. For fossilization to take place, the original organism or plant must posses hard parts, the organic remains must escape destruction immediately after death, and rapid burials must take place in a material capable of retarding decomposition.

Among the importance and uses of fossils include: tracing the development of the plants and animals of our planet earth, giving information regarding past environments and climates, correlation of rock layers from all over the world that have assisted in making geological maps and discovery of new mineral deposits.