

CHAPTER — 14



Biological Diversity

Biological diversity is the variation of life forms, including plants and animals, occurring within a given ecosystem, locality or on the entire Earth. It is often used as a measure of the health of biological systems. The word **biodiversity** is considered more popular and effective in terms of communication than *biological diversity*. It is generally used to equate to a concern for the natural environment and nature conservation. The term “natural heritage” is also used to mean the biodiversity, though it is a less scientific term, but more easily understood by the people interested in conservation.

The most straightforward definition of biodiversity is “variation of life at all levels of biological organization”. Biodiversity is also a measure of the relative diversity among organisms present in different ecosystems. “Diversity” in this definition includes diversity within a species and among species, and comparative diversity among ecosystems. Ecologists often used to define biodiversity as the “totality of genes, species, and ecosystems of a region”

The 1992 United Nations Earth Summit in Rio de Janeiro defined “biodiversity” as “the variability among living organisms from all sources, including, ‘*inter alia*’, terrestrial, marine, and other aquatic ecosystems. It is the definition adopted by the United Nations

Convention on Biological Diversity.

The **Convention on Biological Diversity**, known informally as the **Biodiversity Convention**, is an international treaty that was adopted in Nairobi on 22 May 1992. The Convention has three main goals, viz. 1. conservation of biological diversity (or biodiversity); 2. sustainable use of its components; and 3. fair and equitable sharing of benefits arising from genetic resources. In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development. The Convention was opened for signature at the **Earth Summit** in Rio de Janeiro in Argentina on 5 June 1992 and entered into force on 29 December 1993.

Robert. M. May of the Oxford University, in his article ‘*How many species are there on earth?*’ published in *Science* in 1988 stated that the number of species living on the earth could be in the range 10 million to 50 million. Out of this, the total number of species actually named and recorded is only around 1.5 million.

Biodiversity is generally equated to the taxonomic richness of a geographic area. Hence, a thorough knowledge of the diverse taxonomic variability of plants and animals, etc of a place is a pre-requisite before taking up steps for conservation of its flora and fauna. Thus, in this chapter, let us look into the different aspects of taxonomic classification of the various forms of life occurring on our earth.

14.1 Basic issues in scientific naming of plants and animals

Whenever we come across an unknown new organism, whether plant or animal, the first thing we usually do is trying to identify that organism as to which group or kind of organisms it belongs. Once identified, the next thing that we have to do is to find a name for the organism.

The first step of finding out to which group the unknown organism belongs is known as **identification**. The second step of giving a name to the newly discovered and identified organism is known as **naming**. However, giving a name to a new organism is no easy task. One has to follow a system of rules and regulations according to which a new name for a new organism can be proposed. **Nomenclature** is a term that refers to a system for naming organisms. In biology the system is said to be “binominal” (earlier spelled ‘binomial’) which means that two names are used to specifically identify every organism.

14.2 Binominal system of nomenclature

The binominal system of nomenclature was introduced by Carolus Linnaeus in 1758. According to this system, a scientific name of a species of organism should be made up of two Latin or Latinized words. The first word represents the genus to which the organism belongs (**generic name**). The second word is the name of the species of organism (**specific name**). The genus name should always begin with a capital letter while the specific name should never begin with a capital letter. When printed, two words are to be **italicized**, and when handwritten, they should be **underlined** separately. The specific name may be formed by Latinizing the name of a revered person, name of a locality, colour, etc.

14.3 Hierarchy of classification

A hierarchy is a systematic framework for biological classification in which taxonomic groups are arranged in an ascending series of levels with ever-increasing inclusiveness. It was first introduced by Linnaeus in 1758. Hence, it is also known as **Linnaean hierarchy**.

The present hierarchy of classification has six basic levels or categories, as follows-

Phylum (for animals) and **Division** (for plants)
Class
Order
Family
Genus
Species

Phylum is the highest taxonomic category under a **Kingdom**. The botanical counterpart of a phylum is **Division**. A phylum includes animals which possess a common characteristic feature. For example, Phylum **Chordata** includes all animals with a notochord. In the same way, Division **Thallophyta** includes plants that do not have a well-differentiated body design with roots, stems and leaves.

Class is the taxonomic category between Phylum and Order. A class is a large group of organisms, who share certain common characteristics. For example, Class **Mammalia** includes warm-blooded animals with fur or hair, mammary glands, etc. Similarly, Class **Insecta** includes all insects, which possess three pairs of jointed legs and their body is divisible into three parts, viz. head, thorax and abdomen.

Order is a taxonomic category between Class and Family. An **order** is a subgroup under a class, which is divided based on the presence of certain characters. Order Lepidoptera (butterflies and moths) under class Insecta, for example, are characterized by minute scales on their wings, a soft-bodied herbivorous larval form (caterpillar), mouthparts in the adult specialized for feeding on nectar, and other liquid foods, etc.

Family is a taxonomic category between Order and Genus. A family is a group of organisms among which the differences are quite minor, e.g. Equidae, which includes horses and their relatives.

Genus is the category between Family and Species. Only very closely related species are grouped together in a single genus. The genus is just like the surname of a person, whereas the species is the first name. So *Canis lupus*, the wolf, is distinguished from *Canis familiaris*, the domesticated dog. Although very similar they are still distinct species, but belong to the same genus.

Species is the basic taxonomic unit used to define a definite **kind** of living organism. Any two individuals are said to belong to the same species if they are able to interbreed and produce fertile offsprings.

Taxonomic classification of man

Phylum	Chordata
Class	Mammalia
Order	Primates
Family	Hominidae
Genus	<i>Homo</i>
Species	<i>Homo sapiens</i>

Activity 14.1 : Write down the taxonomic classification of man.

14.4 Basis of classification

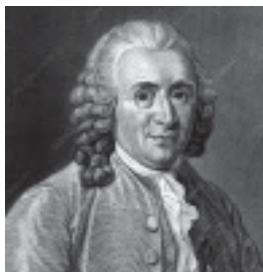


Fig.14.1: Carolus Linnaeus (1707-78)

Classification is the ordering of animals into groups on the basis of their relationships. **Taxonomy** is that branch of biology dealing with the classification and naming of organisms. The ancient Greek philosopher **Aristotle** was the first to classify animals on the basis of their way of living, actions, habits and body parts. His great contributions to biology earned him the title “father of biological classification”. British naturalist **John Ray** was credited with revising the concept of naming and describing organisms. He introduced the term “species” as a reproducing unit. During the 1700s, Swedish botanist

Carolus Linnaeus Fig.14.1. classified all the then known organisms into two large groups namely Kingdoms **Plantae** and **Animalia**. Most of the principles of taxonomy that we are presently following were introduced by Linnaeus. Hence, he is aptly called as the “father of taxonomy”. The two kingdom system of biological classification introduced by Linnaeus was later found insufficient. **Robert H Whittaker** in 1969 proposed five kingdoms namely **Plantae**, **Animalia**, **Fungi**, **Protista**, and **Monera**. Other schemes involving an even greater number of kingdoms have lately been proposed, however most biologists employ Whittaker’s five kingdom system.

14.4.1 Two-Kingdom Classification of Linnaeus

The **Two-kingdom classification** was proposed by Carolus Linnaeus in 1758. It was one of the earliest schemes of natural system of classification. According to this system, all the living organisms may be grouped into two kingdoms, viz. **Kingdom Plantae** and **Kingdom Animalia**. It means that a living organism can be either a plant or an animal. However, the two-kingdom classification had many drawbacks. For example, there are organisms which may be placed in both the kingdoms, and also there are organisms that cannot be placed in both the two kingdoms. The followers of the two kingdom system were not able to find a proper place for fungi, which are not neither green in colour nor had roots and leaves like a plant. Another problem was that of *Euglena*, a microscopic organism with chlorophyll, like a plant but having muscle fibres like an animal. Moreover, bacteria with prokaryotic cells were placed together with higher plants with eukaryotic cells. Single –celled microscopic protozoans are grouped together with multicellular massive animals like whales, elephants, etc.

14.4.2 Five Kingdom Classification of Whittaker



Fig.14.2: Robert H. Whittaker
(1920-1980)

American ecologist Robert H. Whittaker (Fig.14.2) in 1969 created the five-kingdom classification that accounted for prokaryote and eukaryote distinctions. In this system, all prokaryotes were placed in the kingdom **Monera**. The remaining eukaryotes were separated by differences mostly in structure. Plants and animals were easily separated into their own kingdoms, **Plantae** and **Animalia**. It was decided that because fungi were neither plant nor animal and subsisted by decaying or decomposing organic matter, they should be placed in their own kingdom **Fungi**. Everything else was clumped into the kingdom **Protista**. The protists included all eukaryotes that did not clearly fit into the kingdom **Plantae**, **Animalia** and **Fungi**.

Advantages of the five kingdom system

The advantage of the five kingdom classification system is that there is far less overlap and confusion as compared to the original two kingdom classification system as proposed originally by Linnaeus. While placing organisms in any one of the five

kingdoms, the following three characteristic features are considered:

1. The kind of cells that make up the organism.
2. The number of cells that make up the organism.
3. The method by which the organism obtains food.

The five kingdoms used in the system are

1. Kingdom Monera,
2. Kingdom Protista,
3. Kingdom Fungi,
4. Kingdom Plantae, and
5. Kingdom Animalia.

14.4.3 Kingdom Monera (About 10,000 known species)

Kingdom Monera includes all the prokaryotic organisms including bacteria, cyanobacteria, etc. (Fig.14.3). This group of living organisms does not have any internal membranous organelles such as a nucleus, Golgi apparatus, endoplasmic reticulum, etc. They do have a nucleoid region containing a chromosome organized into a circle, and they also have ribosomes for protein synthesis. Some forms are responsible for causing disease in humans. Most are important decomposers, and are also important in the recycling of nutrients.



Bacteria

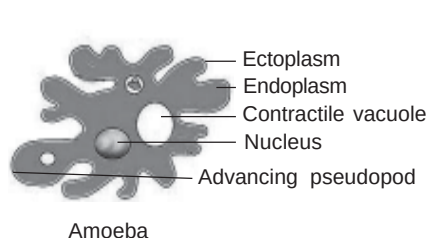


Cynobacteria (*Anabaena*)

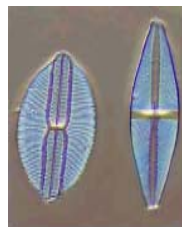
Fig.14.3: Examples of Monera

14.4.4 Kingdom Protista (About 250,000 known species)

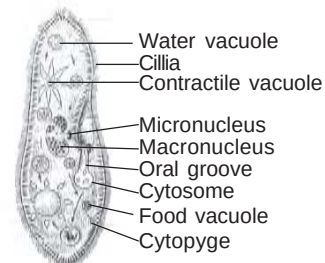
Members of the Kingdom Protista are generally unicellular, eukaryotic organisms, although some multicellular forms are also included. Some forms are responsible for causing disease in humans and other organisms. Examples are protozoans, diatoms, dinoflagellates, etc. (Fig.14.4).



Amoeba



Diatoms



Paramecium

Fig.14.4: Examples of Protista

14.4.5 Kingdom Fungi (About 100,000 known species)

The organisms included in the Kingdom Fungi are eukaryotic, heterotrophic organisms that mainly serve as decomposers, important to the recycling of materials. Some forms are responsible for causing disease in plants and animals including humans. Their cell walls are made up of cellulose and chitin. Reserved carbohydrates stored in their cells are glycogen. Examples include molds, *Agaricus*, *Penicillium*, *Rhizopus*, yeasts, mushrooms, rusts, smuts, etc. (Fig.14.5).



Fig.14.5: Examples of fungi

14.4.6 Kingdom Plantae (About 100,000 known species)

Kingdom Plantae includes the 'plants', which are multicellular, eukaryotic, **photosynthetic** and autotrophic organisms that form the basis of the food web in terrestrial ecosystems. Examples include mosses, liverworts, ferns, conifers and flowering plants.

14.4.7 Kingdom Animalia (About 1,000,000 known species)

Kingdom Animalia includes the animals of this world and represents the largest of the five kingdoms. Animals are multicellular, eukaryotic, heterotrophic organisms. Animals generally have the greatest degree of system development since they generally have senses for detecting food and mobility to capture it. Animals represents all the consumer levels of the food web in any ecosystem. Their wastes and dead bodies, however, are consumed by fungi and bacteria.

14.5 PLANTAE

14.5.1 Thallophyta

Thallophyta includes autotrophic plants without true roots, stems or leaves. The plant body is known as a **thallus**. Their zygote does not develop into multicellular embryo within the female reproductive structures. They are typically nonvascular without a water-conducting system of cells (i.e. without xylem tissue). The thallus ranges from microscopic, unicellular forms in *Chlamydomonas*, diatoms, dinoflagellates (*Ceratium*) etc, filamentous in *Spirogyra*, *Ulothrix* and to the giant macroscopic seaweeds (*Laminaria*), *Fucus* etc. (Fig.14.6).

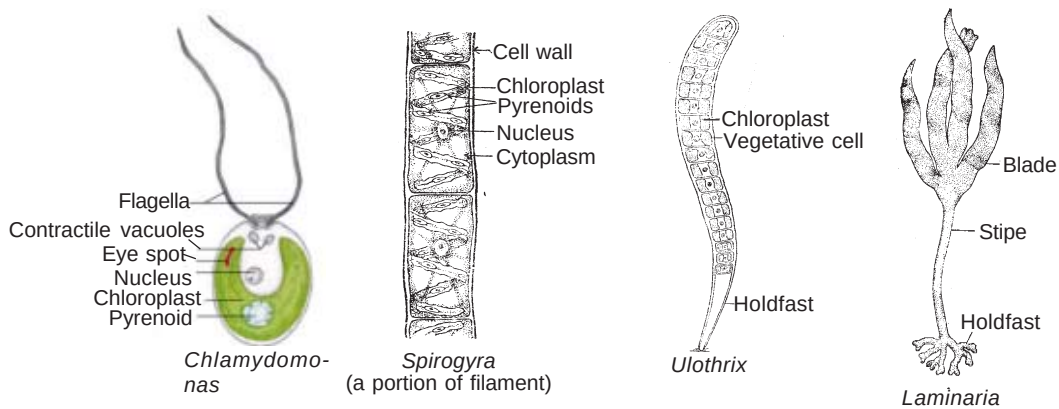


Fig.14.6: Examples of Thallophyta (algae)

14.5.2 Bryophyta

Division Bryophyta (Greek *Bryon* = moss; *phyton* = plant) includes mosses and liverworts, which are plants more advanced than algae but more primitive than pteridophytes. They are very small and inconspicuous plants found in humid and shady places. Their vegetative structures are adapted for terrestrial life. But, their male reproductive structures require water for movement. Hence, bryophytes are also known as amphibians of the plant kingdom. During rainy season they form a green carpet on damp surfaces of soil, walls, rocks or barks of trees.

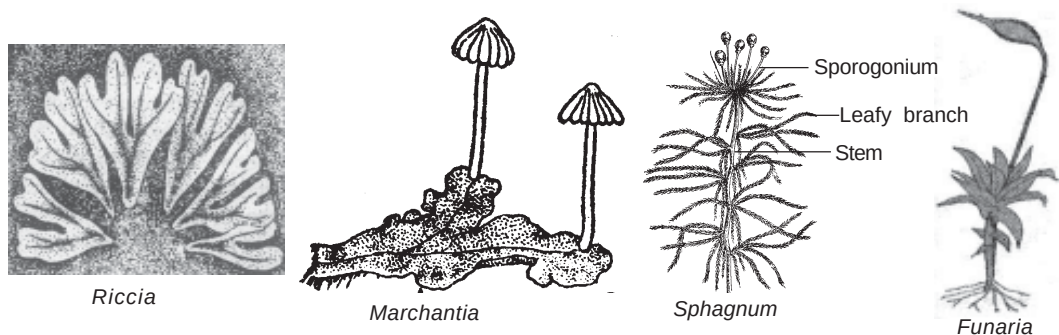


Fig. 14.7: Examples of Bryophytes

In liverworts (*Riccia*, *Marchantia*), the plant body or thallus is flat, green, lobed or forked. They remain attached to the substratum by thin rhizoids. But, in mosses (*Sphagnum*, *Funaria*), the plant body consists of an erect, branched, stem-like structure which bears leaf-like outgrowths. The lateral branches are fully covered with the leaf-like structures. The mosses also attach themselves to the substratum by thin root-like rhizoids (Fig.14.7).

14.5.3 Pteridophyta (Greek. *Pteridos*-fern; *Phyton*-plant)

Pteridophytes or ferns are seedless vascular plants. Their reproductive structures are called **sporangia** which are born in clusters on spots called **sori** on the underside of leaves or **fronds**. The fronds arise from subterranean, creeping **rhizomes** and from

trunks of tree-like forms (called tree ferns). Examples are water ferns such as *Azolla* and *Salvinia*, clover-leaf fern such as *Marsilea*, Horsetail (*Equisetum*), common Indian fern (*Dryopteris*) etc. (Fig.14.8).

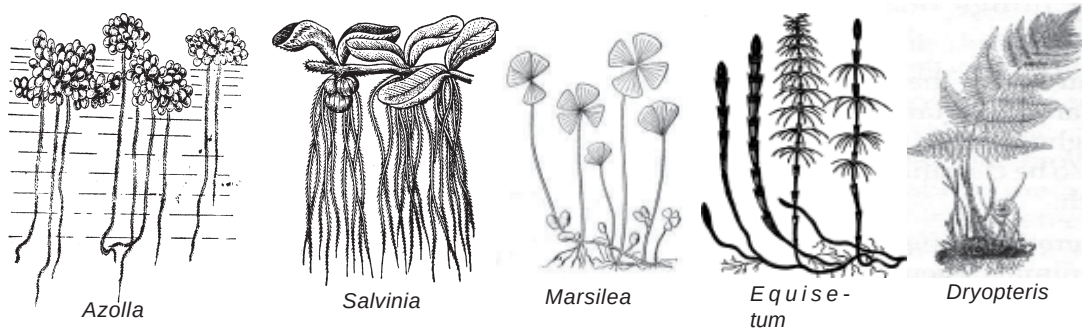


Fig.14.8: Some examples of Pteridophytes

14.5.4 Spermatophyta (Greek. Sperma-seed; Phytion-plant)

Division Spermatophyta (also known as **phanerogams**) comprises the seed-bearing plants. Seed-bearing plants may be further divided into **Gymnosperms** and **Angiosperms**. Gymnosperms are Tracheophytes with naked seeds. Angiosperms are flowering plants which bear their seeds enclosed within ripened ovary (fruit).

14.5.5 Gymnosperms

Gymnosperms are divided into the following divisions:

- Division Cycadophyta (Cycads)
- Division Ginkgophyta (Maidenhair Tree)
- Division Gnetophyta (*Gnetum* & *Welwitschia*)
- Division Coniferophyta (Cone-Bearing Trees & Shrubs)

14.5.5 (i) Cycadophyta (Cycads)

These are palm-like plants with large seed and pollen cones. They flourished during the days of the dinosaurs and undoubtedly were a major food supply for herbivorous dinosaurs. The cycads were so numerous in Mesozoic times that this era is often called the Age of Cycads and Dinosaurs. Cycads are dioecious species with pollen cones and seed cones produced on separate male and female individuals. In some species, the enormous pollen and seed cones may reach 3 feet in length and may weigh up to 90 pounds, the largest of all living cone-bearing plants. Examples : *Cycas* (**Yendang**) (Fig.14.9).



Fig. 14.9 : A *Cycas* plant

14.5.5(ii) Ginkgophyta (Maidenhair Tree)

The Ginkgophytes are medium-sized dioecious trees with tall and branched stems. The leaves are similar in shape to the maidenhair fern (*Adiantum*). Reproductive structures, namely pollen sacs and ovules, are borne on dwarf shoots known as **strobili** (Singular strobilus). Seeds are borne in pairs. Division Ginkgophyta has only one living representative ***Ginkgo biloba***. It is a true living fossil dating back 185 million years (Fig.14.10).

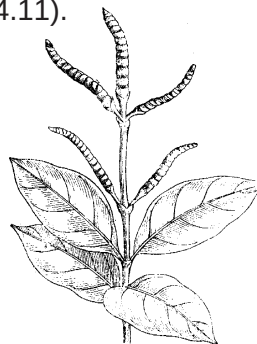


Fig. 14.10 : A twig of *Ginkgo biloba*

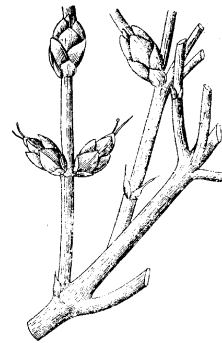
The seeds of *Ginkgo* are edible. An essential oil is also obtained from the seeds. The timber is used for making poles, furniture, building materials, etc.

14.5.5(iii) Gnetophyta (Gnetum & Welwitschia)

Division Gnetophyta is a remarkable plant division including *Ephedra*, *Gnetum* and *Welwitschia*. The stems of *Ephedra* are jointed with small scale-like leaves at the nodes. The bizarre, shredded, wind-blown leaves of *Welwitschia* arise from a woody caudex on the desert floor. In general habit *Gnetum* looks like an angiospermic plant. This division includes species with vessels and other characteristics typically found in flowering plants (Fig.14.11).



A twig of *Gnetum*



A twig of *Ephedra*

Fig. 14.11: Examples of Gnetophyta

14.5.5(iv) Coniferophyta (Cone-Bearing Trees & Shrubs)

Members of this division are commonly known as **conifers**. Conifers constitute dominant forest vegetation in temperate parts of the world and regions of high altitude. In India, conifers are mainly confined in the Himalayas and adjoining areas. Most are trees, while some are shrubby species. The stem is much branched. Reproductive structures are borne on cones or strobili. Seeds are borne on the surface of woody scales, the overlapping scales forming a cone. Important examples include pine (*Pinus*), fir (*Abies*), spruce (*Picea*), hemlock (*Tsuga*), larch (*Larix*), juniper (*Juniperus*), cypress (*Cupressus*), Yew (*Taxus*) etc. Conifers also include the tallest (redwood tree) and most massive (giant sequoia tree) living organisms. Some species (especially pines) require fire for seed germination and regeneration. Some are common ornamental plants eg. *Thuja*, *Araucaria* etc. (Fig.14.12).

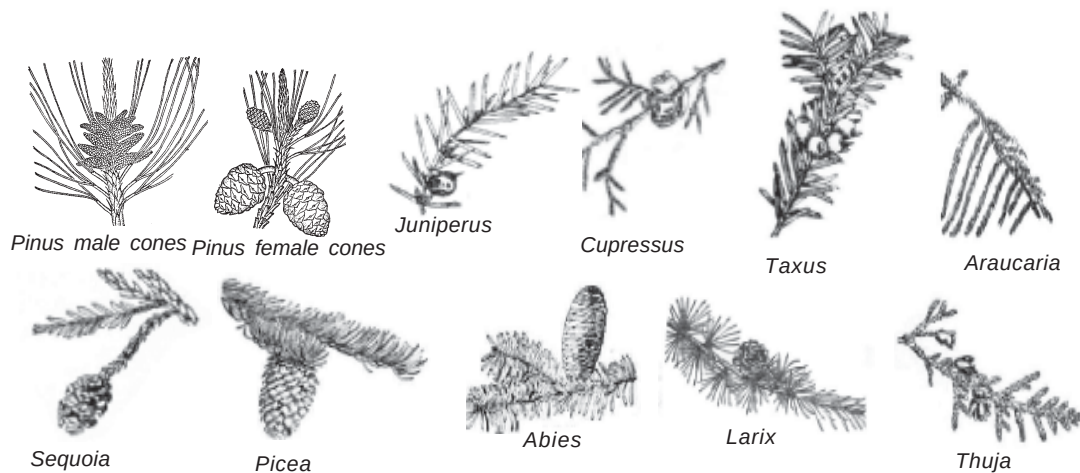


Fig.14.12 : Some examples of Coniferophyta

14.5.6 Angiosperms

Angiosperms are represented by the Division Anthophyta or flowering plants.

Division Anthophyta includes the flowering plants, a large group including many familiar plants in a wide variety of habitats. They form the largest group in the plant kingdom. More than 90% of all plants on earth are angiosperms. There are over 250,000 species in this group. They are found almost everywhere in every possible type of habitat and climate.

Anthophytes may be annual, biennial or perennial herbs, shrubs, trees, climbers, twiners and lianes. They may be as minute as a pin head, e. g. *Wolffia microscopica*. On the other hand, they may be as massive as a 300 feet high tree e.g. *Eucalyptus regnans*.

In flowering plants, the ovules are borne in the closed sporophyll known as the **carpel**. The microsporophyll and megasporophyll are arranged in flowers which may be unisexual or bisexual. The pollen grains are received on the stigma of carpel. Fertilization takes place through formation of pollen tubes.

Flowering plants provide us cereals, pulses, vegetables, fruits, fibres, timbers, gums, resins, tannins, dyes, spices, sugar, starch, condiments, rubber, paper, medicines, tea, coffee, tobacco, fats, oils and several other useful products.

Flowering plants are divided into two groups (classes), as follows:

14.5.6(i) Monocotyledoneae (Monocots)

Monocots have the following features:

1. One cotyledon inside seed;
2. Parallel leaf venation;
3. Flower parts in 3's or multiple of 3's;
4. They include *Lilium*, *Amaryllis*, *Iris*, *Agave*, *Yucca*, orchids (*Vanda*), duckweeds, grasses, maize (*Zea mays*), rice (*Oryza sativa*), wheat (*Triticum aestivum*), palms, etc. (Fig.14.13).

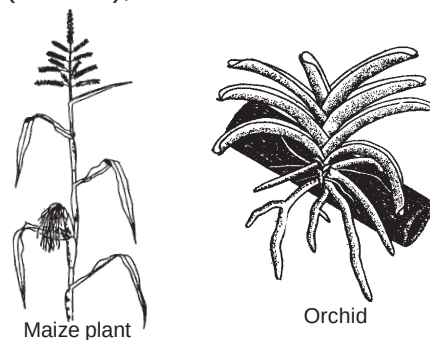


Fig.14.13 : Some examples of monocot plants

Class Dicotyledoneae (Dicots)

Dicots have the following features:

1. Two cotyledons inside seed;
2. Branched or net-like leaf venation;
3. Flower parts in 4's or 5's;
4. They include most species of flowering herbs, shrubs and trees (Fig.14.14).

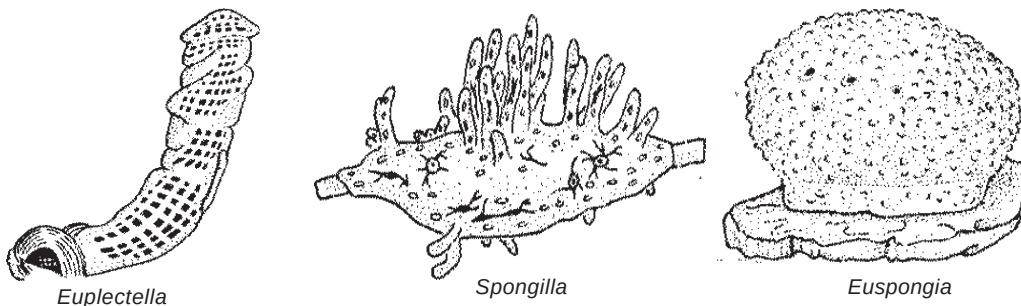


Fig.14.14 : A Dicot plant (Mustard)

14.6 ANIMALIA

14.6.1 Porifera (Sponges)

Phylum Porifera includes sponges, which are simple multicellular aquatic animals that remain fixed to a rock or substratum under water. Most of them are marine, but some species live in fresh water. The cylindrical, globose or irregular bodies of sponges are radially symmetrical. Their body wall is supported by an internal skeleton of minute **spicules** made of calcium carbonate, silica, or a fibrous collagen protein called **spongin**. The body wall is perforated by numerous pores called **ostia** that connect to internal canals and chambers lined by flagellated collar cells called **choanocytes**. Sponges are filter-feeders, taking in microscopic plankton brought in by miniature currents created by the choanocytes.



Marine examples of phylum Porifera are **Euspongia** (bath sponge), **Euplectella** (Venus' flower basket), **Chalina** (dead man's finger), etc. **Spongilla** and **Myenia** are freshwater sponges occurring mostly in running waters (Fig.14.15).

14.6.2 Cnidaria

Phylum Cnidaria includes diverse forms of mostly marine aquatic animals. The name 'Cnidaria' comes from the Greek word "**cnidos**," which means *stinging nettle*. All these animals possess a kind of stinging cells called **nematocysts**. The nematocysts are found on elongated, arm-like structures called **tentacles**. When touched the nematocysts eject barbed threads that inject a paralyzing poison into the body of the prey.

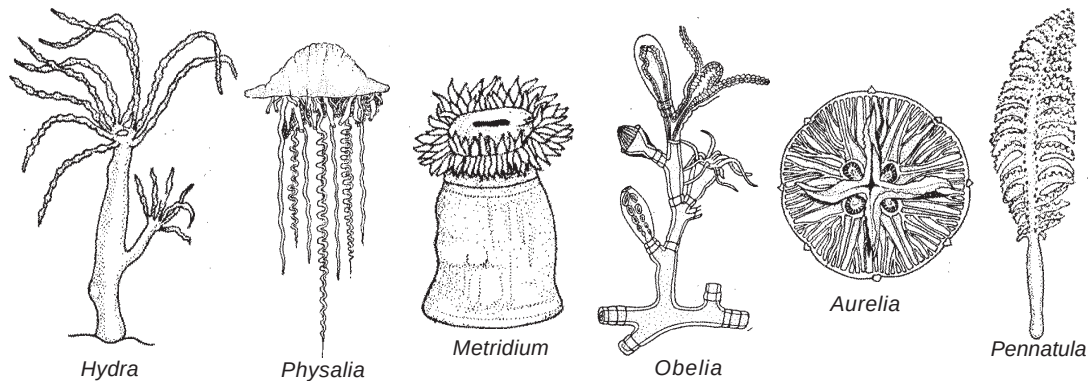


Fig.14.16: Some examples of Cnidaria

Cnidarians have a radially or bilaterally symmetrical body. The life cycle of most of them includes a sedentary or fixed generation called **polyp** and a free-swimming generation called **medusa**.

Many thousands of cnidarians live in the world's oceans, from the tropics to the poles, from the surface to the bottom. Some even burrow. A smaller number of species, for example, *Hydra*, are found in fresh water rivers and lakes.

Examples : True corals (*Tubipora*), sea anemones (*Metridium*), sea pen (*Pennatula*), Australian sea wasp (*Chironex fleckeri*), Portuguese-man-of war (*Physalia*), Obelia, Hydra, true jellyfish (*Aurelia*) (Fig.14.16).

14.6.3 Ctenophora

Phylum Ctenophora (Greek for “comb-bearers”) have eight “comb-like rows” of fused *cilia* arranged along the sides of the animal. These cilia beat synchronously and propel ctenophores through the water. Some species move with a flapping motion of their lobes or undulations of the body. Many ctenophores have two long tentacles, but some do not possess any tentacle.

Ctenophores, variously known as combjellies (*Pleurobranchia*) (Fig.14.17), sea gooseberries, sea walnuts, or Venus's girdles (*Velamen*), are voracious predators. They share several superficial similarities with cnidarians, but they lack stinging cells. Instead, ctenophores possess sticky cells called **colloblasts** or lasso cells with which they capture their prey. In a few species, special cilia in the mouth are used for biting gelatinous prey.



Fig.14.17 : *Pleurobranchia*

Although most ctenophores swim, one group creeps along the bottom of the seas. Most of the species are predators preying on other animals, for instance with echinoderms, sponges, or benthic cnidarians. Many of the ctenophores are *bioluminescent*, i. e. are able to give off light.

14.6.4 Platyhelminthes (Flatworms)

Phylum Platyhelminthes includes worm-like animals with dorso-ventrally flattened, leaf or ribbon-like, bilaterally symmetrical triploblastic body. Their digestive tract is branched and without an anus. Digestive system is absent in parasitic forms. Parasitic forms possess adhesive structures like hooks, spines and suckers. Their excretory organs are called flame cells. A person can get infected with tapeworm by eating poorly or ill -cooked beef or pork containing the encysted bladder worm (tapeworm cyst).

Examples : Free-living flatworms, (*Planaria*), liver flukes (*Fasciola hepatica*), tapeworms (*Taenia solium*) (Fig.14.18).

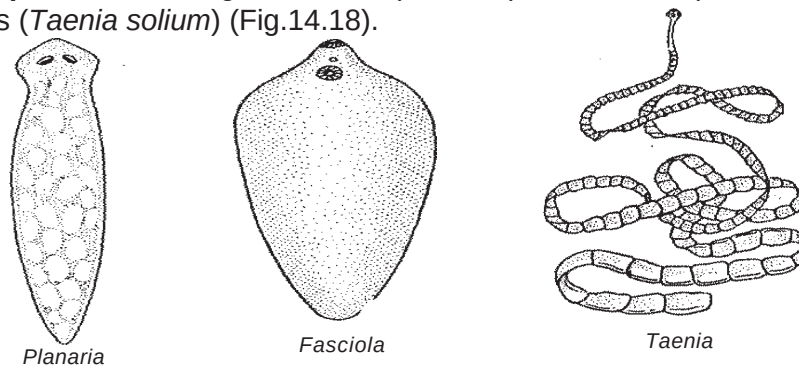


Fig.14.18 : Some examples of Platyhelminthes

14.6.5 Nemertea (Ribbon Worms)

Phylum Nemertea includes free-living marine worms with a distinctive eversible proboscis consisting of a long, hollow tube. They have an unsegmented body covered with cilia. Like flatworms, ribbon worms are acoelomates (without a coelom), but they do have a complete digestive system.

Example: Ribbon worm (*Lineus longissimus*) (Fig.14.19).



Fig.14.19: *Lineus longissimus*

14.6.6 Rotifera (Wheel animalcules)

Rotifers are common microscopic animals living in fresh water, particularly among plants and debris. They possess a rotating ciliated wheel organ called **corona** at the anterior end that resembles the head of an electric shaver, hence the name **wheel animalcule**.

Examples are *Brachionus*, *Philodina*, etc. (Fig.14.20).

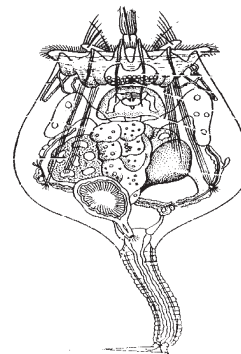


Fig.14.20 : *Brachionus*

14.6.7 Gastrotricha (Gastrotrichs)

Gastrotricha are microscopic (0.06-3.0 mm in body length) free-living, acoelomate, aquatic worms inhabiting the bottom of marine or freshwater habitats. In fresh waters they are a ubiquitous component of periphyton and benthos and also of the plankton. Gastrotrichs are microphagous, detritivorous, benthic community. Gastrotrichs swallow their food, which is made up of microalgae, bacteria and small protozoans, by means of the powerful sucking action of the muscular pharynx. They are preyed upon by turbellarians. The phylum is cosmopolitan with about 690 species. Example is *Chaetonotus* (Fig.14.21).



Fig.14.21 : *Chaetonotus*

14.6.8 Nematomorpha (Horsehair Worms)

The adults are very long, thin, hair-like worms that are free-living in water; the immature (larval) stage is usually parasitic on insects. People once thought that dark hairs from a horse's tail at a watering hole miraculously came to life, hence they are called horsehair worms. Example is *Gordius* (Fig.14.22).

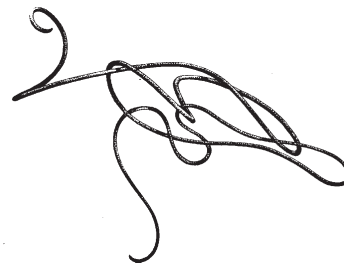


Fig.14.22 : *Gordius*

14.6.9 Nematoda (Nematodes)

This is a large phylum of worms, often called round worms or thread worms. Some of them are free living in soil or water, while many are parasitic forms on plants and animals. Important parasitic forms include hookworms (*Ancylostoma duodenale*), pinworms (*Enterobius*), human round worm (*Ascaris lumbricoides*) and trichinosis worm (*Trichinella spiralis*). Hookworm larvae burrow into the skin between the toes and eventually migrate into the intestines (Fig.14.23).

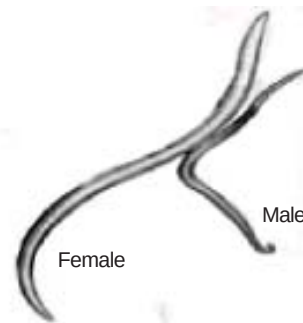


Fig.14.23: *Ascaris*

The disease **trichinosis** is caused by eating undercooked meat (especially pork) containing microscopic cysts of larval *Trichinella spiralis*. If ingested, the larval cysts can eventually migrate into skeletal muscle tissue. **Elephantiasis** is caused by minute filarial worms of the genus *Wuchereria* that invade lymphatic vessels; the filarial worms obstruct the flow of lymphatic fluids causing body extremities to swell to gargantuan proportions; microscopic filarial larvae causing elephantiasis are spread by blood-sucking female mosquitoes. Other dreaded parasitic worms in the phylum include the Guinea worm (*Dracunculus medinensis*) and the giant kidney worm (*Diectophyma renale*).

14.6.10 Acanthocephala (Spiny-Headed Worms)

This phylum includes small round worms that are intestinal parasites of vertebrates. These parasitic worms possess a proboscis at the anterior end which is covered with hooks for attachment to the wall of the intestines. Usually a crustacean or insect serves as an alternate host for young stages of its life cycle. Example is *Echinorhynchus* (Fig.14.24).

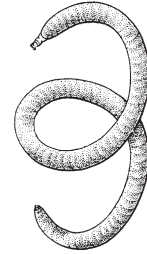


Fig. 14.24 : *Echinorhynchus*

14.6.11 Bryozoa (Bryozoans)

Bryozoans form coral-like colonies in the ocean and fresh water. They are often called “moss animals” because of their delicate branched colonies. Each animal has a fringe of tentacles around its mouth. Freshwater bryozoans produce disc-shaped, chitinous reproductive bodies called statoblasts which are sometimes very abundant in wolffia samples. Example is *Lophopus* (Fig.14.25).

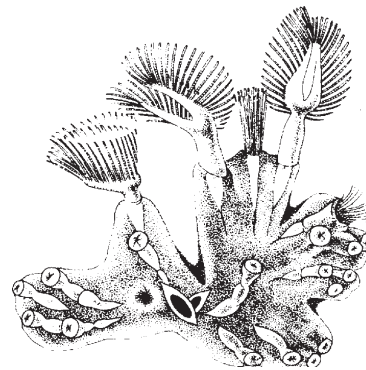


Fig.14.25 : *Lophopus*

14.6.12 Tardigrada (Tardigrades)

Tardigrades are minute creatures that live on moist mosses and lichens. They have short legs with minute claws and are sometimes called **water bears**. Like rotifers, they are able to roll up into a ball and survive long periods of desiccation, a phenomenon called **anabiosis**. Example: *Macrobiotus* (Fig.14.26).



Fig 14.26 : *Macrobiotus*

14.6.13 Brachiopoda (Brachiopods)

Brachiopods are primitive marine bivalve animals attached to rocks by a fleshy stalk. Although they superficially resemble bivalve molluscs, they are really quite different. In brachiopods, the two valves enclose the body dorsally and ventrally instead of laterally as in mollusks. The bivalve shells may be hinged (articulate) or without hinges (inarticulate). In addition, the ventral valve is usually larger than the dorsal, and is usually attached to the substratum directly or by means of a cordlike stalk. Brachiopod shells are abundant in the fossil record, dating back to the Cambrian Period (500 million years ago). There are approximately 280 species of living brachiopods. Example: *Lingula* (Fig.14.27).



Fig.14.27 : *Lingula*

14.6.14 Annelida (Segmented Worms)

Phylum Annelida includes the true worms such as earthworms, leeches, etc. They are triploblastic and bilaterally symmetrical. They have an elongated body composed of many segments. Each segment is provided with fine bristle-like **setae** for locomotion. They have a true coelom between the body wall and wall of the digestive canal. They are mostly aquatic, marine as well as freshwater. Some of them are terrestrial, burrowing or tube-living. Some of them are parasites sucking blood from vertebrate animals.

Examples : Clamworms (*Nereis*), sea mouse (*Aphrodite*), earthworms (*Pheretima*, *Lumbricus*), leeches (*Hirudo*, *Hirudinaria*, *Glossiphonia*), etc. (Fig.14.28).

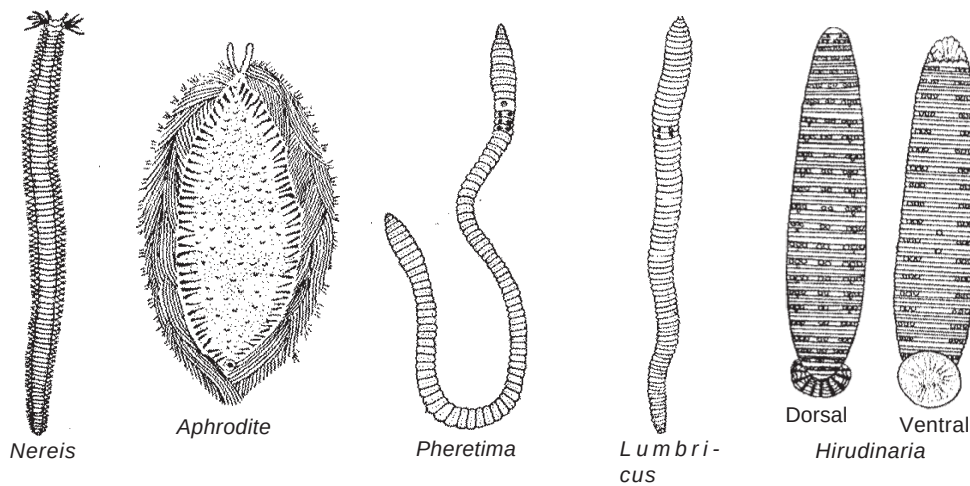


Fig.14.28 : Some examples of Annelida

14.6.15 Sipunculoidea (Peanut Worms)

Peanut worms have a slender, gourd-shaped body. The anterior end of the body is retractile, with short hollow tentacles around the mouth. Peanut worms (phylum Sipunculoidea) are named after their shape when fully contracted, which resembles a peanut pod. These interesting worms live in burrows under rocks of the intertidal zone. Example : *Sipunculus* (Fig.14.29).

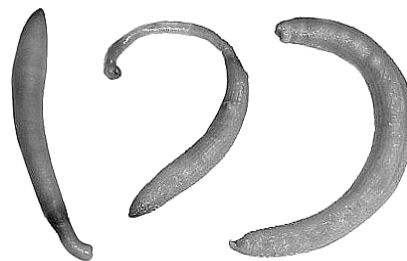


Fig.14.29 : *Sipunculus*

14.6.16 Arthropoda (Arthropods)

The body of arthropods is bilaterally symmetrical, triploblastic and metamerically segmented. All body parts are covered with chitinous exoskeleton. The body is usually divisible into head, thorax and abdomen; head and thorax are fused in some. All of them possess jointed legs. While growing up, the chitinous exoskeleton is shed at intervals and replaced from within by a new one. This is known as moulting.

Examples : Walking worms (*Peripatus*), shrimps and prawns (*Palaemon*), crabs (*Cancer*) barnacles (*Balanus*), ant (*Formica*), bees (*Apis*), silkworm (*Antheraea*), Housefly (*Musca*), mosquito (*Anopheles*, *Culex*), body louse (*Pediculus*), bedbug (*Cimex*), centipedes, (*Scolopendra*), millipedes (*Julus*), spiders (*Araenia*, *Tarantula*), ticks (*Ixodus*), King crab (*Limulus*), etc. (Fig.14.30).

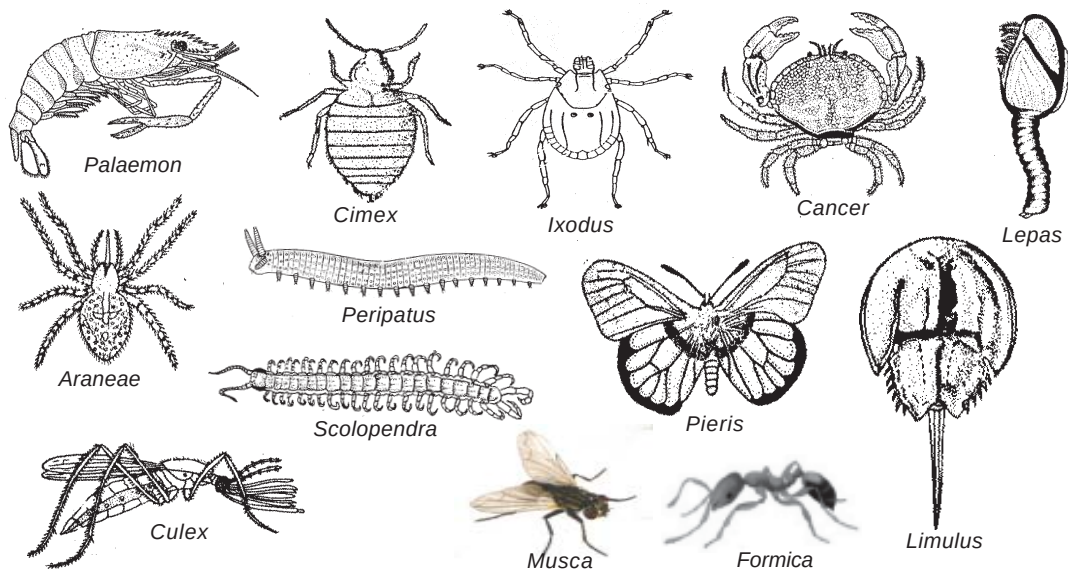


Fig.14. 30 : Some examples of Arthropoda

14.6.17 Chaetognatha (Arrow Worms)

These are small, transparent marine worms with bristles or hooks around the mouth. They have paired fins on the main body trunk and a terminal tail fin for locomotion. Although very small, they have well-developed digestive and sensory systems, and a true coelom.



Fig.14.31 : Sagitta

These planktonic marine animals are only about 5-10 mm in length, about the size of duckweeds of the genus **Wolffia**. They have a torpedo-shaped body with lateral and caudal fins that superficially resemble the feathers of an arrow. The head is covered by a rounded hood that is retracted when the arrow worm feeds. During feeding, the arrow worm captures small planktonic organisms, including copepods and other chaetognaths, using minute spines or bristles around the mouth. Example : Arrow worms (*Sagitta*)(Fig.14.31).

14.6.18 Mollusca (Molluscs)

In Mollusks, the body is soft with bilateral symmetry, often covered by a mantle that secretes a calcareous shell. They usually have an anterior head and a ventral muscular foot for locomotion.

Examples: Chitons (*Chiton*), tooth shells (*Dentalium*), univalve snails & limpets, (*Pila*, *Vivipara*, *Achatina*), bivalve mussels (*Unio*, *Mytilus*), octopus & squids (*Octopus*, *Loligo*, *Sepia*), etc. (Fig.14.32).

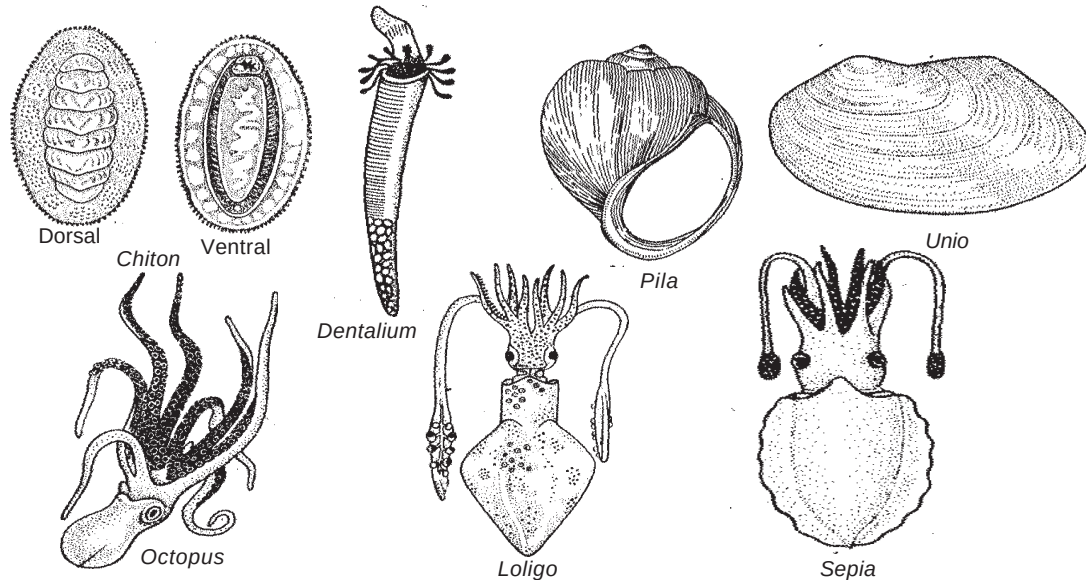


Fig.14.32 : Some examples of Mollusca

14.6.19 Echinodermata (Echinoderms)

Echinoderms have a radially symmetrical body, usually with 5 or more radiating arms. The body is distinguishable into the dorsal or **aboral** side and the ventral or **oral** side. Their body wall bears calcareous plates, often with external spines. They possess a water vascular system and external tube feet for locomotion.

Examples : Sea lilies (*Antedon*), starfishes (*Asterias*), brittle stars (*Ophiothrix*), sea urchins (*Echinus*), sea cucumbers (*Cucumaria*), etc.(Fig.14.33).

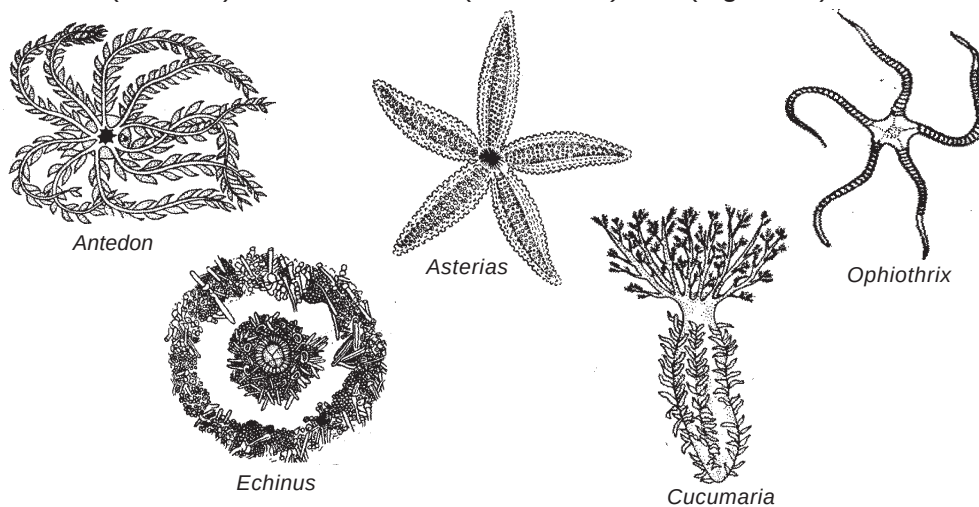


Fig.14.33 : Some examples of Echinodermata

14.6.20 Hemichordata (Acorn Worms)

Phylum Hemichordata includes a small group of marine invertebrates that were once thought to have a short **notochord**, the supportive axial rod that characterizes the phylum Chordata. Hemichordates do possess gill slits or pharyngeal clefts that are also found in chordates. Examples : *Balanoglossus* (Fig.14.34).

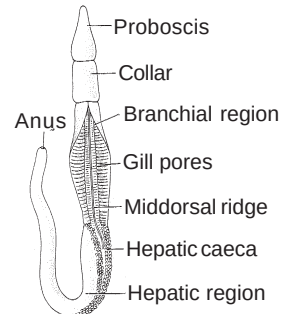


Fig.14.34 : Hemichordata (*Balanoglossus*)

14.6.21 Chordata (Chordates)

Phylum Chordata is characterized by the presence of (at some stage of development or throughout their life) an axial rod-like structure called **notocord** to support the body. They also possess a single dorsal **tubular nerve cord**, a series of **pharyngeal gill slits**, and a **tail** behind the anus.

Phylum Chordata is subdivided into three major subphyla:

1. Subphylum **Urochordata** includes primitive chordates known collectively as tunicates e.g. *Ascidia* (Fig.14.35). They have the notochord in their tail region.
2. Subphylum **Cephalochordata** includes lanceolets. Their notochord extends throughout the length of the body, e.g. *Amphioxus* (Fig.14.36).
3. Subphylum **Vertebrata** includes chordates in which the notochord becomes transformed into a vertebral column. Their skeleton is composed of cartilage or true calcareous bones

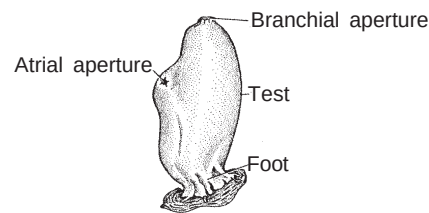


Fig. 14.35 : *Ascidia*



Fig.14.36 : *Amphioxus*

Sub-phylum vertebrata is divided into eight major classes:

1. Class **Ostracodermi** includes primitive, fish-like jawless animals which have become extinct, e.g. *Cephalepsis*.
2. Class **Cyclostomata** includes eel-like jawless and scaleless fishes with a circular mouth, e.g. hagfishes (*Myxine*), lamprey (*Petromyzon*) (Fig.14.37).

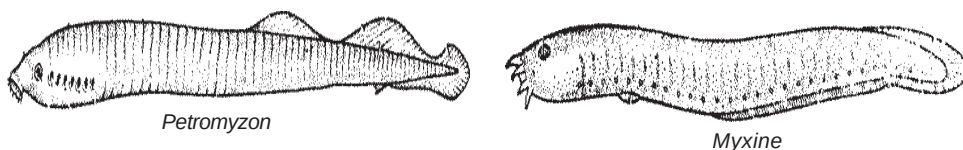


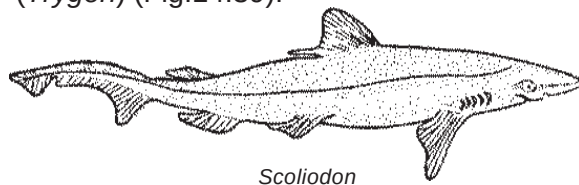
Fig.14.37 : Examples of Cyclostomata

3. Class **Placodermi** includes extinct, armoured fishes with jaws, e. g. *Climatius* (Fig.14

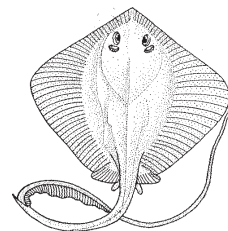


Fig.14.38 : *Climatius*

4. Class **Chondrichthyes** includes mostly marine fishes with cartilaginous endoskeleton and placoid scales, e.g. shark (*Scoliodon*) and sting ray (*Trygon*) (Fig.14.39).



Scoliodon



Trygon

Fig.14.39 : Examples of Cartilaginous fishes

5. Class **Osteichthyes** includes fishes with bony endoskeleton, body with or without scales; scale types are cycloid and ctenoid, e. g. **Pengba**, (*Osteobrama belangeri*), climbing perch (*Anabas*), lung fishes (*Protopterus*), sea horse (*Hippocampus*), Rohu (*Labeo*), Katla (*Catla*), **Porom** (*Ophiocephalus*), **Shareng** (*Wallago*), **Ngakra** (*Clarias*) etc. (Fig.14.40).

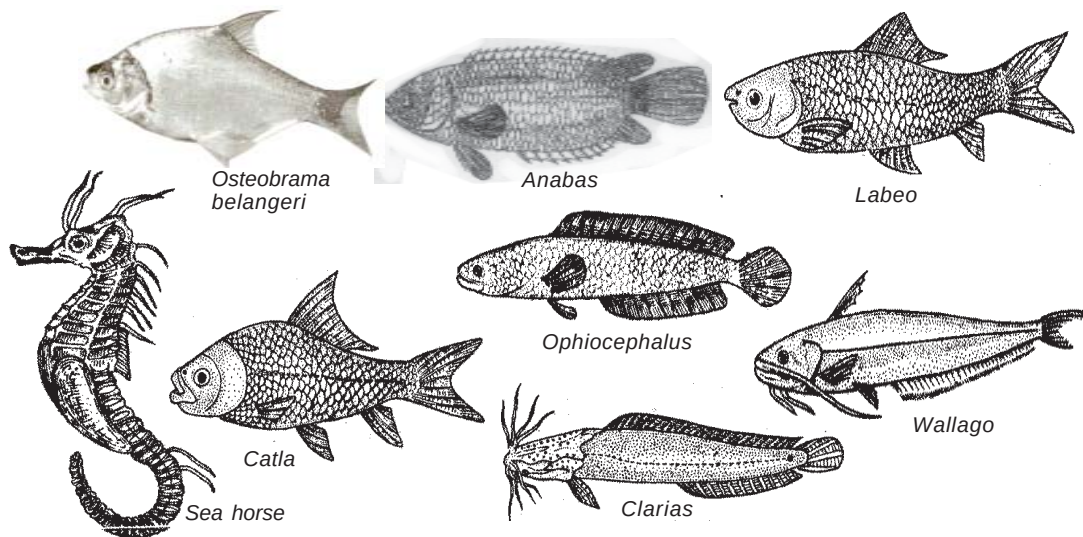


Fig.14.40: Some examples of fishes

6. Class **Amphibia** includes toads (*Bufo melanostictus*), frogs (*Rana tigerina*) and salamanders (*Tylotriton verrucosus*), which are the first group of four-limbed land vertebrates. Their larval stages are aquatic and fish-like. Their skin is always kept moist and used as an accessory respiratory organ (Fig.14.41).

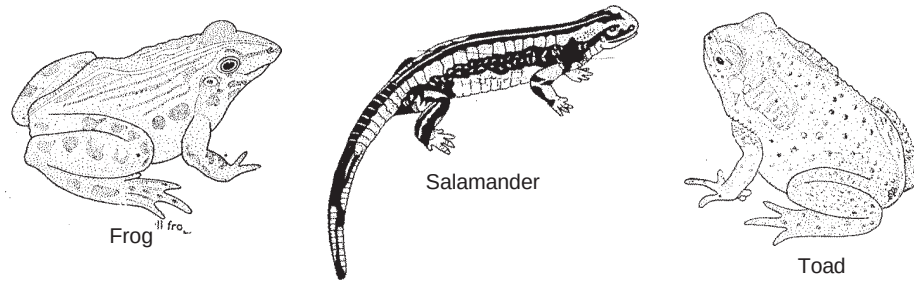


Fig.14.41 : Some examples of Amphibia

7. Class **Reptilia** or reptiles are fully terrestrial tetrapods with dry scales covering the body. They are cold-blooded and respire only with lungs. Examples are Garden lizard (*Calotes*), Wall lizard (*Hemidactylus*), Cobra (*Naja naja*), Ajar (*Python*), Crocodile (*Crocodylus*), etc. (Fig.14.42).

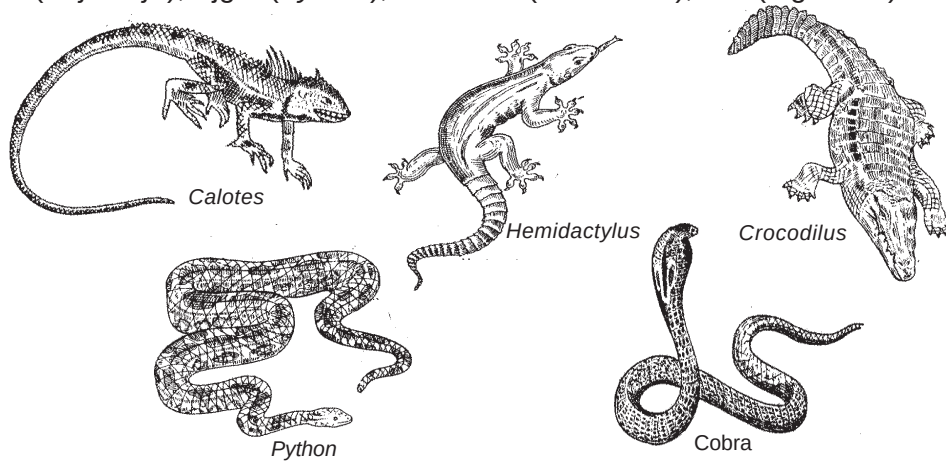


Fig.14.42 : Some examples of Reptiles

8. Class **Aves** includes all kinds of birds which are the only vertebrates with feathers that cover the body. Their forelimbs are modified into wings for flight. However, some of them are flightless birds. Examples are sparrow (*Passer domesticus*), crow (*Corvus macrorhynchos*), Parrot (*Psittacula*), Owl (*Bubo*), Ostrich (*Struthio*), etc. (Fig.14.43); and

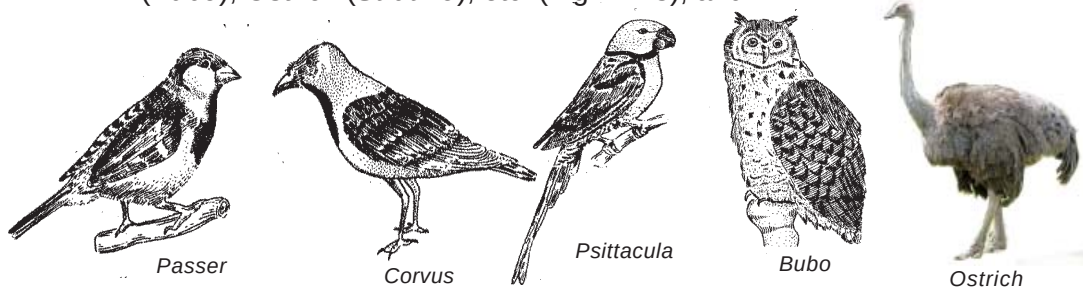


Fig.14.43 : Some examples of birds

9. Class **Mammalia** includes mammals which are warm-blooded animals with hair covering the body. Females suckle their young ones with milk from the mammary glands. They respire only with lungs. Examples are rat (*Rattus rattus*), dog (*Canis familiaris*), spiny anteater (*Echidna*), kangaroo (*Macropus*), brow-antlered deer (*Cervus eldi eldi*), monkey (*Macaca*), chimpanzee (*Pan*) man (*Homo sapiens*) etc. (Fig.14.44).

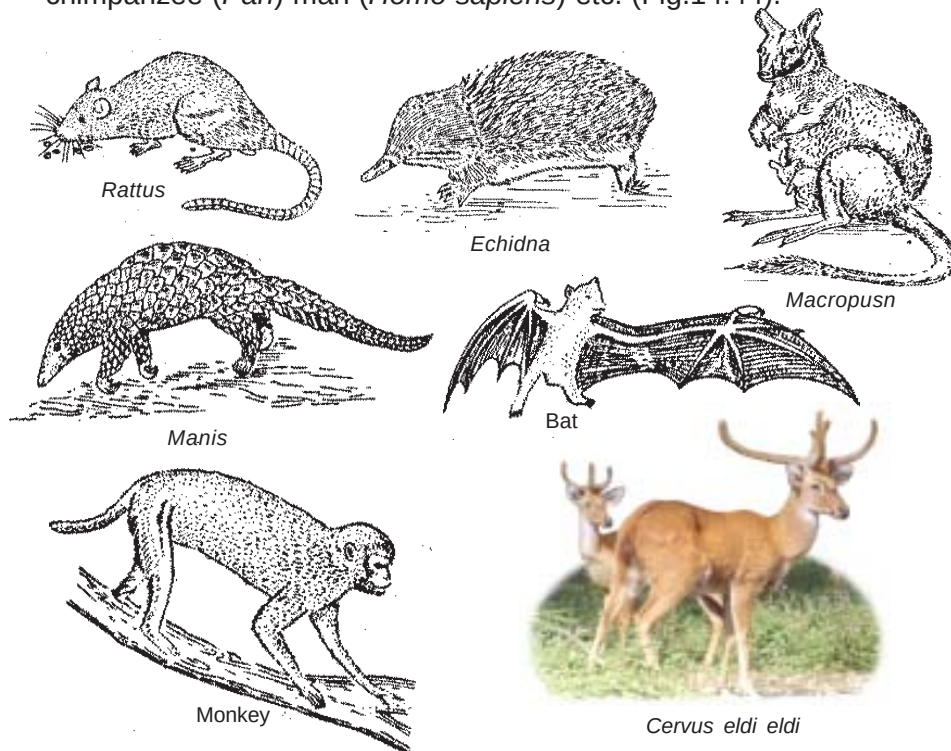


Fig. 14.44: Some examples of Mammals

POINTS TO REMEMBER

- * Biological diversity is the variation of life forms, including plants and animals, occurring within a given ecosystem, locality or on the entire Earth.
- * The number of species living on the earth could be in the range from 10 million to 50 million.
- * The total number of species actually named and recorded till now is only around 1.5 million.
- * The first step of finding out to which group the unknown organism belongs is known as identification.
- * The second step of giving a name to the newly discovered and identified organism is known as naming.
- * The binominal system of nomenclature was introduced by Carolus Linnaeus in 1758.

- * A hierarchy is a systematic framework for biological classification in which taxonomic groups are arranged in an ascending series of levels with ever-increasing inclusiveness.
- * The hierarchy of classification has six basic levels or categories, viz. Phylum (for animals) and Division (for plants), Class, Order, Family, Genus and Species.
- * Classification is the ordering of animals into groups on the basis of their relationships.
- * Taxonomy is the branch of biology dealing with the classification and naming of organisms.
- * Robert H Whittaker in 1969 proposed the five kingdom system of classification.
- * Five kingdom classification is based on the kind of cells that make up the organism; the number of cells that make up the organism and the method by which the organism obtains food.
- * Kingdom Monera includes all the prokaryotic organisms including bacteria, cyanobacteria, etc.
- * Members of the Kingdom Protista are generally unicellular, eukaryotic organisms, although some multicellular forms are also included.
- * Fungi are eukaryotic, heterotrophic organisms that mainly serve as decomposers and play important role in recycling of materials.
- * Plants are multicellular, eukaryotic, photosynthetic and autotrophic organisms that form the basis of the food web in terrestrial ecosystems.
- * Animals are multicellular, eukaryotic, heterotrophic organisms which represent the consumer levels of the food web in any ecosystem.
- * Thallophyta includes autotrophic plants without true roots, stems or leaves.
- * Pteridophytes or ferns are seedless vascular plants.
- * Bryophyta, also known as amphibians of the plant kingdom, includes mosses and liverworts.
- * Division Spermatophyta comprises the seed-bearing plants.
- * Gymnosperms are tracheophytes with naked seeds while Angiosperms are flowering plants which bear their seeds enclosed within ripened ovary (fruit).
- * The cycads were so numerous in Mesozoic times that this era is often called the Age of Cycads and Dinosaurs.
- * Division Ginkgophyta includes the only living representative *Ginkgo biloba*, which is a true living fossil dating back 185 million years.
- * Conifers constitute dominant forest vegetation in temperate parts of the world and regions of high altitude.
- * Division Anthophyta includes the flowering plants, which form the largest group in the plant kingdom. More than 90% of all plants on earth are angiosperms.

- * Flowering plants may be as minute as a pin head, e. g. *Wolffia* microscopica or as massive as a 300 feet high tree, e. g. *Eucalyptus*.
- * Flowering plants provide us cereals, pulses, vegetables, fruits, fibres, timbers, gums, resins, tannins, dyes, spices, sugar, starch, condiments, rubber, paper, medicines, tea, coffee, tobacco, fats oils and several other useful products.
- * Monocots have only one cotyledon inside the seed and parallel leaf venation.
- * Dicot plants have two cotyledons inside the seed and branched or net-like leaf venation.
- * Porifera includes sponges, which are simple multicellular aquatic animals that remain fixed to a rock or substratum under water.
- * All cnidarian animals possess a kind of stinging cells called nematocysts.
- * Ctenophora have eight “comb like rows” of fused cilia arranged along the sides of the animal.
- * Platyhelminthes include dorso-ventrally flattened, leaf or ribbon-like, bilaterally symmetrical worms with, triploblastic body.
- * Nemertea includes free-living marine worms with a distinctive eversible proboscis consisting of a long, hollow tube.
- * Rotifers possess a rotating ciliated wheel organ called corona at their anterior end.
- * Nematomorpha are very long, thin, hair-like worms that are free-living in water.
- * Nematoda or nematodes include round worms or thread worms.
- * Acanthocephala are small intestinal parasites of vertebrates. They possess a proboscis at the anterior end with hooks for attachment to the wall of the intestines.
- * Tardigrades are minute creatures with short legs with minute claws and are sometimes called water bears.
- * Brachiopods are primitive marine bivalve animals attached to rocks by a fleshy stalk.
- * Mollusca include animals with soft, bilaterally symmetrical body, usually covered by a calcareous exoskeleton or shell.
- * Annelida include the true worms such as earthworms, leeches with triploblastic, bilaterally symmetrical and elongated segmented body.
- * Sipunculoidea or peanut worms have a slender, peanut or gourd-shaped body.
- * Arthropoda includes animals with bilaterally symmetrical, triploblastic and metamerically segmented body covered with chitinous exoskeleton. They possess jointed appendages.
- * Chaetognatha or arrow worms are small, transparent marine worms with bristles or hooks around the mouth.
- * Echinoderms have a radially symmetrical body, usually with 5 or more radiating arms.

- * Hemichordata includes a small group of marine invertebrates that were once thought to have a short notochord, the supportive axial rod that characterizes the phylum Chordata.
- * Chordata is characterized by the presence of a notocord to support the body, a single dorsal tubular nerve cord, a series of pharyngeal gill slits, and a tail behind the anus.
- * Urochordata or tunicates include primitive chordates that have the notochord in the tail region.
- * In Cephalochordata, notochord extends throughout the length of the body.
- * Vertebrata includes chordates in which the notochord becomes transformed into a vertebral column.

EXERCISES

1. *What is biological diversity?*
2. *What is meant by identification and naming?*
3. *Write what you know about binominal nomenclature.*
4. *What is taxonomic heirarchy? Who had introduced it?*
5. *Define classification.*
6. *Define taxonomy.*
7. *Who is known as the father of biological classification?*
8. *Why is Linnaeus called father of taxonomy?*
9. *Who had proposed the five kingdom classification?*
10. *What are the advantages of the five- kingdom system over the two-kingdom system of classification?*
11. *Write down the three important bases of the five-kingdom classification.*
12. *Write briefly on the following:*
 - (a) *Kingdom Monera,*
 - (b) *Kingdom Protista,*
 - (c) *Kingdom Fungi,*
 - (d) *Kingdom Plantae, and*
 - (e) *Kingdom Animalia.*
13. *Write down the salient features of the following:*
 - (a) *Thallophyta,*
 - (b) *Pteridophyta*
 - (c) *Bryophyta*
 - (d) *Spermatophyta*
 - (e) *Cycadophyta*

- (f) *Ginkgophyta*
 - (g) *Gnetophyta*
 - (h) *Coniferophyta*,
14. Write down the salient features of the following:
- (a) *Porifera*,
 - (b) *Cnidaria*,
 - (c) *Platyhelminthes*,
 - (d) *Rotifera*,
 - (e) *Gastrotricha*,
 - (f) *Nematoda*,
 - (g) *Mollusca*,
 - (h) *Annelida*,
 - (i) *Arthropoda*,
 - (j) *Echinodermata*.
15. Write down three basic features of *Chordata*.
16. Enumerate the living classes under subphylum *Vertebrata*.
17. Write briefly on the following classes:
- (a) *Chondrichthyes*,
 - (b) *Osteichthyes*,
 - (c) *Amphibia*,
 - (d) *Reptilia*,
 - (e) *Aves* and
 - (f) *Mammalia*.