NONCHORDATA

SC–108

Self Learning Material

Directorate of Distance Education

SWAMI VIVEKANAND SUBHARTI UNIVERSITY
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UNIT 1

INTRODUCTION

STRUCTURE

- Introduction
- Distinguishing Features of invertebrates
- Outline Classification of Animals
  - Summary
  - Student Activity
  - Test Yourself

LEARNING OBJECTIVES

After going this unit you will learn :
- About Invertebrates and their distinguishing features
- A basic idea of the classification of animals

• 1.1 INTRODUCTION

Animals are often distinguished into two major categories, the "chordates" and the "non-chordates". This division is based on the presence or absence of a singular character the ***notochord*** : Notochord is a stiff rod-like structure which serves as an endoskeleton to support elongated body posture of chordates. Animals, lacking a notochord are called ***"Non-chordates"***.

• 1.2 DISTINGUISHING FEATURES OF INVERTEBRATES

"Invertebrata" is not a natural group of classification and the animals included in this group, do not show a single common character except for the absence of vertebral column and notochord except few (Protochordates). Even though there are some major characteristics or patterns that had been kept in mind by the taxonomists to classify the invertebrates.

1. Arrangement of cells : Invertebrates vary in this pattern from single celled body (Protozoa) to multicellular body (Metazoa). In metazoans cells are arranged in layers (porifera) or tissues.

2. Germ layers : Protozoans, Poriferans, Coelentrates and Ctenophorans are all diploblastic (two germ layers) and the rest of invertebrates are triploblastic (three germ layers).

3. Body organization : Invertebrates show a variety of levels of organization. It is protoplasmic in Protozoans, cellular in Poriferans, tissue grade in Coelentrates and Ctenophorans. Rest of the higher invertebrates show organ and organ-system grade organization.

4. Symmetry : Both radial and bilateral symmetry are found in invertebrates.

5. Segmentation : Except annelids and arthropods segmentation is absent in all the invertebrates.

6. Digestive tract : It is incomplete (without anus) in lower invertebrates and complete, but protostomic in higher invertebrates except arthropods and echinoderms.

7. Excretory organ : Various types of excretory organs, *e.g.*, flame cells, pseudo coelomic, lophophorate coelomic, reduced schizocoelomic etc are found in invertebrates.

8. Coelom : It is falsely present in lower invertebrates but true coelom is found in higher invertebrates

9. Respiratory organs : Except Molluscs, Annelids, Arthropods, and Echinoderms specific respiratory organs are absent in rest of the invertebrates.

Further, each phylum of Invertebrates has its own distinguishing features that are characterstic for that phylum only.

• 1.3 OUTLINE CLASSIFICATION OF ANIMALS

There are about 31 phyla, 68 classes and 350 orders of living animals, recognized in the animal kingdom. The following classification is based on the work of *Hyman, Barnes* and *Storer* with slight modification.

Kingdom Animalia

It includes the entire fauna (animal population) of the world.

Sub-kingdom 1–Protozoa

Unicellular, microscopic animals.

Phyum 1 : Protozoa (First animals)

(i) About 50,000 species. solitory or colonial

(ii) Single celled body with single or many nuclei.

(iii) Nutrition holozoic, holophytic or saprozoic

(iv) Free living, commensal, symbiotic or parasitic.

Examples : Euglena, Paramaecium etc.

Sub-kingdom 2–Metazoa

Multicellular animals. Cells are arranged in layers or tissues. Metazoans are divided into 3 branches.

Branch 1–Mesozoa

Digestive cells few, external ciliated. No tissue or organs.

Phylum 2–Mesozoa

(i) About 50 species

(ii) Worm like, small endo-parasites of marine invertebrates.

(iii) Body with an outer single layer of ciliated digestive cells, enclosing one or several reproductive cells.

Example : Dicyema, Rhopalura etc.

Branch 2–Parazoa

Digestive cells many, internal, flagellated. Tissues poorly defined. Organs are absent.

Phylum 3 Porifera (sponges)

(i) About 5,000 species.

(ii) Pore bearing body.

(iii) Different kinds of water canal system are found.

(iv) Flagellated collar cells or choanocytes are found.

(v) Skeleton of minute calcareous spicules or spongy fibers.

(vi) Sessile , solitary or colonial

Example : Leucosolenia, Sycon, Euspongia etc.

Branch 3-Eumetazoa

Multicelled animals with defined organs, mouth and digestive cavity, Subdivided into two grades- Radiata and Bilateria.

Grade (A) Radiata

Radially symmetrical body, diploblastic animal. External opening is mouth.

Phylum 4 Coelentrata (with hollow intestine)

(i) About 10,000 species, cnidoblast cells are found (cnidaria)

(ii) Radial symmetry. Two or three layers of cells.

(iii) Sac like gastrovascular cavity.

(iv) Sessile or free swimming.

(v) Solitary or colonial.

Example : Hydra, Obelia, Aurelia etc.

Phylum 5–Ctenophora (comb-bearer)

(i) Comb-jellies, about 90 species.

(ii) Biradial symmetry.

(iii) 2 tentacles and 8 longitudinal rows of ciliated comb plates for locomotion.

(iv) Free swimming, marine.

Examples : Pleurobranchia, Cestum, Beroe etc.

Grade (B) Bilateria

Bilaterally symmetrical, triploblastic animals with organ-system. Digestive tract complete with anus. It is subdivided into two divisions.

Division 1–Protostomia

Barnes had divided this division into 4 subdivisions–

Subdivision I-Acoelomata

No body cavity or coelom. Body cavity is filled by mesenchymal parenchyma.

Phylum 6–Platyhelminthes (flatworms)

(i) About 15,000 species.

(ii) Body dorso-ventrally flattened.

(iii) Digestive tract branched or absent.

(iv) No anus and circulatory system.

(v) Free living or parasitic.

Examples : Planaria, Fasciola, Taenia etc.

Phylum 7–Rhynchocoela or Nimertinea (Ribbon Worms)

(i) About 750 species.

(ii) Body dorsoventrally flattened and ciliated.

(iii) Mouth and anus are present. Proboscis reversible.

Example : Cerebratulus, Lineus etc.

Subdivision II-Pseudocoelomata

Body cavity is a pseudocoelom. It is a persistent blastocoel, not lined by mesoderm.

Phylum 8–Acanthocephala (spiny headed worms)

(i) About 500 species.

(ii) Minute worm like endoparasites.

(iii) No digestive cavity.

(iv) Protrusible proboscis with recurved spines.

Examples : Acanthocephalus, Gigantorhynchus etc.

Phylum 9–Entoprocta

(i) About 60 species. All are sessile.

(ii) Body of calyx and slender stalk.

(iii) Digestive tube U-shaped.

(iv) Mouth and anus close together and surrounded by a tentacular crown.

Example : Pedicellina, Loxosoma etc.

Superphylum Aschelminthes (Sac worms)

An assemblage of pseudocoelomates with anterior mouth, posterior anus and straight digestive tube. Predominantly aquatic. Free living, epizoic or parasitic. It includes 5 phyla.

Phylum 10–Rotifera (wheel animalcules)

(i) About 1,500 species.

(ii) Microscopic animalcules.

(iii) Anterior end with ciliated crown.

(iv) Pharynx with internal jaws.

Examples : Philodina, Rotatoria etc.

Phylum 11–Gastrotricha (Hairy stomach worms)

(i) About 175 species. Microscopic animalcules

(ii) Ventral surface flattened and ciliated.

(iii) Cuticle with spines, plates or scales.

Examples : Chaetonotus, Macrodasys etc.

Phylum 12–Kinorhyncha (Jaw moving animals)

(i) About 100 species, Small in size.

(ii) Cuticle segmented and with recurved spines.

(iii) Spiny anterior end or proboscis retractile.

Examples : Echinoderes, Pycnophyes etc.

Phylum 13–Nematoda (Round worms)

(i) About 12,000 species.

(ii) Body slender and Cylindrical.

(iii) Cuticle tough, often ornamented.

(iv) Radial or biradial arrangement of structures around mouth.

(v) Free living or parasitic.

Examples : Ascaris, Trichinella, Wuchereria etc.

Phylum 14–Nematomorpha (Horsehair Worms)

(i) About 100 species.

(ii) Body long, thread-like.

(iii) Larval stage are parasitic in insects.

(iv) Adult free-living in water or dump soil.

Examples : Nectonema, Gordius etc,

Subdivision III-Lophophorate Coelomata

Coelom develops as schizocoel or enterocoel. They are with a crown of hollow tentacles (lophophore) surrounding mouth.

Phylum 15–Phoronida

(i) About 15 species.

(ii) Worm-like unsegmented body enclosed in chitinous tube.

(iii) Lophophore horseshoe-shaped.

Examples : Phoronis, Phoronopsis.

Phylum 16–Bryozoa or Ectoprocta (moss animals)

(i) About 4,000 species, sessile.

(ii) Body enclosed in a gelatinous chitinous or calcareous covering

(iii) Lophophore V-shaped or circular.

Examples : Plumatella, Bugula etc.

Phylum 17–Brachiopoda (lamp shells)

(i) About 260 species.

(ii) Body enclosed in two unequal calcareous shell valves.

(iii) Lophophore W-shaped.

Examples : Lingula, Crania etc.

Subdivision IV-Schizocoelous Coelomata

Coelom is a schizocoel which originates as a space by the splitting of the embryonic mesoderm.

Phylum 18–Priapulida.

(i) 8 species.

(ii) Sausage or cucumber-shaped marine animals with a swollen proboscis.

(iii) Body surface covered with spines and tubercles.

Examples : Priapulus, Halicryptus etc.

Phylum 19–Sipunculida (peanut worms)

(i) About 275 species.

(ii) Body elongated and cylindrical with retractile anterior end.

(iii) Lobes or tentacles around mouth.

(iv) Anus dorsal.

Examples : Sipunculus, Aspidosiphon etc.

Phylum 20–Mollusca (soft bodied animals)

(i) About 80,000 species.

(ii) Body soft unsegmented, with ventral muscular foot.

(iii) Mantle with shell glands.

(iv) External limy shell of 1, 2, or 8 plates.

Examples : Chitons, Pila, Unio etc.

Phylum 21–Echiurida (Adder-tailed worms)

(i) About 60 species.

(ii) Body cylindrical unsegmented with anterior retractile proboscis.

(iii) One pair of large ventral setae below mouth.

Examples : Echiurus, Urechis etc.

Phylum 22–Annelida (Ringed worms)

(i) About 8,700 species.

(ii) Body elongated, metamerically segmented.

(iii) Setae for locomotion.

Examples : Pheretima, Nereis, Leech etc.

Phylum 23–Tardigrada (Water bearers)

(i) About 180 species.

(ii) Body segmented with 4 pairs of unsegmented legs terminating in claws.

Examples : Echiniscus, Hypsibius etc.

Phylum 24–Onychophora (Claw bearers)

(i) About 73 species.

(ii) Worm like unsegmented body covered by thin cuticle.

(iii) Many pairs of short stumpy legs ending in claws.

Examples : Peripatus, Peripatopsis.

Phylum 25–Arthropoda (Joint legged animals)

(i) About one million species.

(ii) Body segmented with jointed appendages.

(iii) Exoskeleton chitinous.
(iv) Coelom vestigeal.
(v) Body cavity haemocoel.
Examples : Prawns, Insects, Flies etc.
Phylum 26–Pentastomida (Tongue worms)
(i) About 70 species.
(ii) Worm like unsegmented body with two anterior appendages terminating in claws.
(iii) Blood sucking endoparasites of vertebrates
Examples : Cephalobaena, Porocephalus etc.

Division 2–Deuterostomia

Cleavage radial and indeterminate. Mouth arises some distance away from blastopore. Coelom is an enterocoel which originates as pouch of embryonic gut (archenteron).

Phylum 27–Chaetognatha (Arrow worms)
(i) About 50 species.
(ii) Small elongated transparent body bearing postanal tail and lateral fins.
(iii) Anterior end with grasping spines.
Examples : Sagitta, Spadella etc.
Phylum 28–Echinodermata (Spiny skinned animals)
(i) About 6,000 species.
(ii) Secondary pentamerous radial symmetry.
(iii) Calcareous endoskeleton of plates bearing external spines.
(iv) A part of coelom is as *water vascular canals.*
(v) Locomotion by tube feet.
Examples : Starfish, Brittle stars etc.
Phylum 29–Pogonophora (beard worms)
(i) About 80 species.
(ii) Body long, enclosed in a chitinous tube.
(iii) Anterior end with one to many tentacles.
(iv) No digestive tract.
Examples : Siboglinum, Spirobrachina, Polybrachia etc.
Phylum 30–Hemichordata (acorn worms)
(i) About 80 species.
(ii) Body worm like, divided into proboscis, collar and trunk.
(iii) With gill slits.
Examples : Balanoglossus, Cephalodiscus etc.
Phylum 31–Chordata
(i) About 49,000 species.
(ii) Dorsal tubular nerve cord, notochord, and pharyngeal gill slits at some stage in life history.
(iii) Tail postanal.
Examples : Ascidians, Amphioxus, Fishes, Birds, Man etc.

• SUMMARY

Animals are classified into two major categories, the chordates and the non-chordates. Invertebrates or non-chordates are characterized by the absence of vertebral column and notochord. There are about 31 phyla (major and minor), 68

classes and 350 orders of living animals which are recognized in the animal kingdom. The biggest phylum Arthropoda contains one million species.

Keywords : Chordata, Non-chordata, Vertebral column, notochord.

• STUDENT ACTIVITY

1. Make a labelled chart of outline classification of animals.

• TEST YOUR SELF

1. Explain the distinguishing features of invertebrates.
2. Give outline classification of invertebrates.
3. Give important characters of deuterastomies.
4. Objective type quesitons:
   (1) Spiny skinned animals are :
   (a) Annedidans (b) Echinoderms
   (c) Hemichordates (d) arthropods
   (2) Ringed worms are found in :
   (a) Aschelminthes (b) Annelids
   (c) Platyhelminthes (d) Protozoans
   (3) Mantle with shell glands is a characterstic feature of :
   (a) Arthropoda (b) Annelida
   (c) Mollusca (d) Nematoda
   (4) The biggest phylum is
   (a) Porifera (b) Protozoa
   (c) Annelida (d) Arthropoda.
   (5) Pseudocoelomate animals are not
   (a) Entoprocta (b) Nematoda
   (c) Rotifera (d) Annelida

Ans. (1) b (2) b (3) c (4) d (5) b

UNIT

2

PROTOZOA

STRUCTURE

LEARNING OBJECTIVES

After going this unit your will learn :

- Protozoa in detail their characteristic and classification.
- Their significance in relation to human diseases
- A basic idea of classification of animals.

• 2.1 INTRODUCTION

Protozoans are microscopic, unicellular or acellular animalcules, having one or more nuclei. In the traditional system of classification, '*Protozoa*' is treated as subkingdom or as the first phylum of the animal kingdom as indicated by its name (Gr., Protos, first + zoon, animals). Protozoans are versatile in their habit and habitat and their life forms. To keep all unicellular organisms in protozoa is not proper because there are certain examples, *e.g.*, Euglena and volvox, etc. that possess both plant and animal like characters. Zoologists consider them as animals and Botanists consider them as plants. To avoid this confusion in classification Haeckel (1866) and Whittaker (1969) proposed a separate kingdom protista, for all single celled eukarayotic organisms. In the kingdom Protista, the different classes of protozoa (flagellata, sarcodina, sporozoa and ciliata) become independent phyla.

However, we still treat protozoa as a first phylum of animal kingdom as traditionally done.

• 1.2 CHARACTERISTIC FEATURES OF PROTOZOA

1. About 50,000 species. All are microscopic animalcule.
2. They are most primitive acellular with one or more nuclei and show protoplasmic grade of organization.
3. Free living, parasitic or saprozoic organisms, mostly aquatic, marine as well as freshwater.
4. Solitary or forming loose colonies in which individuals remain alike and independent.
5. Body symmetry is not definite.
6. Body is naked or bounded by a pellicle with or without exoskeleton.
7. There is subcellular physiological division of labour, *i.e.*, single cell performs all the vital functions of life.
8. Locomotion by pseudopodia or flagella or cillia or absent.

9. Nutrition holozoic, holophytic, saprozoic or parasitic. Digestion is intracellular, *i.e.*, inside the food vacuoles.

10. Respiration and excretion through general body surface or through contractile vacuoles, which serve mainly for osomoregulation.

11. Reproduction, asexual by fission or budding and sexual by conjugation of adults (hologamy) or by fusion of gametes (syngamy).

12. Encystment occurs, helps in dispersal and to resist unfavourable conditions of food, temperature and moisture.

• 2.3 CLASSIFICATION

On the basis of locomotory organelles and nuclear apparatus, phylum protozoa is divided into four subphyla.

Subphylum (A)–Sarcomastigophora

(i) Locomotory organelles mostly pseudopodia or flagella or both.

(ii) Nucleus one or more but monomorphic.

Class 1: Mastigophora or Flagellata (Gr. mastix, whip; phoros, bearing)

(i) Simple primitive with firm pellicle.

(ii) Locomotory organelles one or more fine thread like flagella.

(iii) Nutrition autotrophic (chlorophyll bearing) or heterotrophic or both or parasitic.

Examples : Euglena, Noctiluca, Trypanosoma etc.

Class 2: Sarcodina or Rhizopoda

(i) Body has no definite shape (amoeboid), without definite pellicle.

(ii) Locomotion by pseudopodia as lobopodia, filopodia or reticulopodia without axial filaments.

(iii) Nutrition holozoic or saprozoic.

Example : Amoeba, Entamoeba, Actinophrys etc.

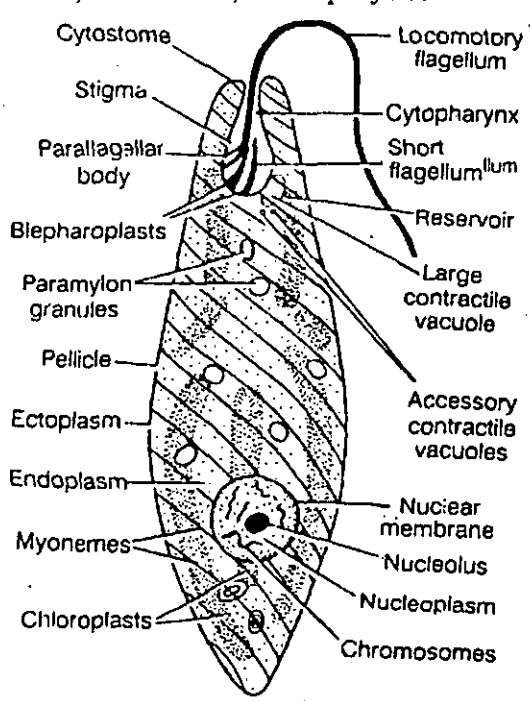

Fig 1. Euglena

Class 3: Opalinata

(i) Entire body is covered by cilia like flagella.

(ii) Nuclei 2 to many but monomorphic.

(iii) Intestinal parasites of Frogs and Toads.

Examples : Opalina, Zelleriella.

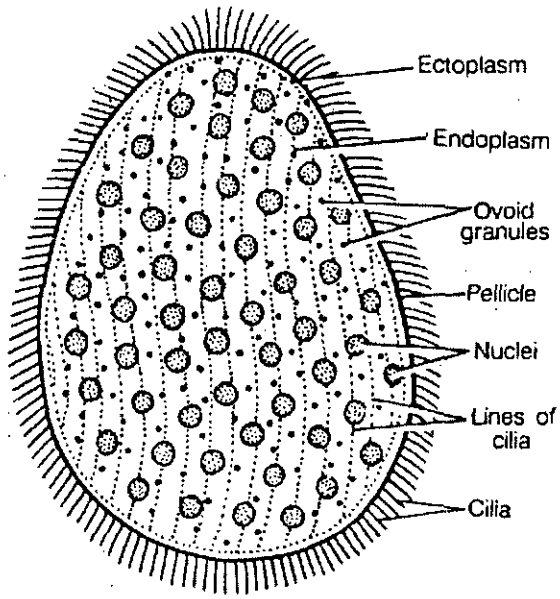

Fig 2. Opalina

Supbhylum (B)–Sporozoa (Apicomplexa)

(i) Exclusively endoparasites.

(ii) Life cycle is complex and spores usually formed, but have no polar filaments.

(iii) No specialized locomotory organelles.

(iv) At some stage of life, an apical complex of ring like, tubular, filamentous organelles is formed.

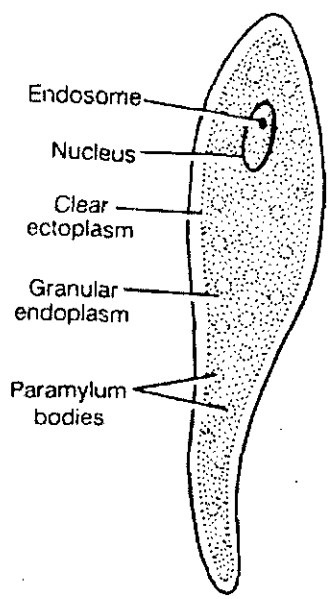

Fig 3. Monocystis

Class 1: Telospora

(i) Spores without polar capsule and filaments.

(ii) Sporozoits, elongated, narrow, naked or encysted.

Examples : Plasmodium, Monocystis. etc.

Class 2: Piroplasmea

(i) Spores absent, sporozoites naked and ovoid.

(ii) Minute intracellular parasites of RBC of cattles.

Examples: Toxoplasma, Babesia. etc.

Subphylum (C)–Cnidospora

(i) Intracellular endoparasites. No locomotory organelles.

(ii) Spores with polar filaments.

Class 1: Myosporea

(i) Spore large with 1 to 4 polar filaments, develops from several nuclei.

(ii) Spore wall is bivalved or trivalved.

Examples: Ceratomyxa, Myxidium. etc.

Class 2: Microsporea

(i) Spores small with 1 to 2 polar filaments, develop from a single nucleus.

(ii) Spore-wall univalved.

Example : Nosema. etc.

Subphylum (D)–Ciliophora

(i) Largest group of protozoans which are structurally most complex.

(ii) Locomotory organelles cilia or ciliary organelles.

(iii) Nuclei two or more and dimorphism found.

(iv) Reproduction asexual mainly by transverse fission and sexual mainly by conjugation.

Class 1: Ciliata

(i) Locomotory organelles numerous hair like cilia present throughout life.

(ii) One or two contractile vacuoles present even in marine and parasitic types.

Examples : Paramecium, Vorticella. Balantidium.etc.

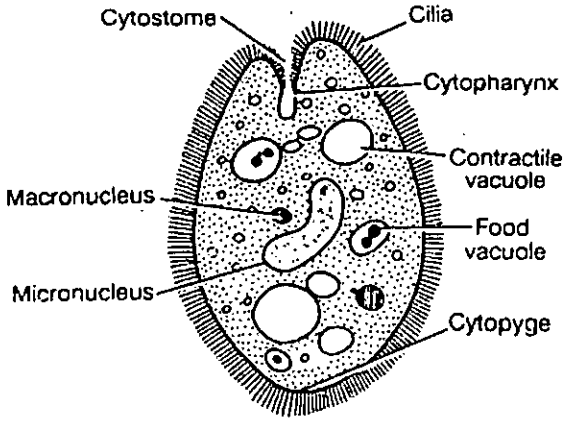

Fig 4. Balantidium

• 2.4 PROTOZOAN PARASITES IN RELATION TO HUMAN DISEASES

In human beings most of the diseases are caused by different kinds of organisms such as Bacteria, Protozoans, Fungi, Viruses Helminths and Arthropods. Pathagenic parasites belonging to various groups of animal kingdom share the following common characteristic features.

(1) All are obligatory parasites, *i.e.,* they depend for their existence upon their hosts.

(2) All show host specificity.

(3) They secrete toxic substances which cause the particular disease.

(4) They complete their life cycle in one or more than one host.

Parasitic species occur in all classes of Protozoa. Most of them cause worst human diseases as follows :

(1) Amoebiasis : This disease is also known as amoebic dysentery and is caused by Entamoeba histolytica which belongs to the class Sarcodina. Its infctious stage, trophzites dive in the walls of colon and cause formation of ulsers. Transmission of the disease takes place through cysts present in the contaminated food and water.

(2) Diarrhoea : Diarrhoea is caused by a flagellate protozoan Giardia intestinalis. It is an endoparasite of small intestine of man. Transmission of the parasite takes place through cysts present in the contaminated water and food.

(3) Trykanosomiasis : The causing agent of this disease in human beings is Trypanosma. It is a flagellate protozoan and a blood parasite of the man. Sleeping sickness is caused by T. gambiense which is a dangerous disease of man in tropical Africa. While the T. Crizi is causing agent of American trypanosomiasis or chaga's disease. This disease is widespread in south and central America. Transmission of T. ganibience takes place through tse-tse fly, Glosina palpalis, while T Cruzi is transmitted by a bug, Triatoma.

(4) Lishmaniasis : This disase is caused by the species of Leishmania. It is a flagellate parasite harbours the the phagocytic cells in body organs of man. Lieshmanian donorani is the causative agent of kala-azar or visceral deishmaniasis. This disease is widespread in India, South China and in Mediterranean countries. L. tropica causes skin leismaniasis which is endemic in warmer countries, especially south-west Asia, Eastem Mediterranean and tropical America. L. brasilliensis cause is a disease called Espundia.

All the Leishmania species are transmitted by bite of sandflies belonging to the genus Phlebotomus.

(5) Trichomoniasis : A flagellate protozoan Trichomonas sps. causes trichomoniasis in man. Most common pathogenic species is Trichomonas vaginalis which inhabits vagina of women.

(6) Malaria : It is caused by the species of Plasmodium, the sporozoan parasite. It is an endoparasite of liver cells and red blood calls and is transmitted through the bite of female anopheles mosquito. Malaria is most destructive disease for man and is widespread in the temperate, tropics and subtropics. P. vivax, P. ovale, P. malariae and P. falciparum are the main species responsible for malaria in man.

(7) Toxoplasmosis : A sporozoan parasite Toxoplasma goudii causes the disase toxoplasmosis in man. It is an endoplarasite of cells of reticulo-endothelial and central nervous system.

(8) Balantidial dysentery : They disease is caused by Balantidium coli, an intstinal ciliate. It is an endoparasite of large intestine and is transmitted through the cysts in contaminated food or water.

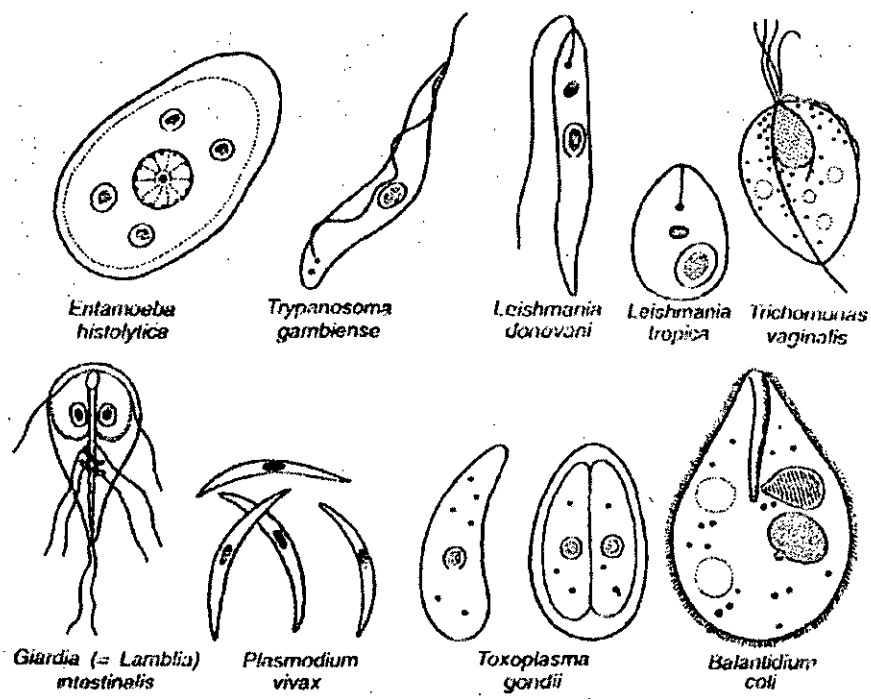

Fig. 5. Some pathogenic protozoan parasites of man.

• SUMMARY

Protozoans are microscopic, unicellular or acellular animalcules having one or more nuclei. These animals are treated in a seperate kingdom 'Protista' by Haeckal and Whittaker. These animals are versatile in their habit and habitat. Subcellular kind of physiological division of labour is found. They reproduce by both asexual and sexual methods. About 50,000 species are divided into four subphyl as which are further divided into classes. In human-beings many diseases are caused by a number of parasitic protozoans. They cause general diseases like amoebiosis, to dreaded ones like malaria leishmaniasis etc.

Keywords : Unicellular, acellular, microscopic, cilia, flagella, parasites.

• STUDENT ACTIVITY

1. Make an illustrative chart/model of parasitic protozoans which cause diseases in man.

• TEST YOURSELF

1. Give an account of classification of phylum Protozoa.
2. Give detailed account of parasitic protozoans which cause disease in human beings.
3. Write characterstic features of Protozons.
4. Give some examples of parasitic flagellated protozoans.
5. Objective Questions :

(1) Amoebiasis is caused by
(a) Amoeba (b) Entamoeba
(c) Noctiluca (d) Paramaecium

(2) Obligate parasite are :
(a) Complete their lifecycle as parasite.
(b) Lead some part of life as free.
(c) Both of them (d) None of them

(3) Malaria is caused by
(a) Plasmodium (b) Paramaecium
(c) Anopheles (d) Ades.

(4) Trypanasoma gambience spreads :
(a) Kala azar (b) Sleeping sickness
(c) Malaria (d) None of these.

(5) Diarrhoea is caused by :
(a) Amoeba (b) Entamoeba
(c) Criardia (d) Trichomonas

Ans. (1) b (2) a (3) a (4) b (5) c

UNIT

3

TRYPANOSOMA GAMBIENCE

STRUCTURE

- Introduction
- Morphology
- Life Cycle of Trypanosoma
- Life Cycle in tse-tse fly
  - Summary
  - Student Activity
  - Test Yourself

LEARNING OBJECTIVES

- After going through this unit you will learn :
- What is Morphology
- Life cycle of tryp

• 3.1 INTRODUCTION

Trypanosoma is a protozoan flagellate which is a blood parasite of vertebrates. It occurs in four forms recognized on the basis of the positions of kinetoplast and blepheroplast and the course taken by the flagellum. Lishmanial form has reduced flagellum, Leptomonad form bears short and unattached flagellum. In crithidial form an inconspicuons undulatting membrane is found while in trypenosomid form it is fully developed.

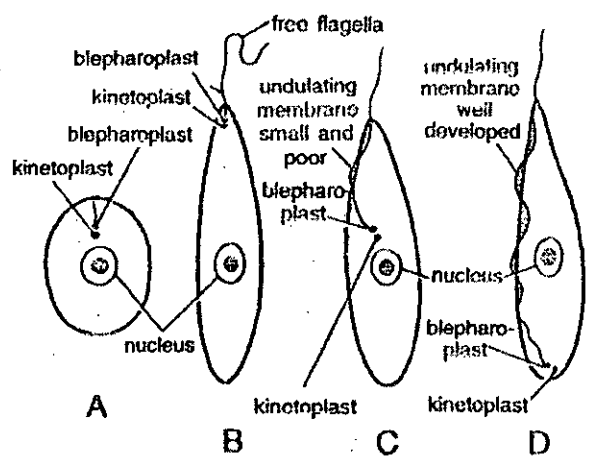

Fig. 1. Polymorphic forms of trypanosomes. A–Leishmanial, B–Leptomonad, C–Crithidial, D–Trypanosomid.

• 3.2 MORPHOLOGY

Trypanosoma gambiense is a polymorphic species and occurs in two devlopmental forms, the trypanosome form and crithidial form. It is a digenetic blood parasite and completes its life cycle in man and in tes-tse fly.

It is found in trypanosome form which is long slender or short shumpy or intrmediate between two in the blood stream of the man. In the midgnt of tse-tse fly trypanosome form is found while crithidial form is found only in salivary gland.

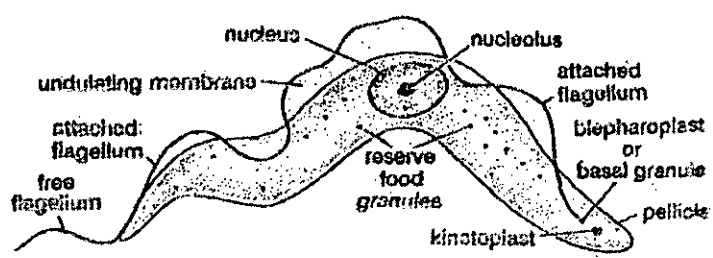

Fig. 2. *Trypanaronia gambiense*. Structure under light microscone

(1) **Pellicle** : The whole body is surrounded

externally by a thin, elastic and firm covering the pellicle. It maintains the shape of the body and serves as a protecting covering.

(2) Flagellum : A single flagellum arising from a basal body (kinetosome) is situated near the posterior end of body. In runs forward, attached along the entire length of body and becomes free at the anterior end.

(3) Undulating membrane : When the flagellum beats, the pellicle to which it is attached is pulled up into a membranous fold called undulating membrane. This is believed to be an adaptation for locomotion in the viscous fluid (blood).

(4) Cytoplasm : The cytoplasm is enclosed within the pellicle. It has not been observed to be differentiated into ectoplasm and endoplasm.

• 3.3 LIFE CYCLE OF TRYPANOSOMA

The primary or definitive host of T. gambiense is man and the intermediate host or vctor is a blood sucking insect called tse-tse fly (Glossina palpalis). The mammals, like antelopes, pigs, buffaloes, etc., often act as reservoir hosts harbouring the parasite.

(1) Life Cycle in man :

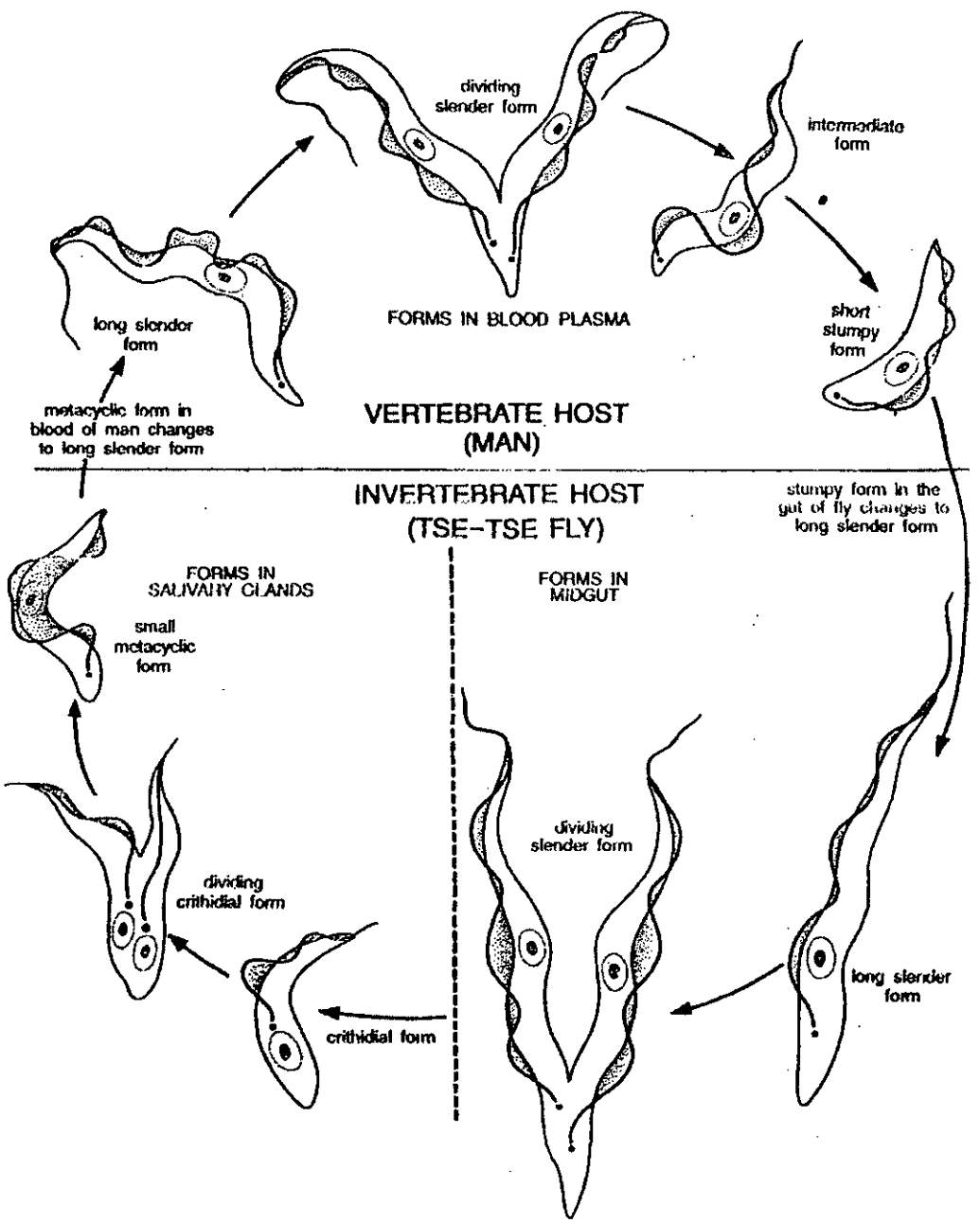

Fig. 3. *Tryponasoma gambiense.* Stages of life cycle in man and tse-tse fly.

Infection : In man the infection of T. gambiense takes place by the bite of the tse-tse fly. It releases infective metacyclic forms into the blood of man during feeding.

Multiplication : All stages of parasite in man are extracellular as they are present in the blood plasma and not inside blood cells. The inoculated metacyclic forms are devoid of a free flagellum, become transformed into long slender forms of flagella. These forms swim freely with the help of flagellums and undulating membrane and multiply actively by longitudinal binary fission.

Metamorphosis : When the immune action of the host responds by the production of antibodies, the trypanosomes stop multiplying. They now shrink to short shimpy forms, which are devoid of a free flagellum. All these forms obtain their energy supply from aerobic oxidation of pyruvic acid.

The shimpy forms do no feed and ultimately die if they are not sucked up by the tse-tse fly along with the blood meal.

Relapse of Infection : It has also been reported that some trypanosomes do not undergo transformation and come over the immune reaction of the host. The unaltered slender forms survive and continue to multiply in blood leading to future relapse of the infection.

• 3.4 LIFE CYCLE IN TSE-TSE FLY

Development in midgut : The shumy forms proceds in the insects midgut along with blood meal and undergo furthr development within peritrophic membrane. Here the parasites transform into long slender forms and multiply by longitudinal binary fission.

Development in salivary glands : From midgut the trypanosomes pass into salivary glands through oesophagus and mouthparts of insects. There they metamorphose into the crithidial forms with shortened body, reduced free flagellum and the kinetoplast in front of the nucleus. These forms multiply inthe lumen of salivary glands and transforms into slender metacyclic forms. When the tse-tse fly bites a healthy person, it transfers the metacyclic forms, along with saliva into the blood where they initiate another infection.

• SUMMARY

Trypanosoma is a protozoan flagellate which is a blood parasite of vertebrates. It is a digenetic parasite which completes its life cycle in two hosts. tse tse fly acts as a vector host for trypanosoma. The biting of tse tse fly causes infection of trypanosomiasis in man. They reproduce asexually in the blood plasma of man and metamorphose into shimpy forms.

Key words : Trypanosoma, Tse-Tse fly, vector host, digenetic, shimpy forms.

• STUDENT ACTIVITY

1 Make a chart of life cycle of Trypanosoma.

• TEST YOURSELF

1. Describe the life cycle of Trypanosoma.
2. Describe different forms of Trypanosoma
3. Give detailed structure of Trypanosoma.
4. Objective type Questions :
   (1) Flagella is absent in panosoma :
   (a) Leishmanial form (b) Trypanosomid form
   (c) Crithidial form (d) all of the above.
   (2) The vector host of Trypanasoma is
   (a) Sand fly (b) Housefly
   (c) Tse-Tse fly (d) None of the above
   (3) In Trypanosoma asexual reproduction takes place by :
   (a) Budding (b) Longitudinal binary fission
   (c) Transverse binary fission (d) Gemmules
   (4) Undulating membrane is found in :
   (a) Plasmodium (b) Leishmania
   (c) Trypanosoma (d) Trichomonas
   (5) Infecting stage of trypanosoma is :
   (a) Stumpy forms (b) Metacyclic forms
   (c) Long slender forms (d) All of the above.

Ans. (1) c (2) c (3) b (4) c (5) b

UNIT 4

PORIFRA

STRUCTURE

- Introduction
- Distinguishing Characters
- Classification
  - Summary
  - Student Activity
  - Test Yourself

LEARNING OBJECTIVE

After going through this unit you will learn :

- Porifera in detail their distinguishing characteristics and their classification

• 4.1 INTRODUCTION

The word "Porifera" means pore bearing animals (Gr., prons, pore + feore, to bear). Their body wall has numerous minute pores called ostia, through which a continuous current of outside water is drawn into the body. About 5,000 species are known in this group.

Poriferans or sponges are lowest multicellular animals or metazoans with cellular level of body organization.

• 4.2 DISTINGUISHING CHARACTERS

1. All are aquatic, mostly marine, a few fresh-water solitary or colonial but all are sessile.

2. Body form vase-like, cylindrical, tubular, cushion-shaped, many branched.

3. Asymmetrical or radially symmetrical.

4. Sponge body is *diploblastic* with an outer dermal (ectoderm) layer of flattened pinacocyte cells, and an inner gastral (endoderm) layer of piculiar collared cells called choanocytes.

5. Body wall is perforated with dermal ostia and folded into various kinds of canals or chambers. Ostia, canals and the exit (osculum) altogether form a kind of water cenal system.

6. Skeleton consists of calcareous or siliceous spicules or of proteinaceous spongin fibres or of both to support and maintain the gross anatomy of sponges.

7. Digestion is intracellular.

8. Respiration and excretion takes place through body surface. Ammonia is chief excretory waste.

9. Primitive kind of nervous system is found or it is absent.

10. All sponges are hermaphrodite but cross-fertilization is the rule. Asexual reproduction by buds or gemmules; Sexual reproduction by ova and sperms.

11. All show regeneration power.

12. Cleavage holoblastic. Development indirect through a free-swimming ciliated larva, the *amphiblastula* or *parenchymula*.

• 4.3 CLASSIFICATION

On the basis of the nature of skeleton, sponges are divided into 3 classes.

Class 1: Calcarea (L; calcarius-limy) **or Calcispongiae**

(i) Marine or shallow seawater.

(ii) Small, body vase-like and cylindrical in shape.

(iii) Skeleton of large monaxonal, tri-radiate or quadriradiate calcareous spicules of Calcium carbonate ($CaCO_3$).

(iv) Canal system relatively simple; of ascon, sycon or leucon type.

Examples : Leucosolenia, Clathrina , Scypha etc.

Class 2: Hexactinellida or Hyalospongiae. (Gr; Hyalos-Glass.)

(i) Deep sea forms. Body is moderate sized.

(ii) Variously coloured, cup-shaped, vaselike or urnlike.

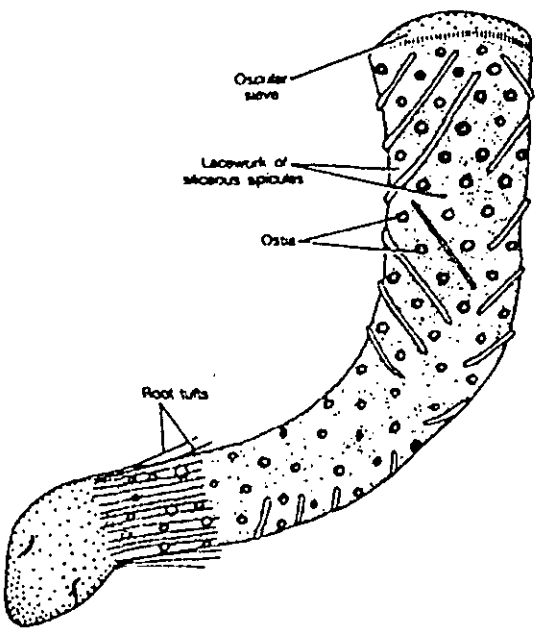

Fig. 1. Euplectella.

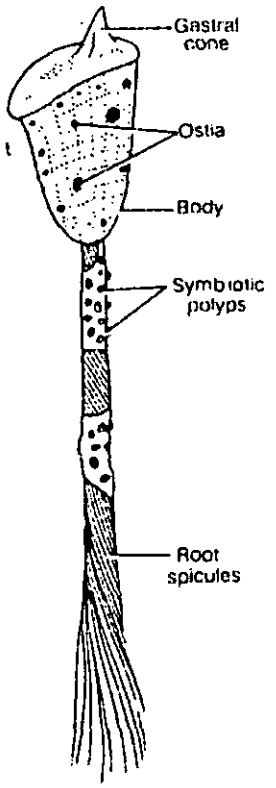

Fig. 2. Hyalonema

(iii) Skeleton of six rayed triaxon siliceous glass like spicules, hence called glass sponges.

(iv) Canal system is complex, sycon or leucon type.

(v) No dermal epithelium or exopinacoderm.

(vi) Choanocytes restricted to finger-shaped chambers.

Examples : Euplectella, Hyalonema etc.

Class 3: Demospongia (Gr. demas = frame)

(i) Mostly marine, few freshwater.

(ii) Small to large sized, solitary or colonial.

(iii) Usually asymmetrical and brilliantly coloured body.

(iv) Skeleton of silicious spicules or spongy fibers or both or absent.

(v) Spicules monaxon or tetraxon, never triaxon.

(vi) Canal system leuconoid, choanocytes small and restricted to rounded chambers.

Examples : Euspongia, Spongilla etc.

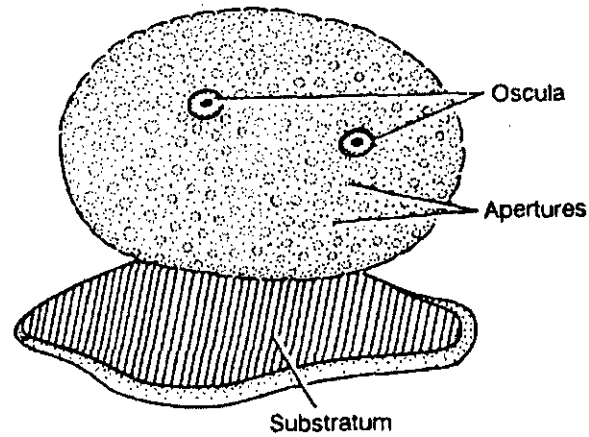

Fig. 3. Euspongia.

• SUMMARY

Phylum porifera includes lowest multicellular pore bearing animals. They are commonly called sponges. On the basis of nature of endoskeleton they are divided into three classes calcarea, Hexactinellida and Demospongia. About 5,000 species are known in this group.

Key words : Porifera, sponges, calcarea, Haxactinellida, Demospongia.

• STUDENT ACTIVITY

1. Make chart/model for ornamental sponges.

• TEST YOURSELF

1. Write characteristic features of phylum Porifera and classify it.
2. Give distinguishing features of porifera.
3. Glass-sponges.
4. Objective type Questions :
   (1) Ostia are found in :

(a) Protozoa (b) Porifera
(c) Coelenterata (d) Cnidaria.

(2) Sponges are included in :
(a) Cnidaria (b) Annelida
(c) Porifera (d) None of the above

(3) Calcareous spicules are found in :
(a) Sycon (b) Class sponges
(c) Euspongia (d) all of the above.

(4) Gemmules are found in :
(a) Worms (b) Annelids
(c) Poriferans (d) Protozoans

(5) Canal system is the characteristic feature of :
(a) Sponges (b) Annelids
(c) Molluscs (d) Echinodermates

Ans. (1) b (2) c (3) a (4) c (5) a

UNIT 5

SYCON

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Sycon in detail
- Development and Life Cycle of Sycon along with its diagrammatic representation
- An idea of various views of sycons through diagrammatic reprsentations

5.1 INTRODUCTION

Scypha or Sycon is commonly known as urnsponge as its shape is like an urn (a water vessel). It is also called the crown sponge because the fringe of long and straight spicules at the top looks like a small crown. The best studied species of scypha are S. coronata, S. ciliatum, S. elegans, S. lingua and S. raphanus.

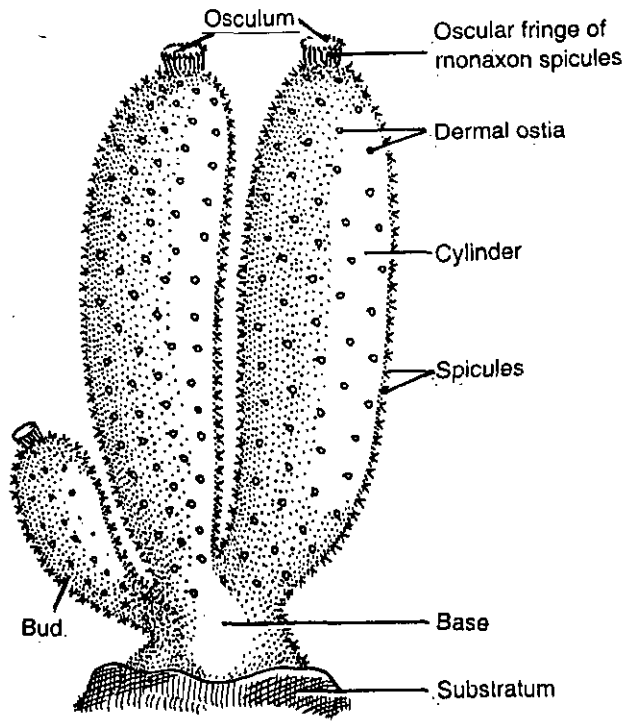

Fig. 1. *Scypha* : Magnified view

• 5.2 HABIT AND HABITAT

Scypha is a marine sponge which is widely distributed, but is best known from North Atlantic shores. It may be solitary or may form a colony by budding. Sessile colonies of cylindrical individuals are found permanently attached to submerged rocks or other solid substrata in shallow sea water along the coasts. They thrive well, where wave action is not too strong and at low tide mark.

• 5.3 CANAL SYSTEM

Body of scypha is organized in such a manner that it forms a complex system of pores and canals. This system is generally referred to as *canal system* or *aquiferous system*. Body wall has essentially the same cellular layers pinacoderm and choanoderm, with a non-cellular gelatinous mesenchyma in between. But the body wall

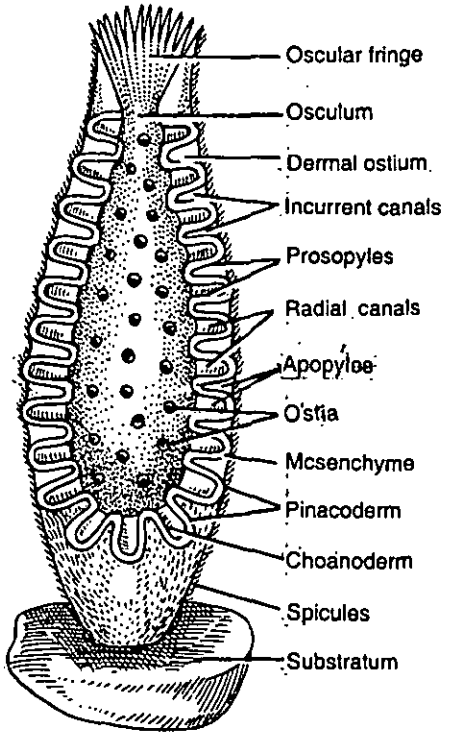

Fig. 2. L.S. of aScypha showing canal system.

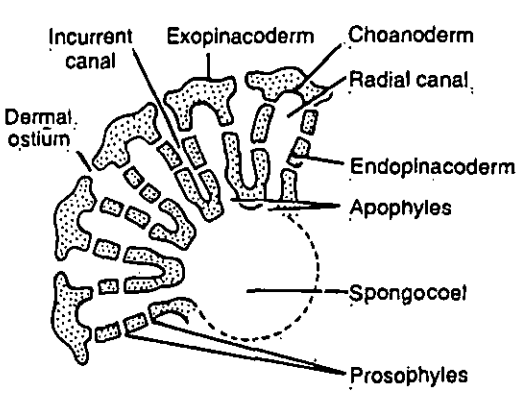

Fig. 3. Scypha : A portion of a T.S. (diagrammatic)

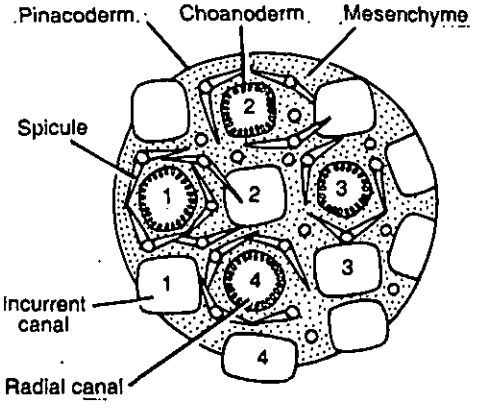

Fig. 4. Scypha : A tangential section of a portion of body wall showing arrangement of incurrent and radial canals

is so folded as to form regularly arranged alternating invaginations and evaginations, establishing sycon type of canal system. Various components of canal system are as follows :

(i) Ostia or dermal pores : The external grooves of body surface are stretched over by a thin pore membrane. It bears two or more openings for the ingress of outside water into the body of sponge. These pores are known as ostia (L., Ostium, door) or dermal pores.

(ii) Incurrent canals : These canals are the invaginated folds of body wall and are also called incurrent canals. These communicate with outside through ostia but end blindly at their inner ends. Pinacocytes line these canals throughout.

(iii) Prosopyles : Incurrent canals communicate with radial canals through intracellular spaces called prosopyles (Gr., Pros, near + pyle, gate).

(iv) Radial canals : These canals are lined by flagellated cells, choanocytes and are formed by evagination of body wall. Therefore these chambers are called flagellated or radial canals. These canals are parallel and alternate with incurrent canal, both vertically and radially. Both the canals in the body wall are arranged in such a manner that each raidal canal is surrounded by incurrent canals and likewise each incurrent canal is surrounded by radial canals.

Radial canals, in turn, open into spongocoel by the inner ends.

(v) Apopyles : Apopyles or inner ostia are the specific openings by which radial canals communicate into the spongocoels. Having contractile myocytes they act as a sphincter.

(vi) Spongocel : Centrally inside the body, a cavity forming its vertical axis is called spongocoel. Spongocoel is lined by epidermal pinacocytes.

(vii) Osculum : Osculum is the exit point through which spongocoel opens outside. It is provided with sphincters to regulate the rate of water flow in the body. Sphincters are lined by special contractile pinacocytes, called myocytes.

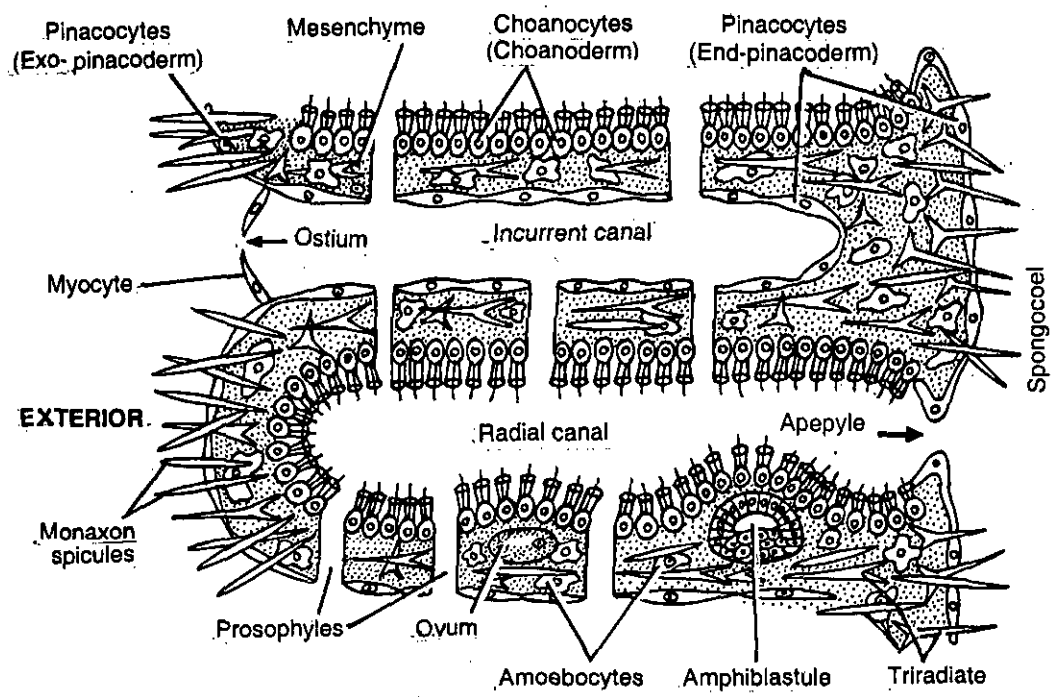

Fig. 5. Scypha : A diagrammatic sectional view of body wall showing one incurrent canal and one radial canal

(viii) Flow path of water current : In the canal system water flows in the form of current and is maintained by continuous beating of flagella of choanocytes lining the radial canals. The course taken by water current into canal system is as follows.

Water from outside → through dermal ostia → In current canals → through prosopyles → Radial canals → through apopyles → Spongocoel → through Osculum → To outside

• 5.4 CELLULAR ORGANIZATION

Sycon is diploblastic, (two germ layers present) the outer cellular layer is pinacoderm and inner cellular layer is choanoderm with an intermediate mesenchyme. Both the layers and mesenchyme have different composition of cells :

1. **Pinnacoderm** : We can divide pinacoderm into two types (i) Exopinacoderm or dermal epithelium makes the cover of entire body surface except dermal ostia and osculum. (ii) Endopinacoderm makes the epithelial lining of incurrent canals and spongocoel. Pinacoderm is composed of large, flattened, polygonal cells, the pinacocytes (Gr., pinako; plank + kytos, cell). They have nucleus bulging out, and are highly contractile. They modify themselves according to the place, where they are situated in size, shape and function.

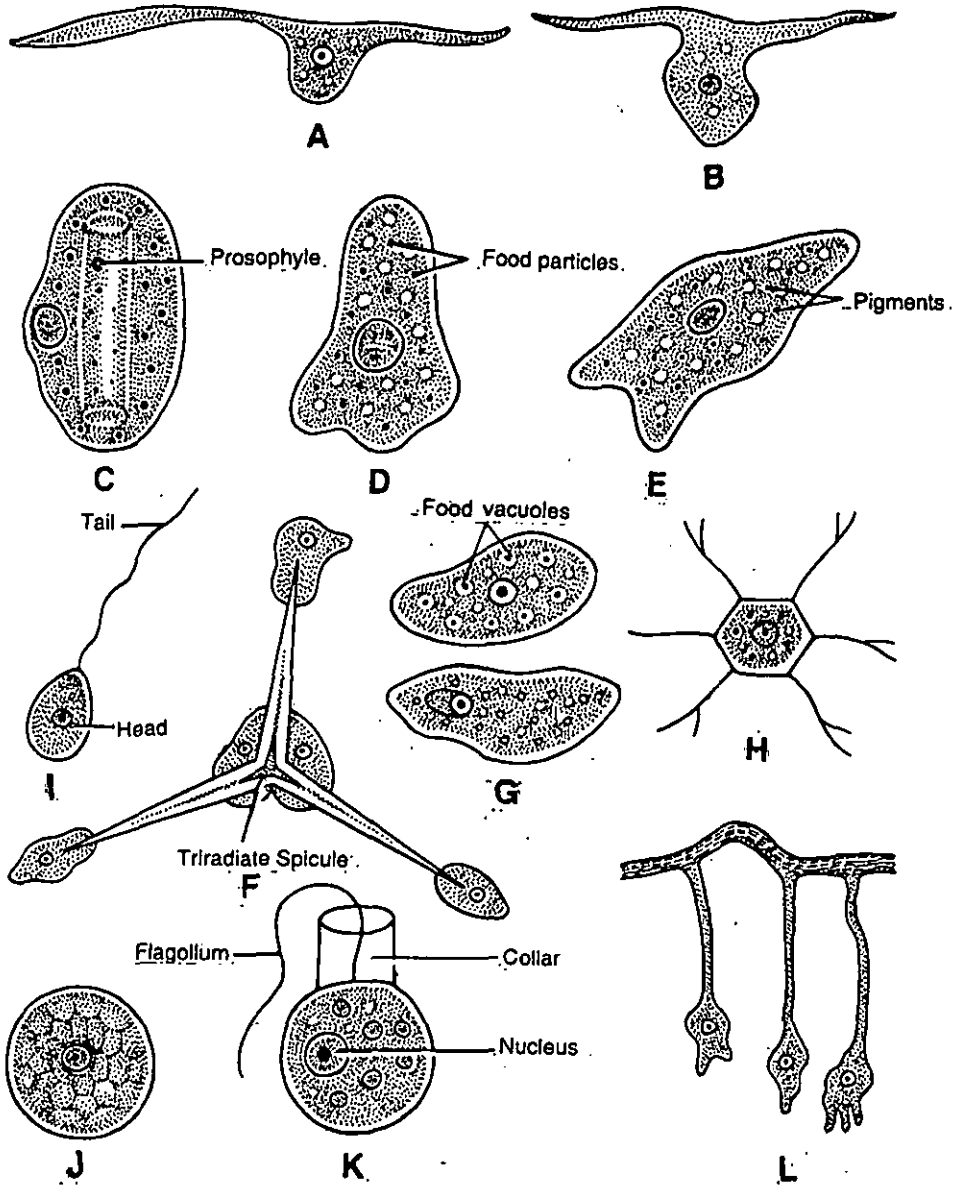

Fig. 6. Scypha : Different kinds of cells A–Pinacocytes B–Myocyte C–Porocyte D–Thesocyte E–Chromocyte F–Sclerocytes G–Archaeocytes H–Collencyte I–Sperm J–Ovum K–Choanocyte L–Gland cells

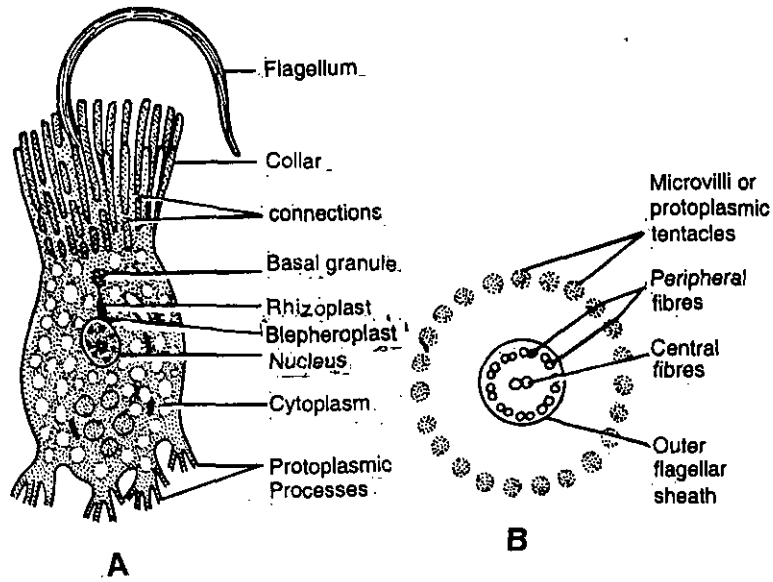

Fig. 7. (a) Structure of a choanocyte based on electron micrography; (b) T.S. through collar region of a choanocyte

The lining of incurrent canal is made up of modified pinacocyte, the tubular porocytes. These porocytes contain intracellular channel called prosopyle to connect incurrent canal to the radial canals. Porocytes are thin walled cells, open at both ends, with the nucleus present in the peripheral cytoplasm. Pinacocytes surrounding the osculum, outer (dermal) ostia and inner ostia (apopyles) are elongated and contractile and act as muscle cells, called myocytes. These cells form sphincters around them to regulate their openings.

2. Choanoderm : Choanoderm which makes the lining of radial canals is composed of flagellated collar cells or choanocytes. (Gr., choane, funnel + kytos, cell) Each cell

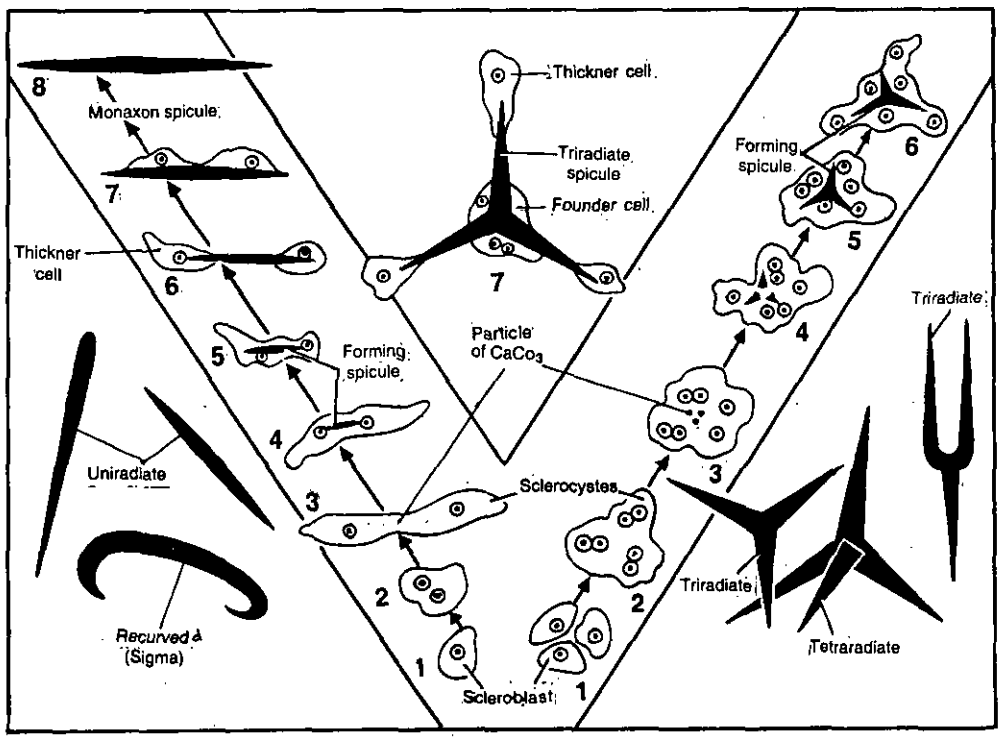

Fig. 8. Scypha. Structure and development of spicules.
(A) Kinds of monaxon spicules; (C) Kinds of triradiate spicules
(B) Development of a monaxon spicule; (D) Development of a triradiate spicule

contains single nucleus and all the cell organells. A single basal granule which gives rise to long whip like flagellum is also found. It is surrounded at its base by a thin cytoplasmic collar.

3. **Mesenchyme** : Mesenchyme is supposed to be derived from pinacoderm and contains a variety of amoeba like cells, the amoebocytes. A few of amoebocytes are as follows : (Fig 6)

(a) **Archaeocytes** : These are undifferentiated embryonic amoebocytes, having blunt pseudopodia and large nucleus with nucleolus. They are totipotent cells as they can give rise to any other kind of cells within an animal. They also give rise to sperms and ova and play an important role in regeneration.

(b) **Collencytes** : Most of the amoebocytes have branched pseudopodia, that unite into a syncytial network. These are called collencytes.

(c) **Chromocytes** : These are pigmented amoebocytes with lobose pseudopodia.

(d) **Therocytes** : These serve as storage cells and are filled with food reserves.

(e) **Myocytes** : These are fusiform contractile muscle cells present around ostia, oscula, and other openings. These form a sphincter which regulates the size of these openings.

(f) **Scleroblasts** : These are modified cells to produce spicules and fibers.

(g) **Gland cells** : These are attached to the body surface by long strands and secrete slime.

(h) **Germ cells** : Amoebocyte can be diferentiate into sex cells to give rise to sperms and ova. In some cases germ cells are produced by choanocytes.

• 5.6 ENDOSKELETON

To support and protect the body calcareous spicules embedded in mesenchyme form a type of endoskeleton in the sponges. Calareous spicules are all megascleres and are of two types :

(a) Monaxon spicules : These may be uniradiate (monactinal) or biradiate (diactinal) depending upon whether they grow in one or both directions along a single axis. They are slender and straight like needles or curved.

(b) Tetraxon spicules : These are also known as tetractines and tetra radiate. Each consists of four rays which are not in the same plane. By loss of one ray they become triradiate, which is very common. Three rays and angles may be equal (regular) or unequal (sagittal Y-shaped or T-shaped). Chemically, apart from the $CaCO_3$ spicules contain magnesium, sulphates, sodium and water.

Development of Spicules

The modified amoebocytes, which are known as scleroblast cells secrete spicules. A monaxon spicule is formed by two sclerocytes produced by the division of one scleroblast. Outer sclerocyte is referred to as thickener cell and the inner one as founder cell. Thickener cell is responsible for the lengthening of the spicule ray. A triradiate spicule develops from six sclerocytes derived by three scleroblasts. A tetraradiate spicule develops in the same the triradiate spicule develops and the fourth ray is developed from the junction of the three rays.

Arrangement of Spicules in the Skeleton

Different kinds of spicules are arranged in a characterstic way. Long monaxons form oscular fringe around the osculum, while T-shaped sagittals form the oscular rim. Short monaxons lie parallel to radial canals and may project from body surface as bristles. Triradiate spicules mostly lie along the radial canals with one ray facing outside. Tetra-radiate spicules occur alongwith the triradiates.

• 5.7 REPRODUCTION IN SYCON

There are both sexual and asexual methods through which Sycons reproduce.

(i) **Asexual reproduction by budding** : There are several asexual methods found in sponges. But in Sycon (marine sponge) asexual reproduction is usually accomplished

by budding. In budding, numerous archaeocytes collect at the body surface and get surrounded by epidermal pinacocytes (pinacoderm). This structure is called bud. An osculum is formed at its free end. Gradually this bud grows into an adult individual. Fully grown bud may remain attached with the parent individual or may be detatched to become free and forms a new sponge by fixing itself to the substratum .

(ii) Sexual Reproduction : Sycon is a bisexual or monoecious sponge but cross fertilization is a rule, because of *protogyny*. Special sex organs are not found but the sperms and the ova are produced in mesenchyme. Undifferentiated amoebocytes, called archaeocytes or choancytes act as sperm mother cell and ova mother cell.

(a) Spermatogenesis : Sperm mother cell or spermatogonium starts to get surrounded by one or more flattened cover cells to form the spermatocyst. Cover cells and spermatogonium are produced by the same amoebocytes or different amoebocytes. Spermatogonium undergoes two or three divisions to form spermatocysts which give rise to spermatozoa. A mature sperm consists of rounded nucleated head and a vibrating tail. The lashing movement of the tail enables the sperm to move in water to reach other sponges .

(b) Oogenesis : A large archaeocyte with a distinct nucleus acts like an egg mother cell or oocyte. Sometimes, a choanocyte with stored food can also be transformed into oocyte by loosing its flagellum. Oocyte then grows by engulfing other amoebocytes or special nurse cells (trophocytes). After growth it undergoes two maturation divisions to form the ovum, which lies in the wall of a radial canal. Now it is ready to be fertilized by a sperm from another sponge.

(c) Fertilization : In sponges, sperms are released out from one individual and enter others to fertilize the ova in situ. In all sponges fertilization is a very remarkable process. First of all, sperm enters the choanocyte that is adjacent to the ripe ovum. After getting into the choanocyte, sperm loses its tail and swollen head and becomes surrounded by a capsule. The choanocyte also loses its collar and flagellum and becomes amoeboid, and is now called carrier cell or nurse cell. Because it carries sperm to the ovum. On the other hand, a conical depression is formed at the outer surface of the ovum by invegination. It recieves the carrier cell and capsulated sperm which now penetrates into the ovum. Fusion of sperm's head and ovum results in a zygote or egg.

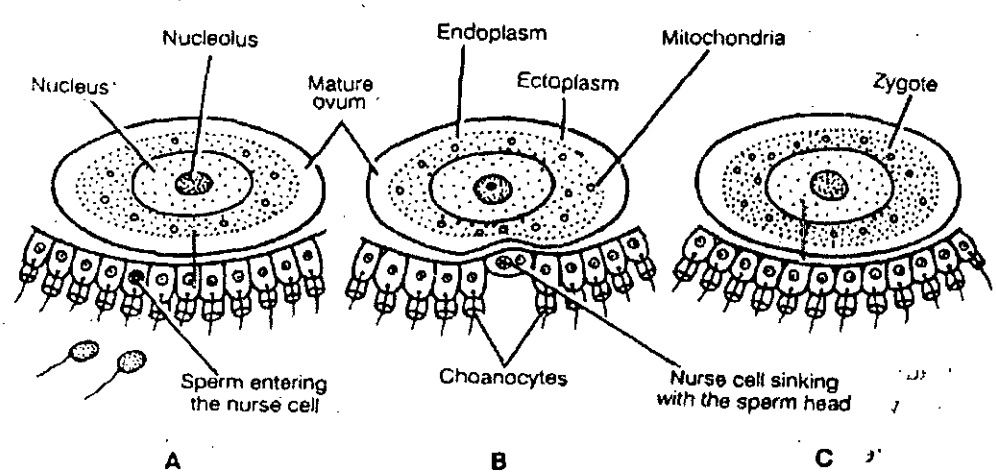

Fig. 9. Fertilization in *Sycon*

• 5.8 DEVELOPMENT AND LIFE CYCLE

In Sycon development is indirect i.e., it involves different forms of larva. Beginning from the zygote development involves following 5 stages

(a) Cleavage : In the mesenchyme embryo (zygote) undergoes equal and holoblastic cleavage. First three divisions are vertical resulting into 8 celled stage. Fourth division

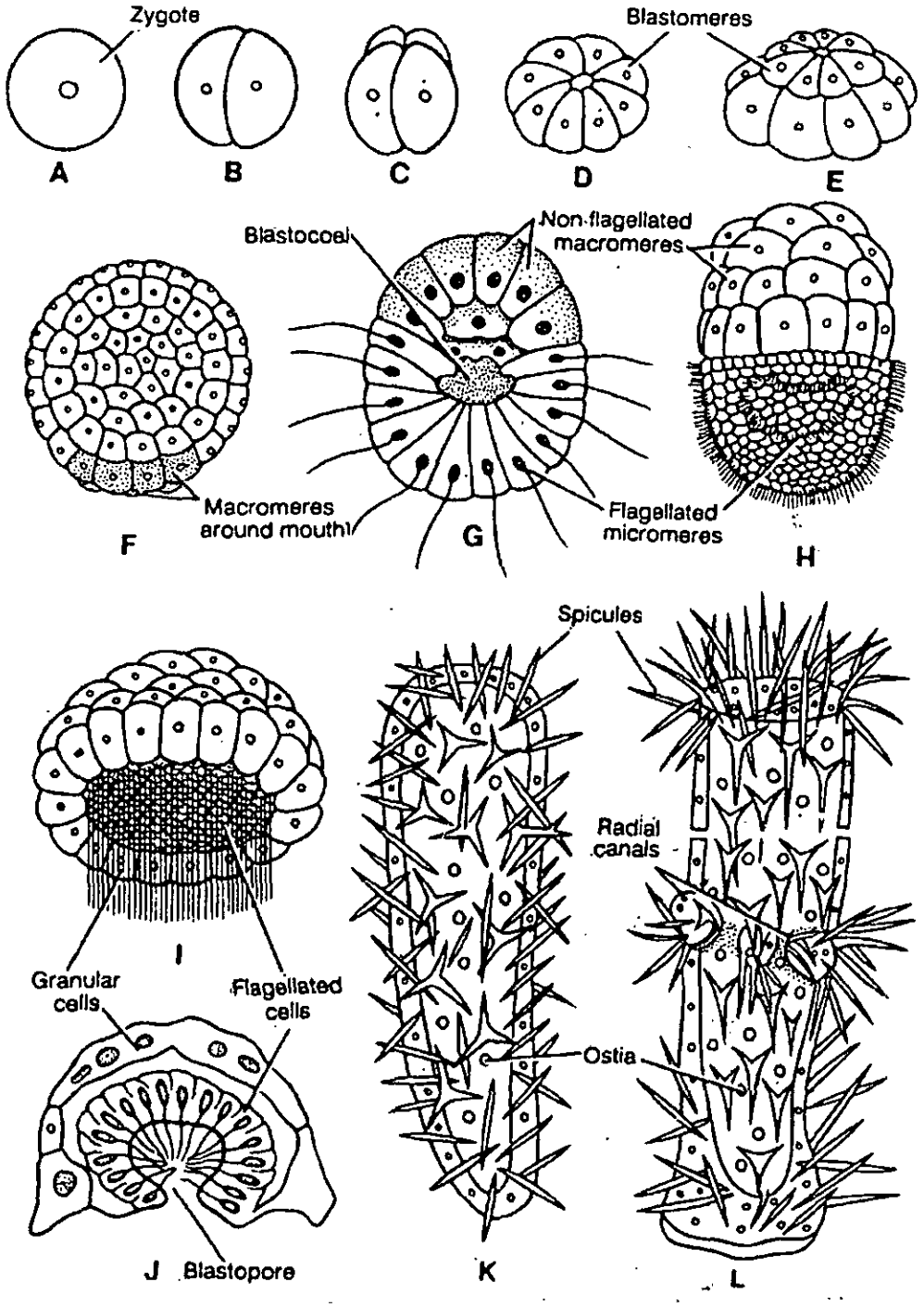

Fig. 10 Developmental stages in *Sycon* : A—Zygote; B—2-cell stage; C—4-cell stage; D—8-cell stage; E—16-cell stage; F—Stomoblastula; G—Amphiblastula (section); H—Amphiblastula (surface view); I—Invagination; J—Gastrula (section); K—Olynthus stage; L—Young *Sycon*.

is horizontal and unequal resulting into 16 blastomeres that are arranged in two tiers. 8 cells of lower tier are larger and are called macromeres. They form pinnacoderm in the adult. Other 8 cells of upper tier are smaller and are called micromeres. They form the choanoderm. Micromeres undergo subsequent division rapidly to produce numerous micromeres. They all acquire flagella at their inner ends, facing the blastocoel. Macromeres don't undergo division but become somewhat rounded. The

embryo is now called blastula, Duboscq and Tuzet have preferred to call this stage as stomoblastula.

(b) Stomoblastula : In this stage 8 rounded and nonflagelated macromers are flanked over by numerous small, elongated and flagellated micromeres. The flagella of micromeres force into blastocoel which opens outside through mouth. Mouth is situated in the centre of macromeres and is used for engulfing the surrounding amoebocytes for nutrition.

(c) Amphiblastula : Amphiblastula is a free swimming larva of Sycon that comes out from the mesenchyme into the spongocoel. It finally passes out from the spongocoel through osculum. It develops from stomoblastula by inversion, in which it turns itself out through the mouth, so that the flagella of micromeres become directed outwards. Now the embryo acquires a look in which its one half bears flagella and the other half does not. The embryo is now called amphiblastula (Gr., amphi, both + blastos, germ,) having two kinds of blastomeres.

Amphiblastula larva swims freely in water for some time. While swimming, the flagellated pole is directed anteriorly and the force for swimming is supplied by the beating of flagella.

(d) Gastrula : After some time, amphiblastula attaches to some substratum and undergoes gastrulation. In this process the macromeres multiply more rapidly than micromeres, and grow over the flagellated half. The larva now resembles a typical double walled gastrula; Outer wall consists of non-flagellated micromeres and inner wall consists of flagellated micromeres. It opens through mouth, called blastopore.

(e) Post Larval Period or Metamorphosis : At the blastoporal end gastrula fixes itself and lengthens into a cylinder. At the free distal end osculum is formed and numerous small ostia are formed in the wall of cylinder. Outer nonflagellated granular cell wall forms pinnacoderm, scleroblasts and porocytes in the future adult stage. While inner flagellated cell develops into choanoderm and gives rise to functional choanocytes, archaeocytes and other amoebocytes. Mesenchyme cells are thus derived from both the embryonic layers.

This young cylindrical form of scypha is called *olynthus* larva and resembles a simple ascon sponge. From the middle part of choanoderm of *olynthus* radial canals start to develop by budding. Folding occurs, within the body walls as the growth of larva continues. Sycon type canal system finally develops in the young sycon and it forms colony by further branching and differentiation in the course of time.

• SUMMARY

Sycon is a marine sponge found in solidary or colonial forms at North Atlantic shores. Endoskeleton of sycon is made up of calcareous spicules. The body wall is folded at regular intervals and forms a special kind of canal system, called sycon type canal system. In these animals various kinds of specialized cells are present and show cellular grade of body organization. Development is indirect and involves different kinds of larval stages. Amphiblastula is the main free swimming larva pressent in their life cycle.

Key words : Sycon canal system, callular grade, amphiblastula.

• STUDENT ACTIVITY

1. Make labelled diagram of Amphiblastula larva of sycon

• TEST YOURSELF

1. What is canal system? Describe canal system of sycon and discuss its importance.
2. Give an account of skeleton found in Sycon and describe the development of spicules.
3. Describe life cycle of sycon with different kinds of larvae.
4. What is sycon type of canal system
5. Describe flagellated cells of sycon
6. Descrebe olynthus larva of sycon.
7. Give structure of the sycon.
8. Objective type Questions :

(1) Olynthus larva is found in the life cycle of :

(a) Sycon (b) Euspongia

(b) Hyalonema (d) all of the above.

(2) Sycon type of canal system is found in :

(a) Sycon (b) Leucosolenia

(c) Euspongia (c) None of the above.

(3) Choanocytes are :

(a) Flagellated cells (b) Non-flagellated cells

(c) Mesenchymal cells (d) Muscle cells.

(4) Sycon is :

(a) Freshwater sponge (b) Marine sponge

(c) Terrestrial sponge (d) None of the above

(5) Amoebocytes in sycon are

(a) Germ cells (b) dermal cells

(c) flagellated cells (d) all of the above.

Ans. (1) a (2) a (3) a (4) b (5) a

UNIT 6

CNIDARIA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Cnidaria in detail including their distinguishing characteristics and classification.

• 6.1 INTRODUCTION

Cnidarians are metazoans that possess tissue grade organization and radial symmetry. The "Coelenterata" signifies the presence of a single internal cavity called coelenteron or gastrovascular cavity. This cavity performs both the functions digestive and body cavity. The modern name "Cnidaria" indicates the presence of stinging cells (Gr., knide-needle or stinging cells). This phylum groups about 9,000 species.

• 6.2 DISTINGUISHING CHARACTERS

1. All aquatic, mostly marine, some fresh water.
2. Solitary or colonial, sedentary or free swimming.
3. Symmetry radial or biradial about a longitudinal oral-aboral axis.
4. Body organization of cell-tissue grade. Cells mostly scattered and specialized for different functions. Some cells form tissues like nerve net.
5. Mouth typically surrounded by highly contractile thread like sensory tentacles.
6. Body wall diploblastic with two cellular-layers outer epidermis and inner gastrodermis and in between a gelatinous acellular mesogloea. In advanced types mesogloea is found with cells and connective tissue, hence they become triploblastic.
7. Two types of individuals occur, attached polyps and free-swimming medusae.
8. Both epidermis and gastrodermis or only epidermis contain certain highly specialized and unique "stinging cells" or "nematoblasts" found nowhere else in the animal kingdom. These cells are used for food capture, defence and attachment.
9. A single internal cavity lined with gastrodermis called gastrovascualr cavity or coelenteron, into which mouth opens. Anus is absent.
10. Digestion intracellular as well as extracellular.
11. Nervous system is primitive.
12. Sensory organs form ocelli and statocyst.

13. Asexual reproduction by budding or fission, sexual reproduction by ova and sperms. Sexual forms monoecious or dioecious.

14. Development includes a free swimming ciliated planula larva.

15. Life history illustrates regular alternation between the asexual polypoid stage and sexual medusoid stage. True alternation of generation absent.

• 6.3 CLASSIFICATION

Chiefly on the basis of the dominance of either medusoid or polypoid phase in life cycle cnidarians are divided into three classes :

Class 1 : Hydrozoa (Gr. hydros, water + zoon, animal)

(i) Mostly marine, some fresh water. Solitary or colonial.

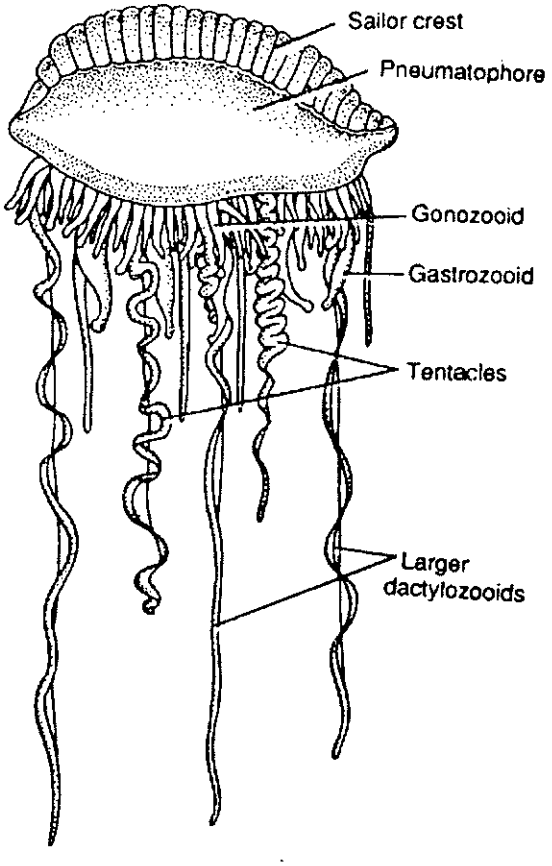

Fig. 1. Physalia

(ii) Only polypes or polypoid form is dominant if both polyp and medusa are present.

(iii) Medusa with true velum.

(iv) Mesogloea noncellular.

(v) Gonads epidermal. Sex cells shed directly on outside.

Examples : Hydra, Obelia, physalia etc.

Class 2 : Scyphozoa (Gr., Skyphos, cup)

(i) All marine and solitory, chiefly free swimming.

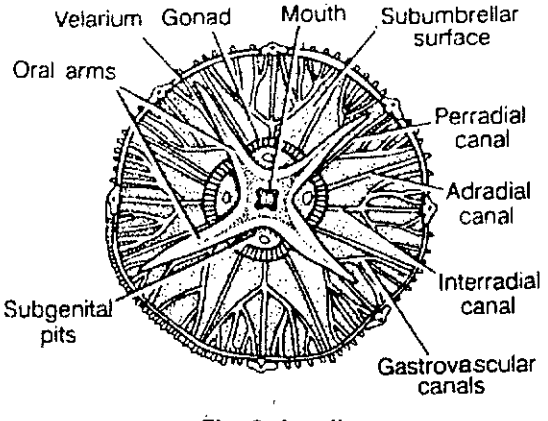

Fig. 2. Aurelia

(ii) Medusoid phase dominant, polypoid stage absent or reduced to a small larval phase.

(iii) Medusae appear jelly-like due to a great thickening of mesogloea, Hence commonly called jelly-fishes.

(iv) Medusa without velum.

(v) Mesogloea contains epidermal amoeboid cell.

(vi) Nematoblasts in both cell layers.

(vii) Sex cells develop from interstitial cells of gastrodermis.

Examples : Aurelia, Rhizostoma etc.

Class 3 : Anthozoa (Gr. anthos; flower)

(i) All marine, solitary or colonial.

(ii) Only polypoid forms, but polyps structurally complex and sessile.

(iii) Free end of body flattened to form an oral disc, bearing a central mouth and hollow marginal tentacles.

(iv) Mesogloea with cells and fibres.

(v) Nematoblasts in both epidermis and gastrodermis.

(vi) Gastrovascular cavity divided into compartments by vertical septa or mesentries.

(vii) Sex cells develop in gastrodermis.

(viii) Many forms secrete a soft and leathery or a hard and horny or calcareous skeleton called ***coral.***

Example : Tubipora, Madrepora, Adamsia, Fungia etc.

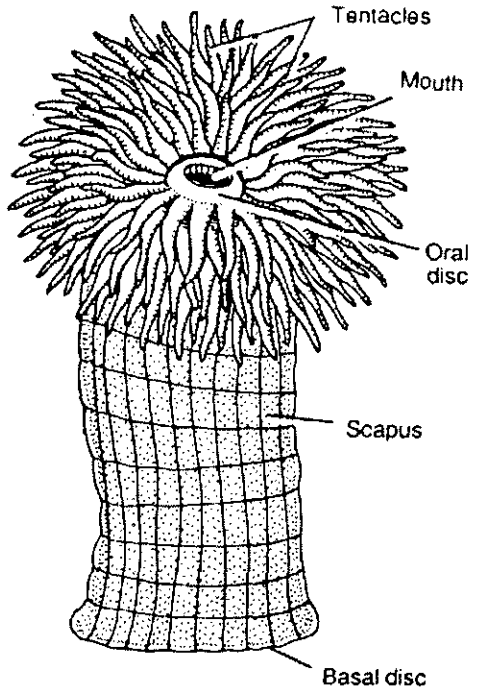

Fig. 3. Adamsia

• SUMMARY

The Phylum coelenterata includes the animals that possess radial symmetry and tissue grade organization. The coelenterata signifies the presence of a single internal cavity called coelanteron or gastrovascular cavity. About 9,000 species are grouped into this phylum divided into three classes on the basis of the zooid (body form) which they possess prominently in their life cycle. The presence of specialized cells chidoblast meant for defence is another characterstic feature of the animals of this phylum.

Key words : Coelenteron, zooid, cnidoblast.

• STUDENT ACTIVITY

1. Make labelled diagrams of physalia and Adamsia.

• TEST YOURSELF

1. Describe the 'cnidaria' and classify it upto classes.
2. Give an account of characteristic features of phylum coelenterata.
3. Give characterstic features of class Anthozoa.
4. Draw labelled diagram of Aurelia
5. Objective Questions :

(1) Coelenterata signifies the presence of
(a) Coelenteron (b) Enteron
(c) Coelom (d) none of the above

(2) Cnidoblast cells are :
(a) Food cells (b) Stinging cells
(c) Sex cells (d) Polyps

(3) Plamula larva is found in
(a) Protozoa (b) Coelenterata
(c) Porifera (d) Annelida

(4) Alternation of generation is found in :
(a) Arthropoda (b) Mollusca
(c) Protozoa (d) Coelenterata

(5) Adamsia represents
(a) Polypoid form (b) Medusoid form
(c) Both of these (d) None of these

Ans. (1) a (2) b (3) b (4) d (5) a

UNIT 7

POLYMORPHISM

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Polymorphism in detail along with Metagenesis in Obelia.

• 7.1 INTRODUCTION

The occurrence of more than one type of individuals, which differ in form and function, in the same species is known as polymorphism. In cnidaria the different individuals or zooids often get united in the form of a colony. On the basis of number of different kinds of zooids colonies in Cnidarie are divided as follows :

(1) Dimorphic Colony : Some cnidarians like Obelia, Tubularia Campanularia etc. the colonies are dimorphic. This is the simplest and commonest pattern of plymorphism observed in phylum cnidaria. They have only two types of zooids (individuals), the grastrozooids or hydranths and the gonozooids or blastostyles. Gastrozooids are meant for feeding while gonozooids produce medusae by asexual reproduction.

(2) Trimorphic Colonies : Some forms, like plumularia are trimorphic because they bear three different kinds of zooids. Besides, gastrozooids and gonozooids, a third type of individuals, the dachylozooids are formed. These are functionally non-feeding and defensive polypes bearing batteries of nematocysts.

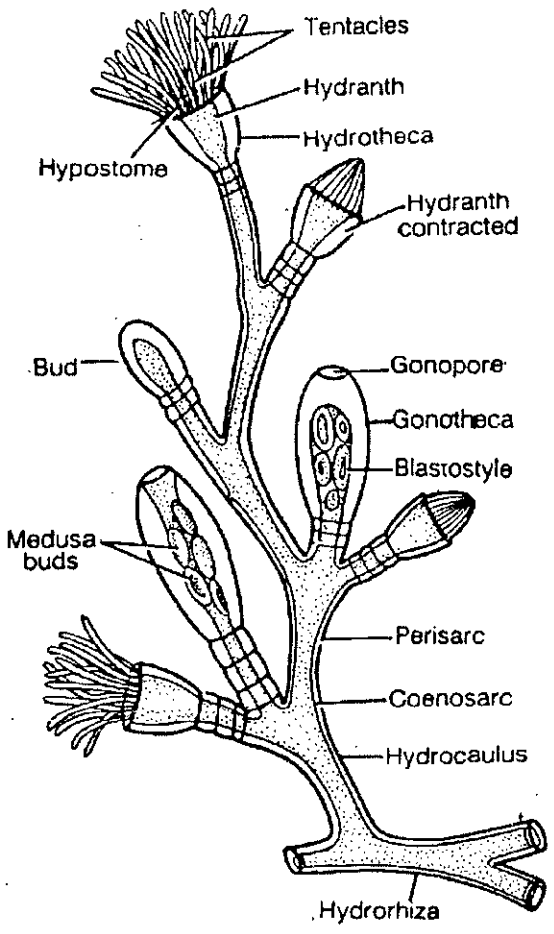

Fig. 1. *Obelia* colony (a part)

(3) Polymorphic colonies : Cnidarians having more than three types of individuals are called polymorphic. In the colony of Hydractinia five kinds of zooids with different functions are found. These are :

(i) Gastrozooids for feeding.

(ii) Spiral dactylozooids or protection.

(iii) Long sensory tentaculozooids with sensory cells.

(iv) Skeletozooids as spiny projections of chitin and

(v) Gonozooids or reproductive individuals, bearing male or female gonophores or medusae for sexual reproduction.

Palymorphism reaches its peak in siphonophora.

• 7.2 METAGENESIS IN OBELIA

In obelia, two clearly defined phases, one sessile hydroid colony and a free-swimming medusa, come alternately but regularly during the life cycle. Hydroid colony reproduce asexually to give rise to medusae, but medusa in turn reproduce sexually to give rise to gametes. The gametes unite to form zygote, which undergo development and again produce hydroid colony.

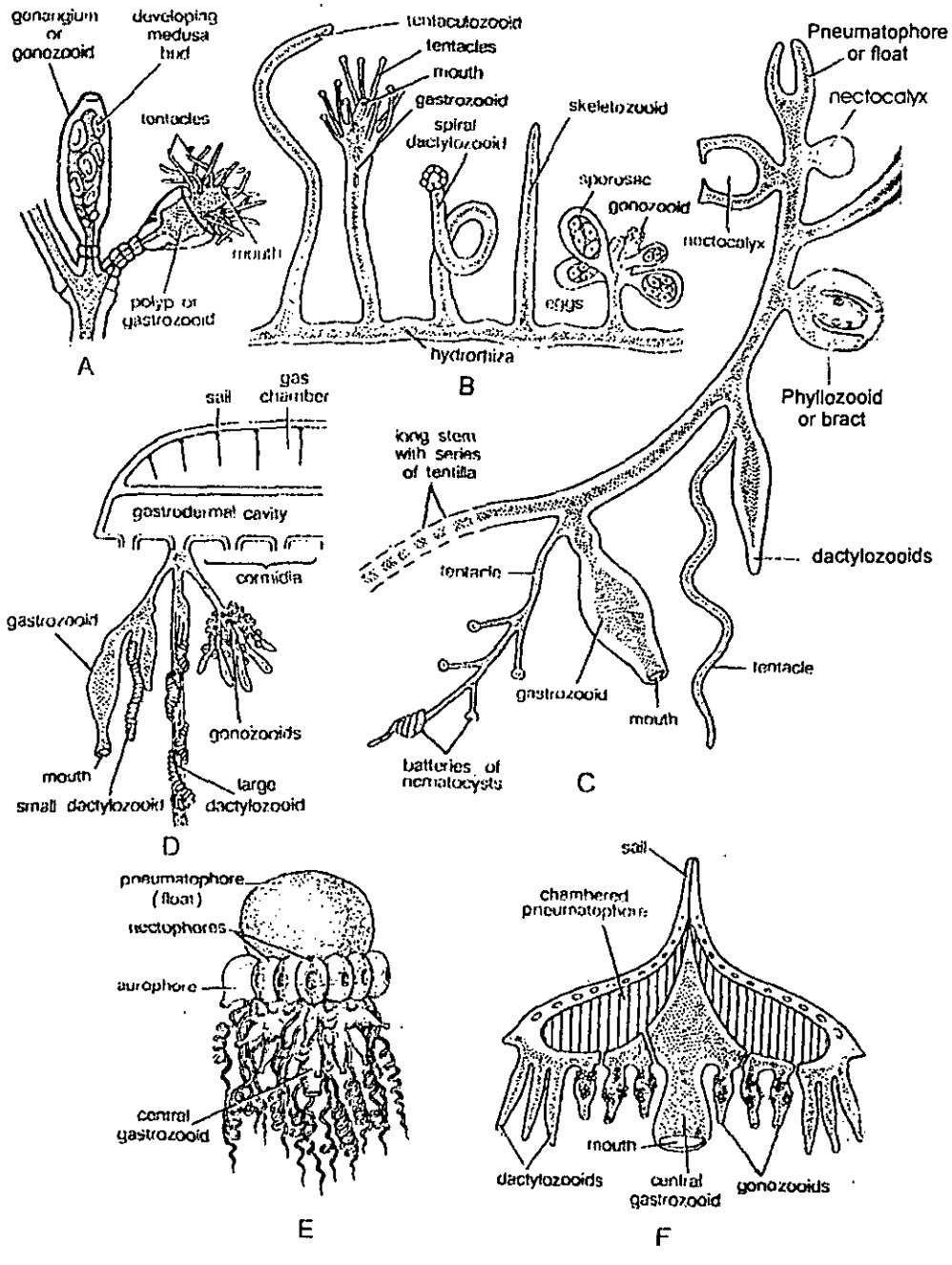

Fig. 2. Polymorphic colonies of Hydrozoa, A–*Obelia*, B–*Hydractinia*, C–Generalized calycorphoran Siphonophora showing a single cormidium. D–*Physalia* showing a single comidium. E–*Stephalia* swimming bells and aurophore. F–*Velella* in V.S. (Z-I)

At first sight it seems an "alternation of generation" in the life cycle of obelia. But actually this is not so because both the hydroid colony and medusa belong to single diploid generation. On the contrary, they just represent the different phases-asexual and sexual, respectively. Therefore in coelentrates, the other suitable term to describe this alternation of different asexual and sexual phages, "Metagenesis" has been used, rather than "Alternation of generation". Hydroid colony bears different kinds of zooids and further medusa is also a zooid, of course has different habit and habitat. They show good example of "Polymorphism" rather than the Alternation of generation.

True kind of 'alternation of generation' found in plants where a distinct diploid sporophyte and a haploid gametophyte represent different generations of life cycle and develop from each other alternately but in a regular way.

• SUMMARY

Polymorphism is an interesting phenomenon found in the animals of phylum coelenterata. The occurrence of more than one type of individuals, which differ in form and function in the same species is known as polymorphism. Two types of body forms or zooids are mainly found in the life cycle of animals. On the basis of number of types of zooids, colonies may be dimorphic, trimorphic and polymorphic. Another interesting feature, alternation in generation is also exhibited by coelenterates However, in case of coelentrates it is not the alternation in generation in true sense as found in plants, a special term metagensis has been coined to describe this phenomenon.

Key words : Polymorphism, zooids, alternation in generation, metagensis.

• STUDENT ACTIVITY

1. Make a model/chart showing polymorphism in obelia.

• TEST YOURSELF

1. What is Polymorphism? Describe it in obelia colony.
2. Describe different kinds of colonies found in coelenterata.
3. Describe metagenesis vs alternation in generation.
4. Describe different kinds of colonies in coelenterata with examples.
5. Objective type Questions

(1) Polyps are meant functionally for

(a) Food and feeding (b) Asexual reproduction

(c) Both of themse (d) None of these

(2) Medusae are

(a) Free swimming (b)Sessile

(c) Both of these (d) None of these

(3) Medusae are ment for :

(a) Dispersal (b) Sexual reproduction

(c) Both of these (d) None of these

(4) Obelia is

(a) Dimorphic colony (b) Trimorphic

(c) Polymorphic colony (d) None of these

(5) Dactylozooids are meant for :

(a) Defence (b) Food

(c) Reproduction (d) None of these

Ans. (1) c (2) a (3) c (4) a (5) a

UNIT

8

PLATYHELMINTHES

STRUCTURE

- Introduction
- Distinguishing Characters
- Classification
  - Summary
  - Student Activity
  - Test Yourself

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Platyhelminthes their basic knowledge including its distinguishing characteristics and their classification

• 8.1 INTRODUCTION

Phylum platyhelminithes (Gr. platys, flat + helmins, worms) includes flat worms and about 10,000 species of the phylum are known. They may be defined as bilateral and protostomial "organ grade" eumetazoans without a body cavity.

Except the beginning of organ grade organization in the phyla of platyhelminthes, several other advancements are also seen in this phyla. Phylogenetically flatworms are supposed to have evolved from a coelenterate-like ancestor.

• 8.2 DISTINGUISHING CHARACTERS

1. Free living, commensal or chiefly parasitic, mostly invertebrates. Some pathogenic.

2. Cephalization (Differentiation of head) with a brain and in some primitive eye spot is the mark of advancement, which is first seen in platyhelminthes.

3. Tissue grade organization, Triploblastic i.e., body derived from three germ layers; ectoderm, mesoderm and endoderm.

4. Bilaterally symmetrical with definite polarity of anterior (head) and posterior (tail) ends.

5. Body unsegmented except in class cestoda.

6. Acoelomate i.e., without any body cavity spaces between various organs filled with special mesodermal tissue, the mesenchyme or parenchyma.

7. Adhesive structures like hooks, spines and suckers and adhesive secretions suit for parasitic life.

8. Muscular system of mesodermal origin longitudinal, circular and oblique muscle layers beneath epidermis.

9. Digestive system branched and incomplete without anus.

10. Skeletal, respiratory and circulatory systems are wanting.

11. Excretory system includes lateral canals and protonephridia (flame cells). Absent in some primitive forms.

12. Nervous system primitive, ladder-like, comprises a pair of anterior ganglia with longitudinal nerve cords connected by transverse nerves.

13. Sense orgens simple. In free living forms eye spots or photoreceptors are developed.

14. Mostly monoecious (hermaphrodite) with well developed reproductive system. Yolk produce separately in yolk or vitelline glands.

15. Fertilization internal, may be cross or self.

16. Development direct or indirect. Usually indirect in endoparasites with a complicated life cycle involving many larvae and hosts.

• 8.3 CLASSIFICATION

On the basis of mode of life, presence or absence of digestive system and cilia on body wall, Platyhelminthes are divided into three classes.

Class 1: Turbellaria (L., turbella-stirring)

(i) Some ectoparasites, but mostly free living worms, called planarians and terrestrial, marine or freshwater in habitat.

(ii) Body unsegmented, flattened and covered with ciliated cellular or syncytial epidermis containing muscus secreting cells and rod shaped bodies called rhabdites.

(iii) Mouth ventral. Intestine preceded by muscular pharynx.

(iv) Suckers absent. Tango, chemo and photoreceptors are common in free living forms.

(v) Mostly hermaphrodite, some reproduce asexually. Development usually direct.

Examples : Mesostoma, Dugesia, Bipalium etc.

Class 2: Trematoda (Gr. Trema, hole + eidos, form)

(i) Ecto or endoparasites on vertebrates; commonly called flukes.

(ii) Body unsegmented dorso-ventrally flattened leaf like. Tegument thick and without cilia and rhabdites.

(iii) Suckers and often hooks and spines present for attachment to host tissues.

(iv) Digestive system well developed with terminal mouth, but no anus.

(v) Three pairs of longitudinal nerve cords.

(vi) Mostly monoecions. Development direct (in ectoparasites) or indirect (in endo parasites) with alternation of host.

Examples : Polystomum, Fasciola, Schistosoma, etc.

Class 3: Cestoda (Gr. Kestos, girdle + eidos, form etc)

(i) All endoparasites, mostly in alimentary canal of vertebrates, commonly called tape worms.

(ii) Body segmented, elongated, flat ribbon-like tegument with microvilli.

(iii) Scolex with suckers, or hooks or both.

(iv) No alimentary canal. No sense organs.

(v) Each mature segment or proglottid monoecious with male and female organs.

(vi) Life cycle complicated involving one or more intermediate hosts. Embryos with hooks.

Example : Taenia, Echinococcus, Hymenolepis etc.

• SUMMARY

About 10,000 species of flatworms are known and are included in the phylum platyhelminthes. They are the animals which show organ grade of body organization

for the first time in the evolution. They are acoelomate animals. Most of the platyhelminthes are parasites. On the basis of mode of life and digestive system they are classified into three classes, Turbellaria, Trematoda and Cestoda.

Key words : Flat worms, Platyhelminthes, acoelomate, parasites.

• STUDENT ACTIVITY

1. Make a chart of outline classification of phylum platyhelminthes

• TEST YOURSELF

1. Give an account of characters and classification of phylum platyhelmithes.
2. Write distinguishing characters of platyhelminthes.
3. Objective Type Questions :
   (1) Taenia is a
   (a) Cestoda (b) Arthropod
   (c) Mollusc (d) None of these
   (2) Flukes are kept in class
   (a) Turbellaria (b) Trematoda
   (c) Cestoda (d) None of these
   (3) Tape worms belong to the class
   (a) Turbellaria (b) Trematoda
   (c) Cestoda (d) Nematoda
   (4) Acoelomates are
   (a) Without coelom (b) With psendocoelom
   (c) With body cavity (d) None of these
   (5) Flat worms are included in the phylum
   (a) Porifera (b) Nematoda
   (c) Platyhelminthes (d) Coelenterata.

Ans. (1) a (2) b (3) c (4) a (5) c

UNIT 9

FASCIOLA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Fasciola in appropriate detail including its habits and habitats, external features and its life cycle and development.
- Also its parasitic adaptations and its various categories.

• 9.1 INDRODUCTION

In phylum Platyhelminthes, class trematoda includes all parasitic animals. They are commonly called "Flatworms or flukes that inhabit liver and bile duct of vertebrates like cattle, sheep, goat, rabbit, pig, dog, and man. Fasciola hepatica is the common liver fluke of sheep and we will discuss here, its biology in detail.

• 9.2 HABIT AND HABITAT

Fasciola hepatica is a cosmopolitan in distribution and is of great parasitological and pathological importance because it is the causative organism of facialiosis or liver rot. It is a digenetic endoparasite, *i.e.*, it completes its life cycle in two hosts. sheep is the

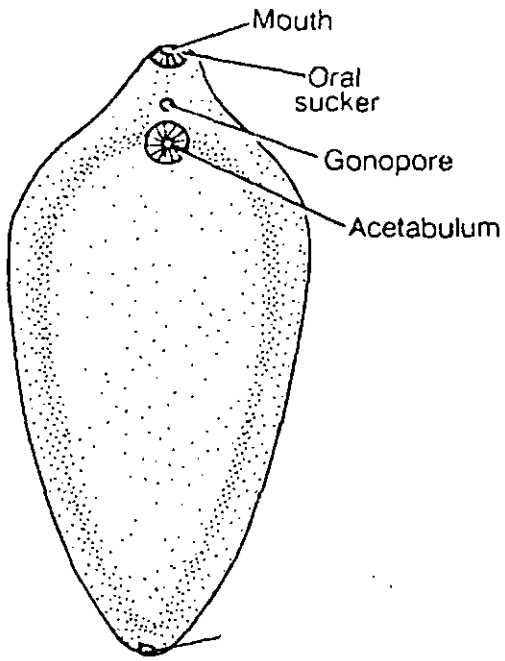

Fig. 1. *Fasciola hepatica*

primary host and a freshwater gastropod, either Limnea truncatula or some specific species of Planorbis or Bulinus are the other intermediate hosts.

• 9.3 EXTERNAL FEATURES

1. Shape and Size : Fasciola is a dorso-ventrally flattened, soft, leaf like oval shaped endoparasite. It is about 1.8 to 3.0 cm long, with a maximum width of 0.4 to 1.5 cm. which is a little in front of the middle region of body. Anterior end is somewhat broad and rounded, while posterior end is bluntly pointed.

2. Colour of the body : Transparent body wall makes all the body organs visible. Due to this, the colour of the fluke appears pinkish.

3. Oral cone : Anterior end of body is drawn out into a prominent conical projection, termed the oral cone or head lobe. At the apex of cone, a triangular mouth is found.

4. Suckers : There are two small suckers, anterior and ventral. Both are devoid of hooks and spines.

(a) Anterior Sucker : Anterior or oral sucker is a cup-shaped muscular organ with enclosed mouth at the centre of its bottom. The diameter of oral sucker is 1 mm. Muscles of oral sucker radiate from margin of mouth to the periphery of sucker. Oral sucker serves for adhesion as well as ingestion.

(b) Ventral sucker : Ventral sucker or acetabulum is bowl like situated mid ventrally behind the oral sucker. It is without an aperture and is 1.6 mm in diameter.

5. Apertures : In front of acetabulum a small common genital aperture or gonopore is for fertilization. Another aperture, excretory pore lies at the posterior end slightly towards the ventral surface. During breeding season a temporary opening of Laurer's canal appears on dorsal surface, a little anterior to the middle of body. Digestive tract is incomplete without anus.

6. Scales : Body covered with cuticular tegument from which numerous minute spinules or scales appear. They serve for the anchoring of body to the walls of liver to protect and to help in locomotion.

• 9.4 LIFE CYCLE AND DEVELOPMENT

(a) Copulation and Fertilization : Though Fasciola is hermahrodite, cross fertilization, usually takes place preceded by copulation. Copulation takes place in the bile duct of the host. During copulation cirrus of one fluke everted through its gonopore, penetrates the Laurer's canal of the other fluke through its temporary opening and injects spermatozoa. Secretions of prostate glands and mehlis glands, keep the sperms active for fertilization. From Laurer's canal sperms move into uterus where fertilization task place.

In a few cases of self-fertilization sperms enter the uterus of same fluke through female genital aperture and get down to fertilize the egg.

(b) Capsules : Each fertilized egg gets surrounded by yolk cells, containing yolk and shell material. Shell material forms the shell of sclerotin around fertilized eggs like that of Insects. Shelled eggs or capsules are yellow or brown in colour and oval in shape. They are provided with an operculum. About 3,000 or more such capsules are found in the uterus of single fluke.

Development: In Fasciola development is indirect and complicated because it involves five larval stages that come one after another.

(a) Cleavage : Cleavage is holoblastic and unequal and starts when eggs remain in the uterus. First division of zygote results in two unequal cells, a larger somatic cell and a smaller propagatory cell. Somatic cell divides to give rise to larval ectoderm and tissues. Propagatory daughter cell divides further into two daughter celsl. One daughter cell gives rise to remaining larval body by division and the other one forms a mass of germ cells which are clustered and stored in the posterior part of larval body.

Further development takes place when capsules come out from the sheep's intestine into the water.

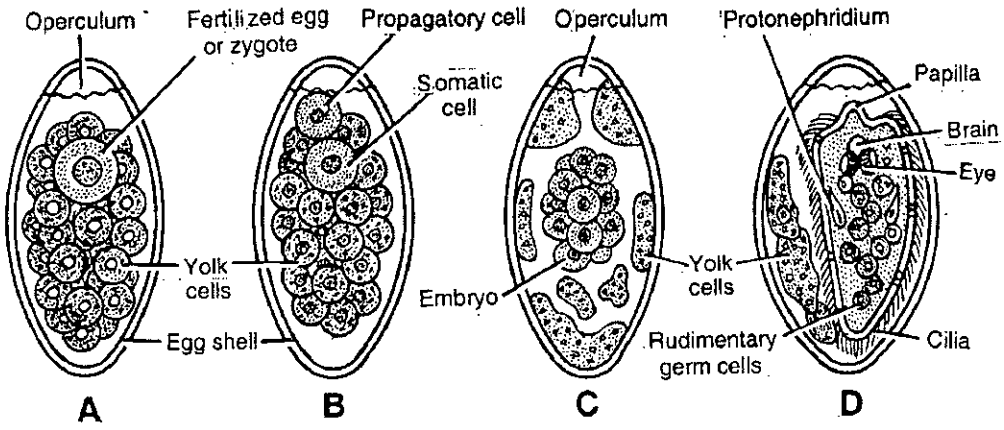

Fig. 2 F. hepatica. Early or embryonic development. (a) Zygote in capsule; (b) 2-cell stage; (c) Many-cell stage; (d) Miracidium in capsule

(b) Ist larval stage : Miracidium larva : Miracidium is the first larval stage. It hatches out from encapsulated embryo with the help of hatching enzyme. It is a 0.07 mm long, oval and richly ciliated, active, free swimming larva. Its broader anterior end is mobile and non-ciliated called apical papilla or terebratorium. Its body is covered with flattened ciliated epidermal 21 plates, arrange in five rows or tiers. Below the plates a fine layer of sub-epidermal musculature is found and it is followed by a thin layer, sub-epithelium. All three layers together form the body wall of miracidium.

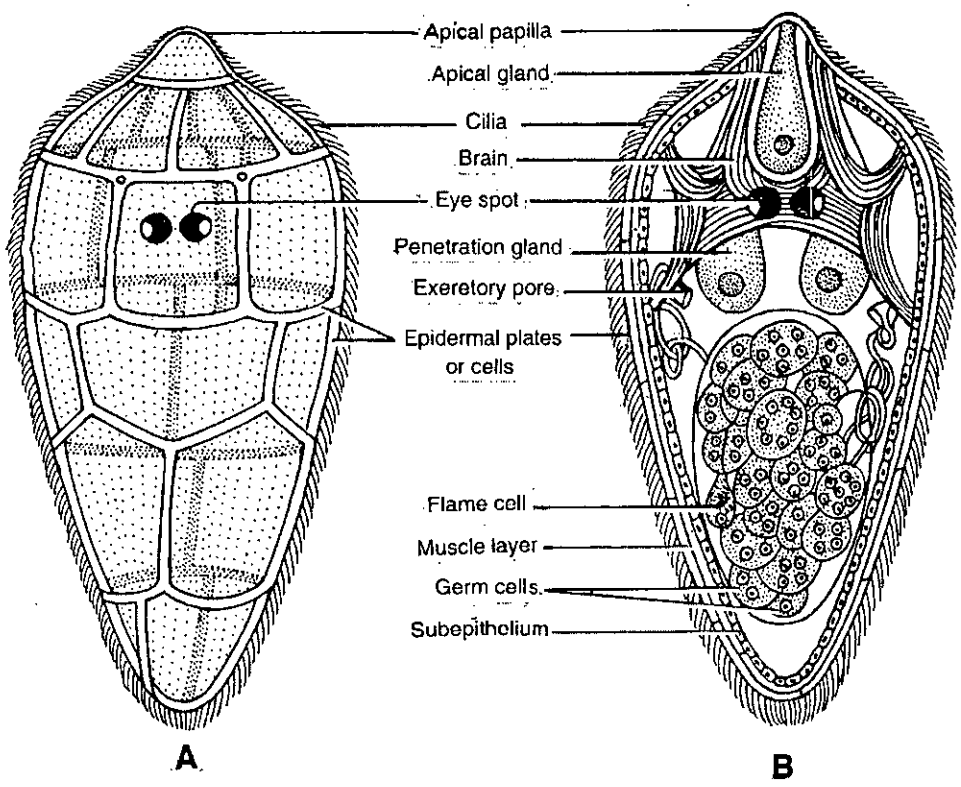

Fig. 3 *F. hepatica*. Miracidium larva (a) External structure; (b) Internal structure

Internal structure: There is a sac like multi-nucleate mass of granular protoplasm and it is attached to the centre of apical papilla by a stalk. A pair of large, unicellular cephalic or penetration glands open by their narrow ends near the apical

papilla. Below the 2nd tier of epidermal cells a brain with several associated nerve fibers is found. Above the brain, "X" shaped larval eye with two pigmented eye spots is found. A pair of long tubular protonephridia or flame cells open to the exterior through two nephridiopores or excretory pores. Germ cells lie in groups and are called germ balls, in the rear part of the body.

Physiology: Miracidium does not feed, swims desperately to find its suitable intermediate host (snail). Those, who find it, penetrate into it with the help of apical and penetration glands. During penetration miracidium larva casts off its ciliated epidermis.

It soon makes its way into the digestive gland of snail, where it undergoes various changes and, in about 4 days develops into the second larval stage, the sporocyst larva.

(c) 2nd larval stage : Sporocyst : It is an elongated larva of 0.7 mm length and bears the body wall like miracidium except ciliated epidermis. In place of it a thin cuticle is found. Glands, brain, eye spots and apical papilla of miracidium larva degenerate and disappear in sporocyst. Protonehridia of each side divides into two flame cells which open outside by a common excretory pore. Sporocyst moves in the digestive gland and feeds upon tissues of the host. Its germ balls develop into the 3rd larval stage, the redia. Each sporocyst produces 5 to 8 rediae.

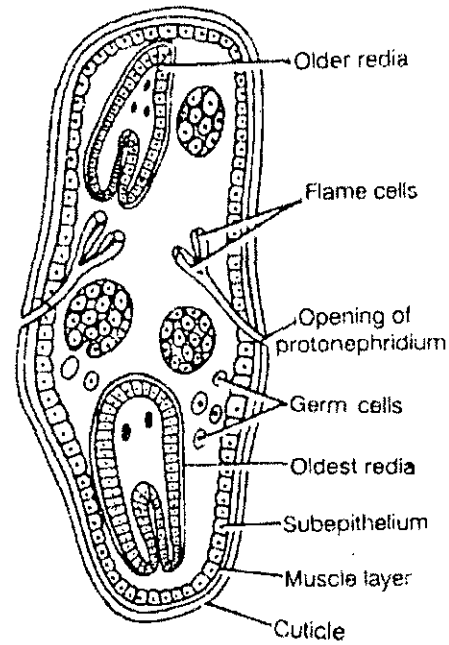

Fig. 4 Sporocyst of *Fasciola*

(d) 3rd larval stage : Redia : By rupturing the body wall of sporocyst rediae come out in the host's tissue. It has a 1.3 to 1.6 mm long, elongated and cylindrical body. It bears a mouth at the anterior end, a ring of muscular swelling or collar, a permanent birth pore a little behind collar, and a pair of lappets procruscula ventrolaterally near the posterior end. Body wall is same as in sporocyst. viz., cuticle, musculature and subepithelium. Mouth leads into a short muscular pharynx. followed by an elongated sac-like intestine, Enteron or gut is lined by a single layer of cells. Numerous unicellular pharyngeal glands open into pharynx. Protonehridia divide further and form a much branched system. Body of larva is packed with germ balls and mesenchyme cells.

Through muscular contraction aided by collar and lappete rediae larvae wander in the host's tissue and feed. It moves into various organs but prefers to migrate into digestive glands. During summer months germ ball of redia gives rise to a second generation of rediae. During winters germ balls of second generation rediae produce cercaria larva.

(e) 4th larval stage : Cercaria larva : 14 to 20 cercari emerge out from each redia through birth pore into the host's tissue. It bears a close resemblance with the adult fluke. It is 0.25 to 0.35 mm long with an oval body and a tail for swimming.

Layers of body wall are same viz., cuticle, musculature and subeithelium, but cuticle bears backwardly directed spines. Beneath the body wall lie several cystogenous gland cells, which secrete cyst for the next larval stage. Mouth leads into a muscular pharynx followed by esophagus and intestine. Intestine is forking in front of the ventral sucker to form two tubular limbs. Flame cells are found in large number, along the lateral zones, open into a pair of excretory tubules, which unite to form an excretory vesicle or

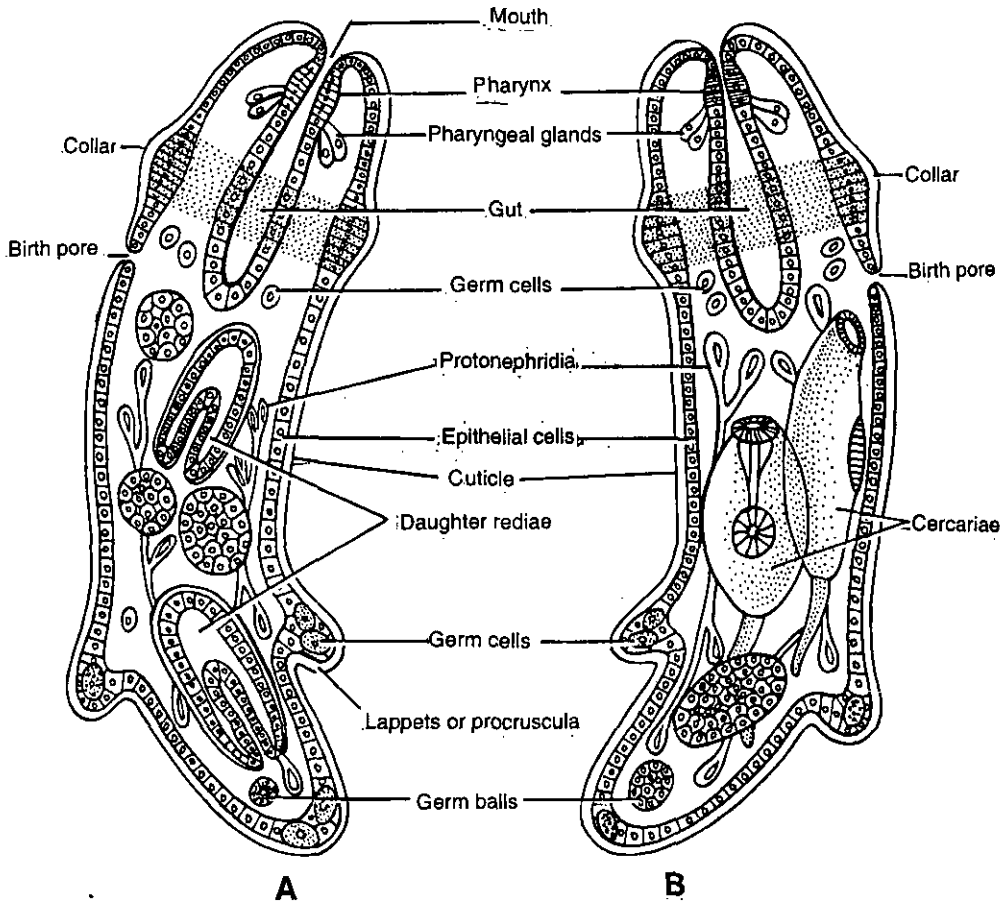

Fig. 5 *F. hepatica.* (a) Redia with daughter rediae; (b) Redia with cercariae

bladder. From the bladder a secretory duct arises and extends into the tail region where it bifurcates and opens out through a pair of nephridiopores. Germ cells are present.

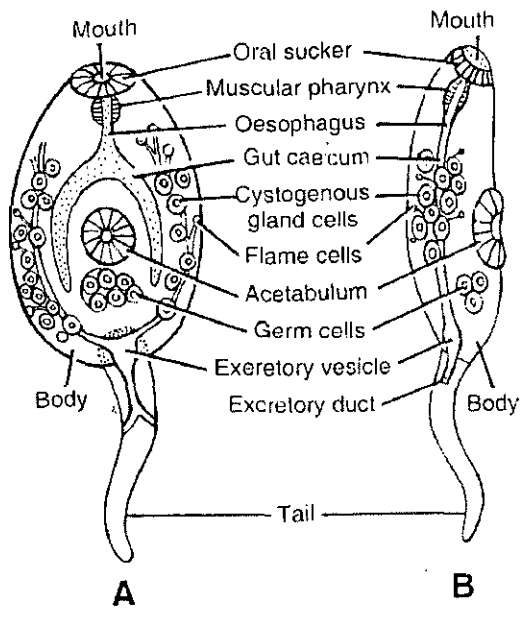

Fig. 6. F. Hepatica. (A) Cercaria in ventral view; (B) Cecaria in lateral view.

Mature cercaria makes its way through pulmonary sac of the snail and finally escapes into the water. The development of fluke in the snails's body from the stage of miracidium larva to cercaria larva takes 35 to 65 days depending upon availability of food and temperature. After an active life of two or three days it settles down on the leaf of aquatic plants and undergoes encystment to become metacercaria.

(f) 5th Larval stage : Metacercaria : Metacercaria is round, 0.2 mm in diameter, surrounded by a thick and hard cyst. It contains a large number of flame cells, but its excretory bladder opens out directly through single pore. Tail and cystgenous glands become degenerate. Metacercaria is, in fact, the juvenile fluke, also called marita. Germ cells or genital rudiments are present as such.

Infection of primary host (sheep) : Sheep get infection by grazing on cyst loaded leaves of aquatic plants. After ingestion metacercaria survive from sheep's gastric juice and slides to the proximal part of intestine. Here cyst breaks to set free larva and it penetrates the intestine wall to move into coelomic cavity. Now it infects the liver, feeds and grows in size for five to six weeks. Then it goes to bile duct, where it finally attains the sexual maturity. In 11 to 13 weeks of infection fluke gets matured to lay eggs.

• 9.5 PARASITIC ADAPTATIONS

To suit the endoparasitic life Fasciola undergoes several morphological and, physiological modifications, which are called parasitic adaptations. These are as follows :

(a) Morphological adaptations

1. Outer tegument is thick and enzyme resistant so that it saves parasite from digestive juices.

2. Locomotory organs are absent in adult fluke, because of no need.

3. Oral suckers, acetabulum and spines of body wall of adult fluke help in attachment to the host's body.

4. Being parasite, digestive tract is incomplete (no anus). Suctorial pharynx helps in sucking bile and much branched intestine serves for distribution of food to the entire body.

(b) Physiological adaptations

1. The nervous system and sensory organs in adult fluke are degenerate.

2. Circulatory and Respiratory organs are absent.

3. Respiration is anaerobic as free O_2 is not available.

4. The medium of body fluid of fluke is isoosmotic to the medium of bile duct.

5. Parasite stimulates the gut to secrete mucus which forms a protective covering around it.

(c) Reproductive adaptation

1. Fasciola is monoecious, hermaphrodite. It ensures self fertilization in absence of cross fertilization.

2. Reproductive system is highly modified and developed in order to produce thousands of eggs. (About 20,000 eggs per fluke)

3. Zygote is provided with resistant egg shells for safety.

• SUMMARY

Fasciola hepatica is commonly called liver fluke because it is an endoparasite of liver and bile duct of vertebrates. It is a digenetic endoparasite, i.e., complete its life cycle in two hosts. Sheep, cattle etc are its primary host and fasciala cause liver rot disease in them Fasciola is monoecious and reproductive organs are well developed. Cross fertilization is found. Life cycle is complicated and development is indirect involves five kinds of larvae. Miracidium and cercaria larva are free swimming while rest of the larvae are parasites. Various kind of parasitic adaptations are exhibited by fasciola.

Key words : Liver fluke, digenetic, liver rot, miracidium, cercaria.

• STUDENT ACTIVITY

1. Make a chart/model of structure of fasciola

• TEST YOURSELF

1. Give an account of development in Fasciola
2. Describe the structure and physiology of miracidium larva
3. Describe parasitic adaptations in fasciola
4. Describe cercaria and Metacercaria larvae of Fasciola.
5. Objective type Questions

(1) Acetabulum is a
(a) Ventral sucker (b) Oral aperture
(c) Gonopore (d) None of these

(2) Flat worms or flukes are endoparasites of
(a) Liver and bile duct (b) Kidney
(c) Brain (d) Intestine

(3) Body is covered in flukes by
(a) Cuticle (b) Chitin
(c) Mucin (d) None of these

(4) Fasciola causes liver rot in its
(a) Vertebrate host (b) Invertebrate host
(c) Both of these (d) None of these

(5) Miracidium is the larva of
(a) Ist stage (b) IIIrd stage
(c) Vth stage (d) None of these

Ans : (1) a (2) a (3) b (4) a (5) a

UNIT

10

PHYLUM NEMATODA (NEMATHALMINTHES)

STRUCTURE

- Introduction
- Distinguishing Characterestics
- Classification
  - Summary
  - Student Activity
  - Test Yourself

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Phylum Nematoda in detail including its distinguishing characteristics and classification.

• 10.1 INTRODUCTION

The term "Nematoda" literally means "thread worms or roundworms" (Gr. neam-thread + eidos- form). About 12,000 species are known of this phylum, which are mostly endoparasites and pathogenic .

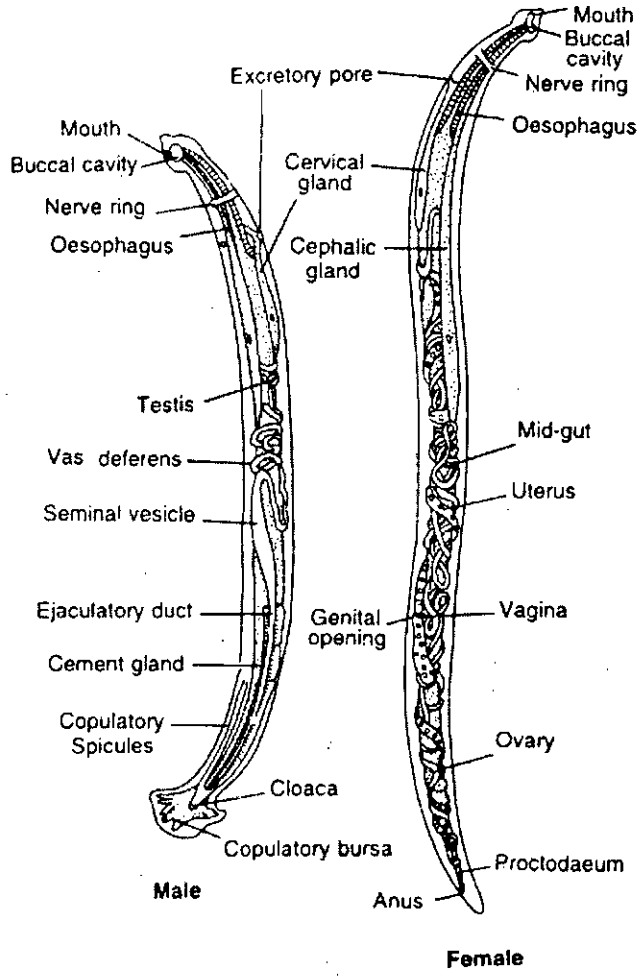

Fig. 1 Ancylastoma duodenale

Phylum Nematoda is characterized as bilateral and prostomial "organ grade" eumetazoans in which the space between body wall and alimentary canal is a pseudocoel derived from embryonic blastocoel.

• 10.2 DISTINGUISHING CHARACTERS

1. Many endoparasites of various animals and plants. Others free living and widely distributed in all sorts of water and damp soil.
2. Mostly minute or small, some large.
3. Body elongated, slender, cylindrical and tapering towards both ends unsegmented.
4. Body wall formed of a thick, tough and shiny cuticle, a syncytial hypodermis followed by muscular quadrants.
5. Pseudocoel is spacious, with a fluid but no free cells.
6. Digestive system of glandular organs, canals, or both.
7. No cilia, circulatory and respiratory system.
8. Excretory system of glandular organs, canals or both.
9. Nervous system with circulatory ring and anterior, and posterior nerves, sense organs simple.
10. Reproductive system well developed. Usually dioecious with sexual dimorphism.
11. Fertilization internal. Development usually direct. No asexual reproduction or regeneratation.

• 10.3 CLASSIFICATION

On the basis of the presence or absence of some specialized sense organs and caudal glands and characterstics of excretory system, nematodes are classified into two classes.

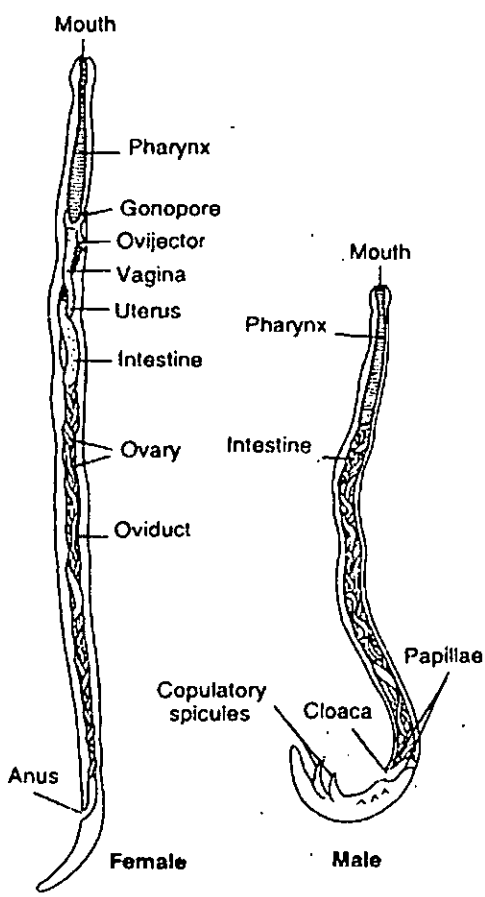

Fig. 2. Wuchereria bancrofti

Class 1 : Phasmidia or Secarnentea.

(i) Mostly parasitic.

(ii) Possess a pair of unicellular, pouch-like sense organs called phasmid, near hind end of body.

(iii) Another pair of reduced, pore-like sense organs, called amphid, present near anterior end.

(iv) Excretory system with paired lateral canals.

(v) Caudal glands are absent.

Examples : Ascaris, Enterobius, Ancyclostoma, Wuchereria etc.

Class 2 : Aphasmidia or Adenophorea :

(i) Mostly small, free living. No phasmids.

(iii) Amphids spiral, cord-like or disclike seldom porelike.

(iv) No lateral excretory canals.

(v) Caudal glands present.

Examples : Trichinella, Capillaria etc.

• SUMMARY

About 12,000 species of thread worms or round worms are grouped together in the phylum Nematoda. They are mostly endoparasites and pathogenic to their hosts. They are pseudocoelomate animals. All the physiological systems are less developed. Reproductive system is well developed. They are usually dioecious and show sexual dimorphism development is direct.

Key words : Threadworms, Nomatoda, pathogenic, dioecious, sexual dimorphism.

• STUDENT ACTIVITY

1. Make a chart of pathogenic nematodes

• TEST YOURSELF

1. Give an account of characterstic features of phylum Nemathelminthes and classify it.
2. Write distinguishing characters of phylum nematohelminthes
3. Objective type Questions

(1) Nematodes are

(a) Acoelomates (b) Coelomates

(c) Pseudocoelomas (d) None of these

(2) Sexual dimorphism is found in

(a) Protozoa (b) Porifera

(c) Nematoda (d) Platyhelminthes

(3) Phasmids are sense organs in

(a) Porifera (b) Rotifera

(c) Nematoda (d) Castoda

(4) Syncytial hypodermis is found in

(a) Porifera (b) Mollusca

(c) Coelenterata (d) Nematohelminthes

(5) Nematodes are

(a) Threadworms (b) flatworms

(c) Ring worms (c) Silk worms

Ans. (1) c (2) c (3) c (4) d (5) a

UNIT

11

ASCARIS–A TYPE STUDY

STRUCTURE

LEARNING OBJECTIVES

After going through this unit you will learn :

- Ascaris; its external features, life history and development and its habit and habitats.
- Its parasitic adoptations and its effect on human beings.

• 11.1 INTRODUCTION

Ascaris is a nematod, commonly called roundworm belonging to phylum Nematoda of superphylum Aschelminthes.

• 11.2 HABIT AND HABITAT

The most common and best known species *Ascaris lumbricoides* is a gastrointestinal endoparasite of man. it is found more frequently in children than in adults. It is a monogenetic parasite i.e., it completes its life cycle on single host. It has a cosmopolitan distribution, but chiefly found in India, China, Korea, Philippines and Pacific Islands.

• 11.3 EXTERNAL FEATURES

Body is elongated cylindrical and gradually tapering at both ends, the anterior end is more slender than the posterior. Ascaris is dioecious and shows sexual dimorphism. Female ascaris measures 20.0 to 40.0 cm in length and 4.0 to 6.0 mm in diameter with a straight tail. While male is smaller upto 20.0 cm in length and 2.0 to 4.0 mm in diameter with a tail curved ventrally. The colour of ascaris is light yellow and light pink because of transparent cuticle. Cuticle bears minute transverse striations giving a pseudosegmented appearance to the worm.

All along the length of body four longitudinal streaks or lines - one mid-dorsal, one mid-ventral and two lateral are visible. Dorsal and ventral lines appear pure white, while, lateral lines appear brown.

Anterior end : On the anterior end is a small terminal triradiate mouth guarded by three broad lips or labia. Inner or oral margin of each lip has forked fleshy core, consisting of two anterior extensions of labial parenchyma and bears minute denticles. These denticles help in rasping of tissues. Outer surface of each lip bears minute sensory papillae (L., papilla, nipple). A single amphid, near papilla on lateral lip is also present. Papillae are perhaps tangoreceptors while amphids are probably chemoreceptors.

Posterior end : The posterior end is straight in male. In female, a little in front of the tail end lies a mid ventral transverse aperture, or anus guarded by thick lips. Only digestive tube opens to outside through anus.

In male, anus is replaced by a cloaca. It is the common aperture for digestive and genital tubes. Two small needle-like and cuticular penial spicules or copulatory setae are often seen protruding out from the cloacal aperture. They serve to transfer sperms into female vagina during copulation. The ventral body surface in cloacal region bears 50 pairs of preanal (precloacal) papillae in front of cloacal aperture and 5 pairs of

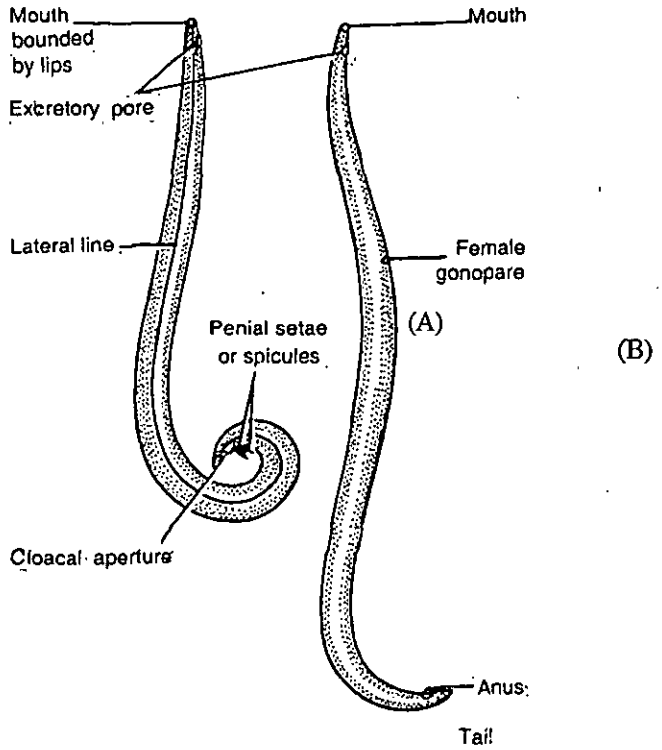

Fig. 1. *Ascaris lumbricoides*. Adult worms in lateral view. A–Male; B–Female.

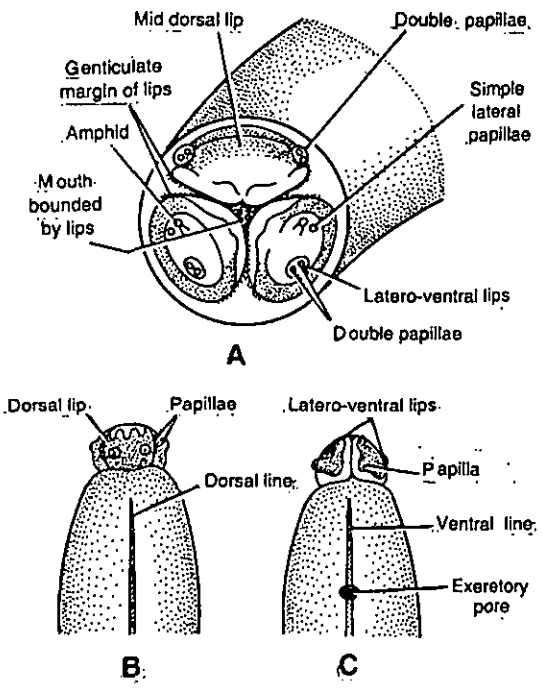

Fig. 2. Ascaris-Anterior end (A) in front view, (B) in dorsal view, (C) in ventral view

postanal (postcloacal) papillae behind it. These papillae serve to hold the female during copulation.

Excretory pore : A single excretory pore lies mid-ventrally at a distance of about 2 mm from the anterior end.

Female gonopore : About one third distance from the anterior end, the genital pore or vulva of female lies midventrally.

(a) Sexual Dimorphism : Ascaris shows remarkable difference between male and female individuals which is called *sexual dimorphism*. Main points of difference are described in the table.

	Male Ascaris	Female Ascaris
1.	Body smaller, 15-30 cm long and 3-5 mm thick.	Body larger, 20-30 cm long 6-8 mm in diameter.
2.	Tail end curved ventralwards.	Tail end straight
3.	Anus and genital pore common (Cloacal aperture) located midventrally about 2mm in front of posterior end.	Anus and genital pore separate. Genital pore midventral at about 1/3 body length behind anterior end. Anus mid-ventral, about 2mm in fron of hind end.
4.	A pair of needle-like and protrusible penial setae in cloaca.	No penial setae.
5.	Pre-anal and post-anal papillae present upon ventral body surface in cloacal region to help in copulation.	No such papillae.

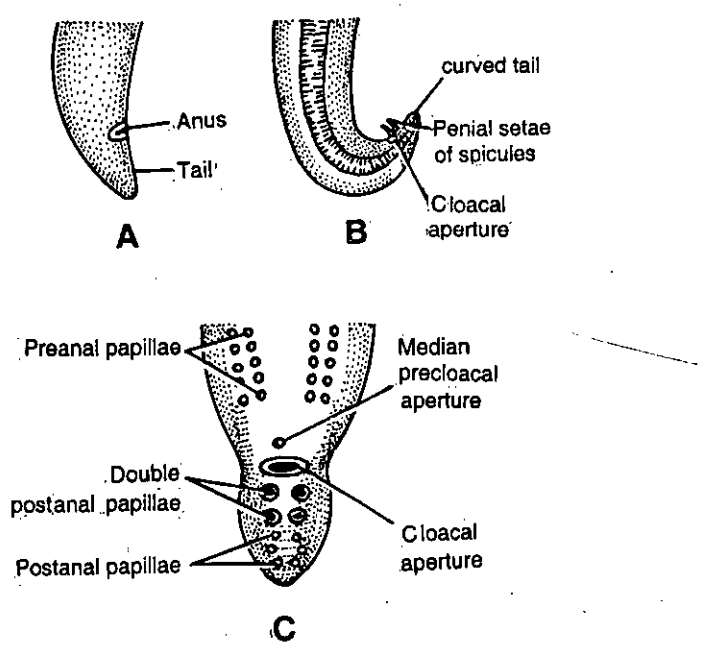

Fig. 3. Sexual Dimorphism in Ascaris; (A) Posterior end of male in side view; (B) Posterior end of female in side view. (C) Posterior end of male in ventral view showing papillae.

• 11.4 LIFE HISTORY AND DEVELOPMENT

Copulation and Fertilization : Copulation occurs in host's intestine, where the adult worms live. The male and female lie in such a position that the cloacal aperture of male and vulva of female come in close contact. Penial setae of male help to open the vulva and sperms are transferred into vagina. Then the sperms pass on to the proximal end of uteri to fertilize the eggs.

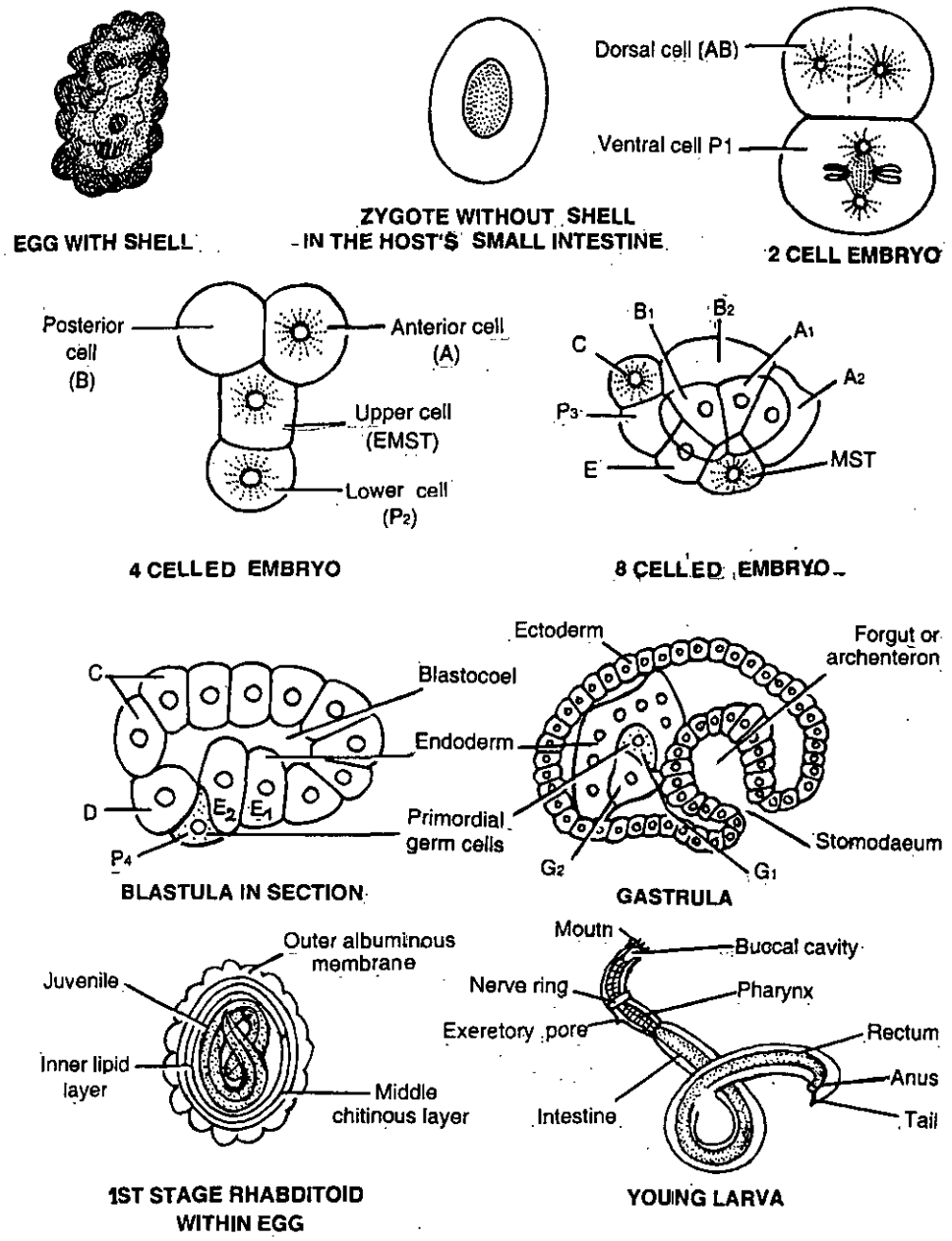

Fig. 4. Ascaris : early development stages of Embryo and juvenile

Zygote : After fertilization the glycogen globule of the egg comes on surface to form a fertilization membrane. It becomes harder and forms a thick, clear and chitinous shell. The fat globule of the egg forms a thin lipoid layer below shell. As the zygote moves into the uterus, its wall secretes a brown albuminous coat.

A mature female ascaris may contain 21 million eggs in its uterus. Zygotes then pass out through gonopore into the host's intestine and finally in the soil with host's faeces. Under suitable conditions of temperature, moisture, and oxygen it undergoes cleavage and develops into the infective stage.

Cleavage and early development : Cleavage is of spiral and determinate type. Fate of various cells of the zygote at 16 cell stage is fixed and it contains a cavity to become blastula. Blastula undergoes a process of invagination and becomes gastrula. It grows in length to become an active juvenile in 10-14 days from the start of cleavage. This juvenile closely resembles with another nematod, *rhabditis* and therefore is termed as *rhabditiform larva* of first stage. At this stage it is not infective. In another

week's time it moults within the egg shell and becomes the second stage of *rhabditoid*, which is capable of infecting the host.

Under suitable conditions of moisture, O_2 and temperature, these infective eggs are known to remain viable for about six years.

Later development and migration into new host : Being a sole host, man acquires infection by consuming egg contaminated food and water. In the small intestine, by the action of host's digestive juices egg shells disolve and the juveniles (second stage larva) hatch out. It performs active thrashing movements and bores through the epithelium of host's intestine and starts its migration into different organs.

Primary migration : Firstly larva enters the hepatic portal circulation from the wall of the intestine and reaches into the liver. Then it migrates to the heart and finally goes to the lungs via pulmonary artery. It grows in size and ruptures out of blood capillary into the alveoli of the lung. After about 6 days of stay it moults to become *third stage larva*. After 4 days it again moults to become *fourth stage larva* and grows upto a length of 2 to 3 mm.

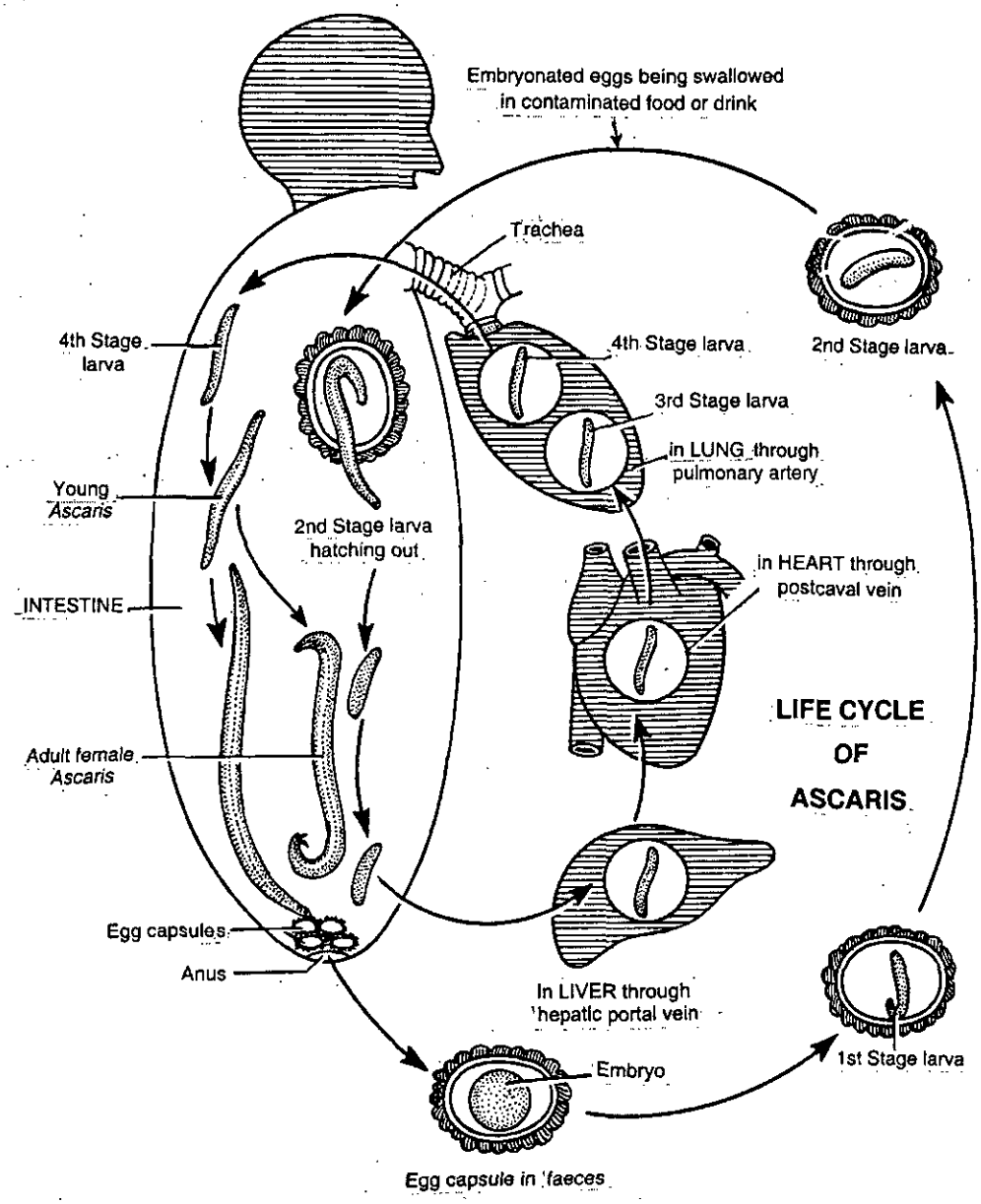

Fig. 5. Ascaris. Life cycle

Secondary migration : Fourth stage larva then migrates from lung alveoli to the pharynx through trachea. From trachea it is couged up and then swallowed for the second time into gut. In the intestine it moults for the fourthtime, the last time to become an adult.

Adult attains sexual maturity within 8-10 weeks. The average life span of ascaris in the host is 9-12 months.

Aberrant migration : Sometimes larva does not follow its usual path of migraton, but reaches the brain or spinal cord or any other such vital organ, which is called aberrant migration. Larva is not able to survive in these organs and a calcareous cyst is formed around it.

• 11.5 PARASITIC ADAPTATIONS IN ASCARIS

Ascaris bears the following parasitic adaptations to suit its parasitic mode of life:

1. Tough, thick and resistant cuticle covering of the body protects the ascaris from host's digestive enzymes and antitoxins.
2. Muscular contraction of body counteracts the peristaltic movements in the intestine.
3. Muscular pharynx facilitates ingestion of food by sucking action.
4. Pseudocoelomic fluid serves for absorption, transport and distribution of food, oxygen and wastes, so that there is no circulation system.

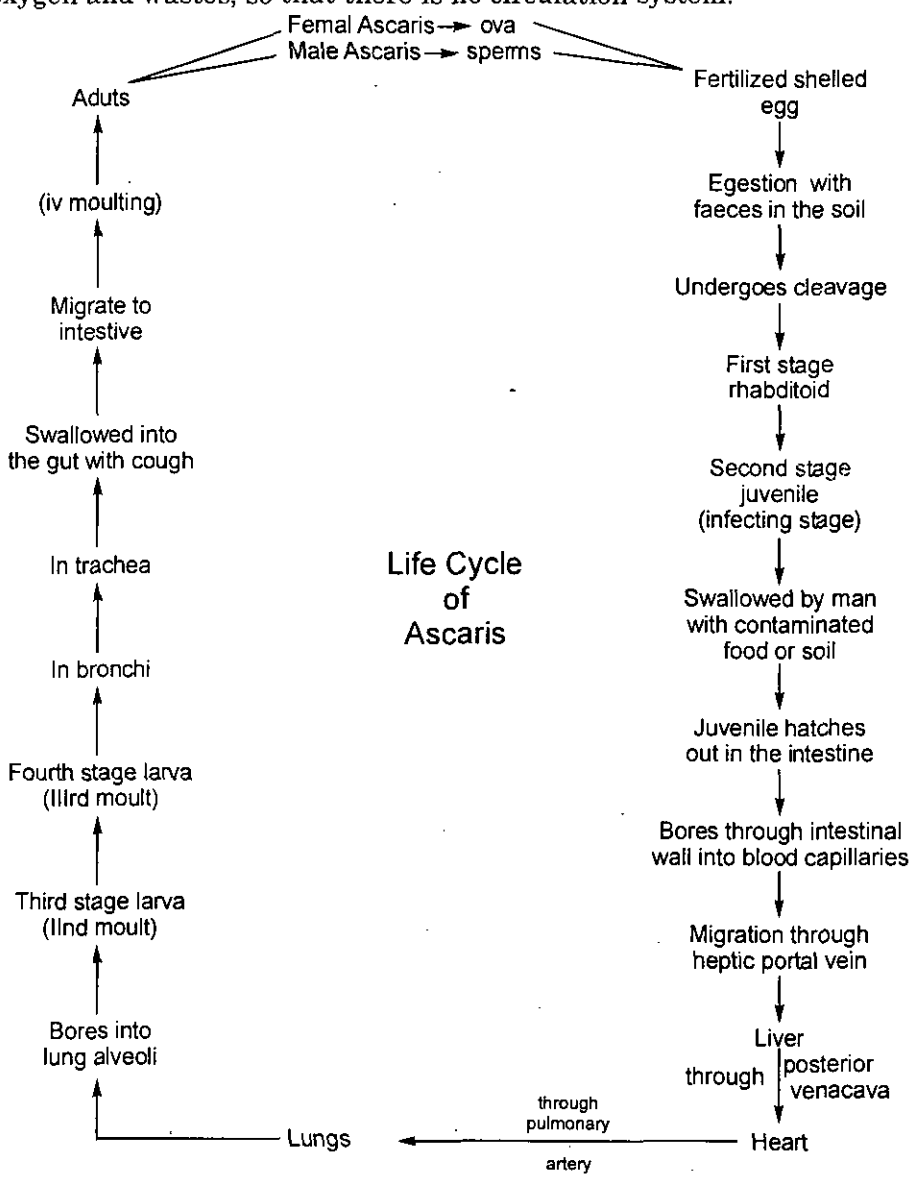

Fig. 6. Migration path of juvenile upto adulthood

5. Extremely low metabolic rate and anaerobic respiration enables the worm to live inside the host's intestine, where free oxygen is negligible.

6. Sensory organs are simple because there is no need.

7. Enormous rate and capacity of reproduction which is required to face all the risks of death in finding new specific host.

8. Zygote is provided with a shell for safety from unfavourable environmental conditions.

9. Minute size and resistant nature of egg affords far and wide dispersal of the parasite.

• 11.6 PATHOGENESIS

In human-being the infection of Ascaris causes *ascariasis*. Larva often prove more injurious than adult worms by causing haemorhage. During migration if the larva accidently enters into some other vital orgam it produce serious injuries. In severe infection, they may cause acute pneumonia with fatal consequences. Frequently anaemia, temperature are results of infection.

Therapy : Ascaris infection is diagnosed by examining host's stool for eggs. Certain antihelminth drugs such as oil of Chenopodium, Alcopar, Emanthal, Hetrazin Vanpar, Zentel etc are commonly used to kill the worms and cure the patient.

Prophylaxis : Since people get infected with ascaris due to unhygienic habits and by consuming contaminated food and drinks, strict sanitary and hygienic measures alone can effectively check the incidence of infection.

• SUMMARY

Ascaris is commonly called roundworm & is found as a gastro-intestinal endoparasite of man. It is a monogenetic parasite *i.e.*, it completes its life cycle on single host. Ascaris is diocions and shows sexual dimorphism. Development is not direct and involves rhabditiform larva. Ascaris shows a number of parasitic adaptations to suit its parasitic mode of life. In human beings it causes the disease ascariasis.

Key words : Roundworm, monogenetic, dioecious, rhabditiform larva.

• STUDENT ACTIVITY

1. Make a sketch diagram or chart of life cycle of Ascaris

• TEST YOURSELF

1. Give an account of external features of Ascaris with special reference to sexual dimorphism.
2. Write a detailed note on parasitic adaptations in Ascaris
3. Describe life cycle of Ascaris
4. What disease is caused by Ascaris? Write in brief about its pathogenesity, therapy and prophylaxis.
5. Write a note on sexual dimorphism in Ascaris.
6. Objective type questions :

(1) Penial setae are found in
(a) Male ascaris (b) Female ascaris
(c) Ancyclostoma (c) None of these

(2) Ascaris is a
(a) Gastro-intestinal parasite (b) Blood parasite
(c) Liver parasite (d) None of these

(3) Ascaris is an endoparasite of
(a) Man (b) Sheep
(c) Cattle (d) Mosquitos

(4) Rhabditiform larva is found in
(a) Ancyclostoma (b) Flat worms
(c) Ascaris (d) Earthworms

(5) Pseudocoelom is found in
(a) Nematoda (b) Cestoda
(c) Annelida (d) Arthropoda

Ans. (1) a (2) a (3) a (4) c (5) a

UNIT 12

ANNELIDA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Annelida in appropriate detail including its distinguishing features and classification.

• 12.1 INTRODUCTION

Annelids commonly known as "segmented worms" include about 9,000 species. Phylum Annelida (Gr; annelus, little ring + eidos, bears) includes bilateral and prostomial eucoelomate eumetazoans whose long, narrow and worm-like body is divided into ring-like, true or metameric segments and the skin usually bears unjointed, chitinous appendages, termed as setae.

• 12.2 DISTINGUISHING FEATURES

1. Mostly aquatic, some terrestrial, burrowing or tubiculous. Some commensel and parasites.

2. Body elongated, bilaterally symmetrical triploblastic, truely coelomate and metamerically segmented into similar metameres.

3. Body wall is dermo-muscular, with outer layer of longitudinal muscles and inner layer of circular muscles. Epidermis consists of columnar cell and is covered by cuticle.

4. Locomotion by segmentally repeated chitinous bristles, called setae secreted by epidermis or by lateral fleshy appendages or parapodia.

5. Schizocoelic coelom, coelomic fluid with cells or corpuscles.

6. Alimentary canal is straight and complete, Digestion entirely extracellular.

7. A distinct and closed type of blood-vascular system is present. Blood is of red colour with haemoglobin dissolved in plasma.

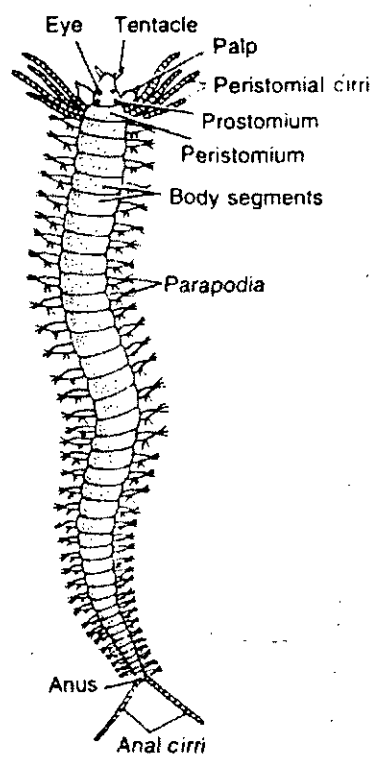

Fig. 1. Nereis

8. Respiration through moist skin, some possess gills.

9. Excretion by minute and coiled paired tubules of ectodermal origin called metanephridia.

10. Nervous system includes nerve ring near anterior end, two ventral nerve cords, bearing ganglia and lateral nerves in each segment.

11. Sensory organs include tactile organs, taste buds statocysts, photoreceptor cells and sometimes eyes with lenses in some of them.

12. Hermaphrodite, reproductive organs develop from coelomic epithelium.

13. Development mostly direct, when indirect a trochophore larva is present.

• 12.3 CLASSIFICATION

On the basis of position and arrangement of setae, absence or presence of sensory organs annelids are classified into three classes :

Class 1: Polychaeta (Gr. polys, many + chaite, hair)

(i) Chiefly marine, some in fresh water.

(ii) Setae numerous on lateral parapodia.

(iii) Clitellum absent.

(iv) A distinct head with tactile tentacles, olfactory palps and often eyes present.

(v) Sexes separate, Gonads temporary and in many segments.

(vi) Trochophore larva present.

Examples : Arenicola, chaetopterus Nereis etc.

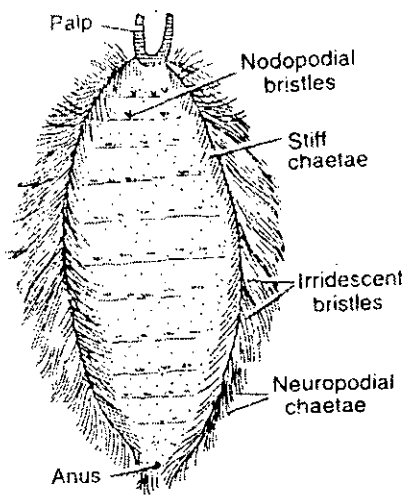

Fig. 2. Aphrodite

Class 2: Oligochaeta (Gr; oligos; few + chaite, hair)

(i) Mostly terrestrial, some in fresh water.

(ii) Head indistinct, without sensory organs.

(iii) Setae few, embedded in skin, parapodia are absent.

(iv) Glandular clitellum present for cocoon formation.

(v) Hermaphrodite, testes anterior to ovaries.

(vi) Fertilization external (in cocoon) development direct, no larval stage.

Examples : Branchiobdella, Lumbricus, Pheretima etc.

Class 3: Hirudinea (L; Hirudo, leach)

(i) Freshwater, marine, or terrestrial. Generally ectoparasitic, blood sucking or carnivorous.

(ii) Body with fixed number of segments 33.

(iii) Segmentation external without internal septa. Parapodia and setae absent.

(iv) Both anterior and posterior ends of body with suckers.

(v) Coelom much reduced due to its filling by botryoidal tissue and forms haemocoelomic sinuses.

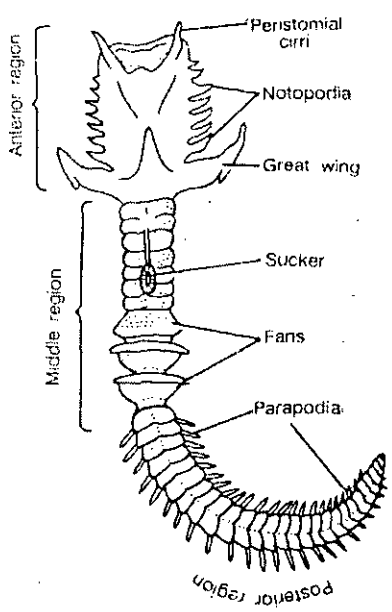

Fig. 4 Chaetopterus

(vi) Hermaphrodite with seperate male and female gonopore.

(vii) Fertilization internal; Development in cocoons, and direct.

Examples : Acanthobdella, Hirudinaria, Polygordius etc.

• SUMMARY

Annelids are represented by segmented worms and count about 9,000 species. These are eucoelomate animals and exhibit metameric segementation of the body. Specialized locomotory organs called setae are found in these animals. On the basis of presence or absence of setae and sensory organs phylum annelida is divided into three classes, polychaeta, oligochaeta and hirudinea.

Key words : Segmented worms, metameric segmentation, setae, Polychaeta oligochaeta and Hirudinea.

• STUDENT ACTIVITY

1. Make diagrams of some annelids on the chart paper.

• TEST YOURSELF

1. Give an account of distinguishing features of phylum Annelida and classify it upto classes.
2. Write characteristic features of class Polychaeta with examples
3. Write characterstic features of phylum annelida.
4. Objective type Questions

(1) Annelids are

(a) Segmented worms (b) Round worms

(c) Flatworms (d) Silkworms

(2) Metameric segmentation is found in

(a) Annelida (b) Protozoa

(c) Porifea (d) Platyhelminthes

(3) Setae are

(a) Sensory organs (b) Locomotory organs

(c) Defensive organs (d) None of these

(4) Schizocoelic coelom is found in

(a) Nematoda (b) Annelida

(c) Platylaelminthes (d) Porifera

(5) Trochophore larva is found in

(a) Arthropoda (b) Annelida

(c) Nematoda (d) None of these

Ans. (1) a (2) a (3) b (4) b (5) b

UNIT

13

HIRUDINARIA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Abou Hirudinaria its Habits and External Featues
- The Parasitic Adoptations of Leeches.

• 13.1 INTRODUCTION

About 300 species of leeches are known to occur in the tropical and temperate parts of the globe. Mostly, they are freshwater, while some are marine or terrestrial. Most of leeches are ectoparasites of vertebrates.

• 13.2 HABIT AND HABITAT

Hirudinaria granulosa commonly called Indian cattle leech is found in India, Burma, Sri Lanka, Pakistan and Bangladesh. It has a blood sucking habit (sanguivorous) feeding on the blood of fishes and frogs, and cattle and men, also who happen to enter the water inhabited by it.

• 13.3 EXTERNAL FEATURES

Shape and Size : Body is 10-15 cm long elongated and dorso-ventrally flattened with a great power of expansion and contraction. Posterior end is broader than the narrow anterior end.

Body of leech is brightly coloured with characterstic marking. Dorsally it is olive green and ventrally it is orange red or orange- yellow.

Segmentation : It shows metamerism and bears fixed no of segments 33, somite. Except the first two and last seven segments, each somite is further superficially subdivided into rings or annuli by transverse furrows. A typical segment possesses five annuli.

Body is Divided into 6 Different Regions

1. **Cephalic region** : It consists of first five segments and includes prostomium, anterior sucker, mouth, anus and eyes. 1st and 2nd segment are uniannulate 3rd is biannulate, 4th and 5th are triannulate.

2. **Pre-cliteller region** : 6th, 7th and 8th segments form precliteller region, all bearing nephridiopores on the ventral surface in the last annulus of each segment. 6th segment is triannulate, while 7th and 8th bear 5 annuli.

3. **Cliteller** : 9th, 10th and 11th segments possess highly glandular walls and nephridiopores. During breeding season a temporary clitellum develops around

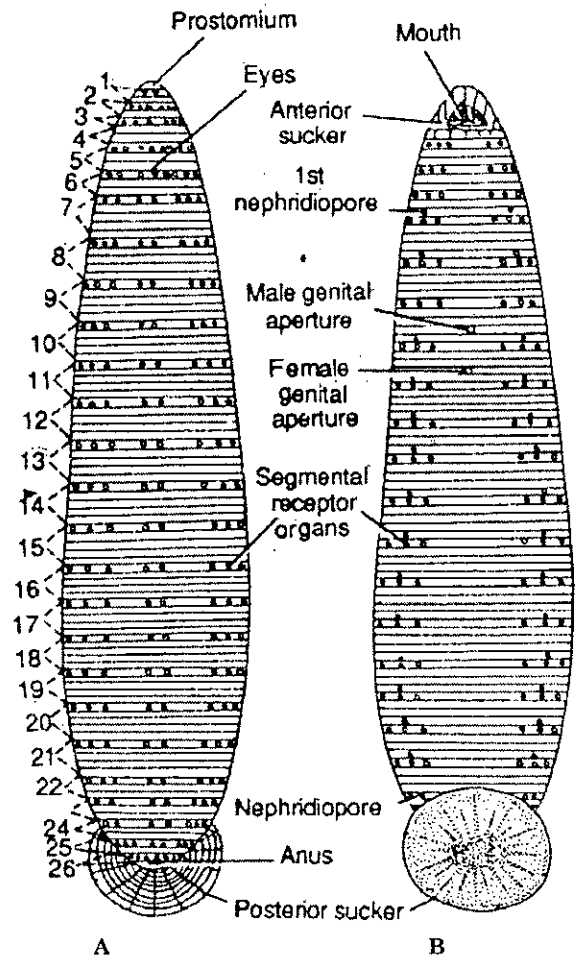

Fig. 1 Hirudinaria : A-Dorsal view, B-Ventral view

this region. Male and female gonopores lie mid-ventrally on 10th and 11th segment. All segments bear five annuli.

4. Middle region : From 12th to 22nd segment, middle region is the largest region, all segments bear 5 annuli and nephridiopores.

5. Caudal region : This region consists of four segments (23rd to 26th) which don't have nehphridiopores 23rd segment is triannulate and the rest are biannulate. Segment 26th bears the mid-dorsal anal aperture.

6. Posterior sucker : From 27th to 33rd, seven segments arranged in a concentric ring, represent single annulus and make posterior sucker.

Receptors

On the dorsal and ventral surface of each annulus of each segment 18 receptors on each side are found which are separated by longitudinal furrow. These are called *annular receptors*. Besides these, each segment has 4 pairs on dorsal and 3 pairs on ventral side the segmental or *sensillae receptors* only in first annulus of the segmetn. The 5 pairs of eyes are also present in ocular segments (1st to 5th) on dorsal surface, in first annulus of each segment.

Suckers

Anterior and Posterior end of the body possesses anterior and posterior suckers, respectively. Both the suckers are hollow muscular organs and are primarily meant for adhesion and locomotion. The anterior sucker (Cephalic region) helps in feeding also.

External Apertures : These are as follows:

1. Mouth : It is a narrow, triradiate aperture at the bottom of the preoral chamber of the anterior sucker.

2. Anus : It is a small aperture located mid-dorsally on the 26th segment.

3. Nephridiopores : These are the openings of nephridia, found in pairs in the last annulus of each segment from 8th to 22nd segment.

4. Male genital pore : It is a midventral aperture in a groove between 2nd and 3rd annuli of 10th segment.

5. Female genital pore : It is also mid-ventral aperture between 2nd and 3rd annuli of 11th segment.

• 13.4 HAEMOCOELOMIC SYSTEM

(b) Haemocoelomic channels : There are mainly four haemocoelmic channels, one dorsal, one ventral, and two lateral and their branches act like blood vessels and contain haemocoelomic fluid and coelomocytes, (Phagocytic in nature.)

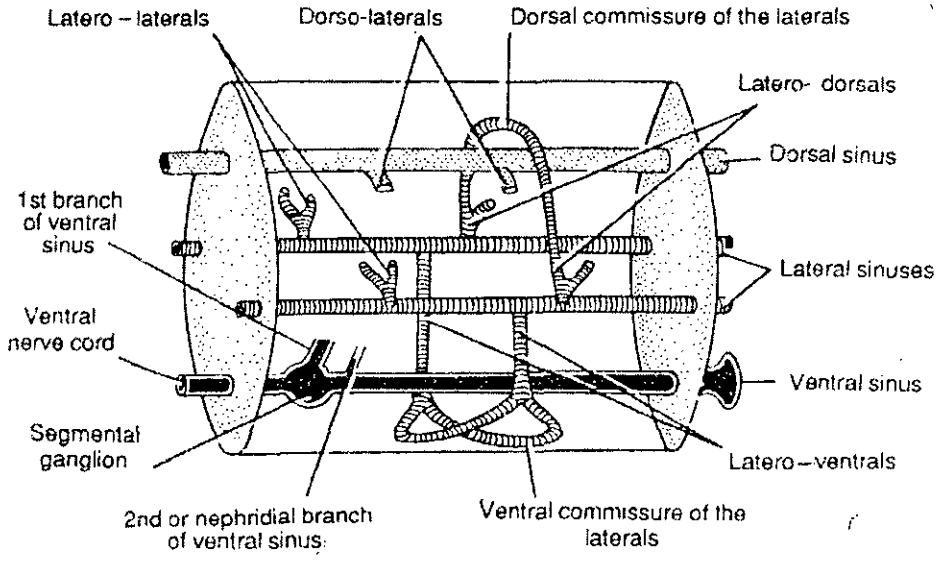

Fig. 2. Diagrammatic representation of haemocoelomic channels (one segment) of Leech

(i) Dorsal channel : It runs above alimentary canal, anteriorly upto 6th segment and then breaks up into smaller branches and capillaries, which extend into the first five segments, both the branches extend, surrounding the ventral channels and rectum to join the posterior dilation of ventral channel.

Dorsal channel has a thin non-contractile wall and is devoid of valves. It is a distributing channel and its haemocoelomic fluid runs from posterior to anterior side. It gives out two types of branches :

(a) **Dosolaterals :** In each segment two pairs of dorsolateral channels arise from dorsal channel. They make capillary plexus and supply to the dorsal and dorso-lateral regions of body wall.

(b) **Dorso intestinals :** All along its length dorsal channel gives rise to numerous dorso-intestinals to supply gut wall.

(ii) Ventral channel : It runs beneath the alimentary canal from one end of the body to the other along a straight course. It is wider and encloses the entire central nervous system including nerve ring and ventral nerve cord. Like dorsal channel it is also a distributing channel but in it haemocoelomic fluid runs from anterior to posterior side. It gives out two pairs of branches in each segment.

(a) Cutaneous branches : In each segment this branch again gives two branches, one ventral branch forming a capillary network in the ventro-lateral row of body wall and the other abdomino-dorsal branch which runs vertically up in the body wall and forms dorso-lateral cutaneous plexus.

(b) Nephridial branch : Nephridial branch of each side runs outward and reaching over the testis sac of its side, it widens into 2 or 3 closely set saccules, the

perinephrostomial ampullae which contain a ciliated organ. This branch supplies the body wall and nephirdia. This branch arises only from the segments 12 to 22, which contain testis sac.

Ciliated organ manufactures coelomic corpuscles for the haemocoelomic system and its cilia are believed to help in the circulation of haemocoelomic fluid.

(iii) Lateral channels : They are like true blood vessels on account of having contractile walls and valves. Haemocoelomic fluid flows in them from behind to forward. They are collecting as well as distributing channels. They collect the blood through latero-lateral and latero-dorsal channels while distribute it though latero-ventral channel.

(a) Latero-lateral : It collects the blood from the capillaries of lateral region of body wall and nephridia. It joins the lateral channel at the level of nephridial vesicle.

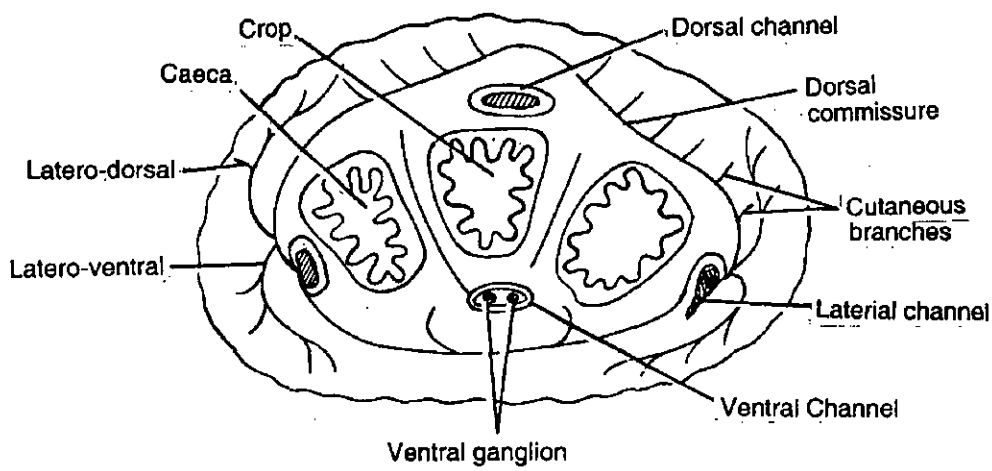

Fig. 3. T.S. of Hirudinaria to show Dorsal and Ventral commissure

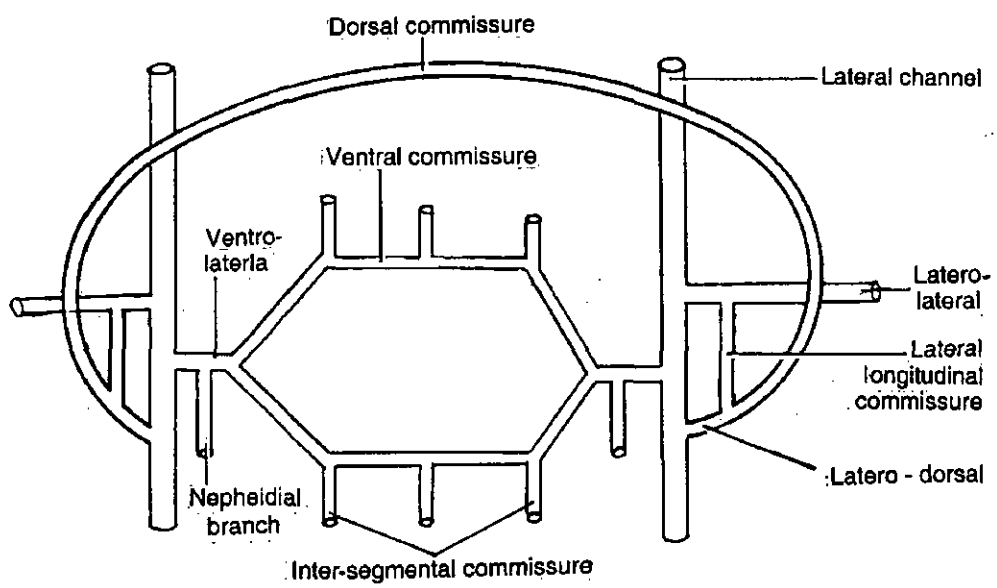

Fig. 4. Hirudinaria, Diagrammatic representation of the lateral channels and their branches in a segment in doresal view

(b) Latero-dorsal : This large channel is formed by branches from the dorsal and dorso-lateral region of body wall, gut wall and nephridium. Both the channels of each side are connected by a transverse loop above the dorsal channel. These are 17 in number from 6th to 22nd segments and are called dorsal commissures. Latero-dorsal and latero-lateral channels are connected by lateral commissure.

(c) Latero-ventral : It arises from the lateral channel and gives off at once a branch to supply nephridium and ventro-lateral regions of body wall. Then it gives two branches, anterior and posterior. These unite with their corresponding fellow of opposite side by ventral commissure. In each segment, ventral commissures making 18 such rhomboids are seen from 6th to 23rd segment. Each rhomboid further communicates with each other by three intersegmental commissures. Latero-ventral channel supplies branches to nephridia, ventral side of alimentary canal and reproductive organs.

Anteriorly both lateral channels break up in 6th segment into capillaries, while posteriorly they open into the dilation of ventral channel where all the four channels are in direct communication.

Circulation of Haemocoelomic Fluid

Haemocoelomic fluid flows in a definite direction from behind to front in dorsal and two lateral channels and from in front to backward in ventral channel. The dorsal channel supplies haemocoelomic fluid to the dorsal and dorso-lateral body wall and gut wall, from where it is collected by latero-dorsals into lateral channels. Latero-intestinals collect blood from alimentary canal and pour it into lateral channels.

Ventral channels supply fluid to the mid-dorsal, ventro-lateral and ventral parts of body wall and nephridia. Latero-lateral and latero-dorsal branches collect fluid from here and pour it into lateral channel.

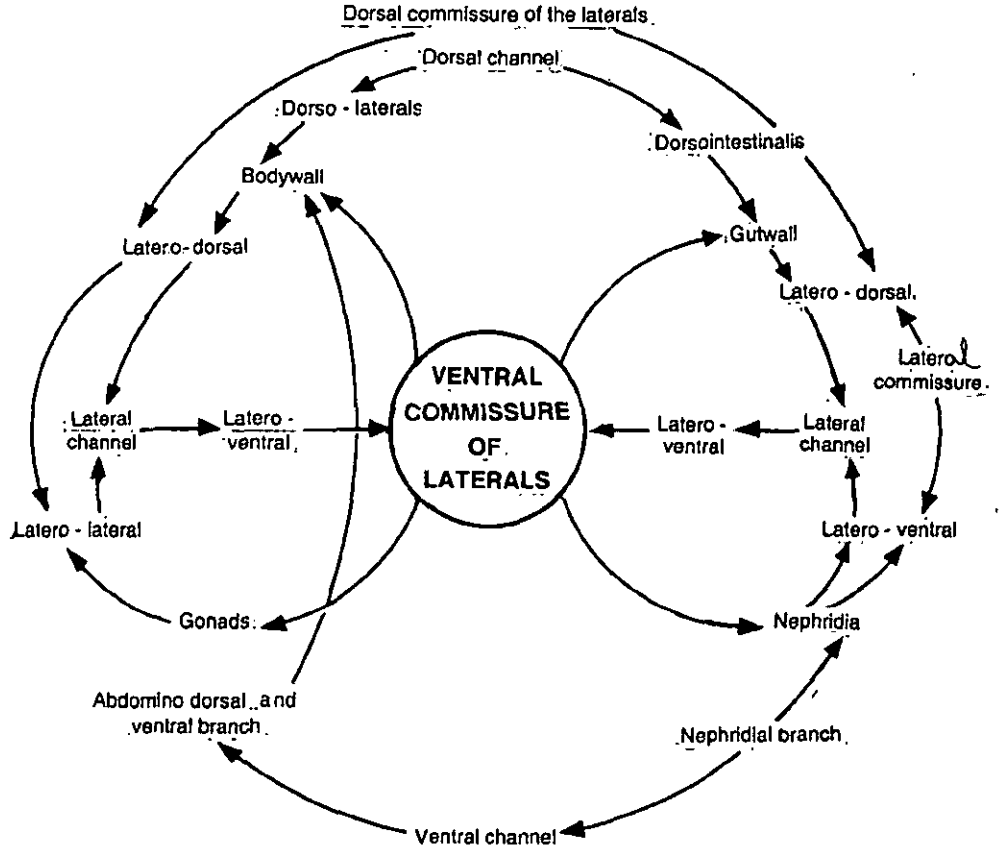

Fig. 5. Diagrammatic representation of the circulation path way of Haemocoelomic fluid in Hirudinaria

Lateral channel supplies fluid to the nephridia, reproductive organs, floor of gut and ventral body wall through latero-ventral branches.

Thus, Dorsal and ventral channels are only distributing channels while lateral channels distribute as well as collect the blood from various parts of the body. All the four channels are connected together in the 26th segment.

• 13.5 PARASITIC ADAPTATIONS OF LEECHES

According to their parasitic mode of life leeches show a number of adaptations in their morphologhy, habit and habitat :

1. Habit and Habitat : Leeches swim actively in search of hosts and inhabit in such a pond or lake where cattle, men and other vertebrates visit frequently.

2. Slime glands : These are present in body wall. Their secretion keeps the body moist and slippery so that the host can't remove it easily while it sucks blood.

3. Suckers : These are the organs that help in locomotion as well as in making firm adhesion to the host's body while feeding.

4. Jaws and pharynx : Triradiate jaws are equipped with denticles, able to make incision in the skin of the host. A muscular suctorial pharynx works as a suction pump to suck more and more blood, oozing out from the wound.

5. Hirudin : Hirudin is an anticoagulant, secreted by salivary gland when it sucks the blood to prevent it from coagulation. It faciliates the feeding.

6. Spacious crop : The availability of the host to the leeches is not regular. Therefore its digestive tract is modified in order to store a great quantity of blood in a single meal whenever it gets chance to feed. To accomodate the large amount of blood the crop is spacious, thin walled, elastic and capable of great dilation.

7. Slow digestion : Blood from crop is poured into stomach drop by drop because digestion is very slow. So that after a full meal a leech can stay for one year or more without feeding. For this reason also, leeches lack elaborate digestive juices and enzymes for digestion.

8. Sense organs : These are well developed and provide the animal with greater opportunities of life.

9. Hermaphroditism : This doubles the rate of reproduction as after copulation both individuals lay eggs.

10. Development : It takes place in cocoon with full safety and efficiency. It is very quick and takes only a fort right.

• SUMMARY

Hirudinaria commonly called leech is an ectoparasite of vertebrates. It has a blood sucking habit (sanguivorous) feeding on the blood of fishes and frogs, cattle and man. Externally the body of leech is divided into a fixed number of segments 33, called somites. Broadly, body can be divided into six different regions viz cephalic, pre-cliteller, cliteller, middle caudal and posterior sucker. In leeches no true blood circular system is found, instead a specialized haemocoelomic system is found. Leeches show parasitic adaptations which fit them to their parasitic mode of life.

Key words : Hirudinaria, ectoparasite, sanguivorous, somites, haemocoelomic system.

• STUDENT ACTIVITY

1. Make a labelled diagram of external structure of Hirudinarea.

• TEST YOURSELF

1. Describe the haemocoelomic system of Hirudinaria.
2. Describe the receptor organs of the leech
3. Describe the parasitic adaptations in leeches.
4. Objective type Questions

(1) Spacions crop is found in

(a) Earthworms (b) Leeches

(c) Round worms (d) None of these

(2) Hirudinaria has

(a) 40 somites (b) 33 somites

(c) 15 somites (d) 30 somites

(3) Haemocoelomic system is present in

(a) Nereis (b) Earthworm

(c) Leech (d) None of these

(4) Leech is

(a) Endoparasite (b) Ectoparasite

(c) Blood parasite (d) Intestinal parasite

(5) Jaws in leech are

(a) Triradiate (b) Pentaradiate

(c) Absent (d) Simple

Ans. (1) b (2) b (3) c (4) b (5) a

UNIT

14

PHYLUM ARCHOPODA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- Phylum Archopoda in appropriate detail adding with its classification.
- About various insects and their economic importance

• 14.1 INTRODUCTION

Phylum Arthropoda literally means the animals bearing jointed feet (Gr; arthron, jointed + podos, foot). These are extremely successful animals and the largest no. of species (about 9 lacs) are known to this group. They are defined as "bilateral and prostomial eucoelomate eumetazoa with metamerically segmented body and each segment bearing a pair of jointed locomotory appendages.

• 14.2 DISTINGUISHING FEATURES

1. They are versatile in their habitat viz; land, air, and all kinds of water and free living or parasite, each kind of mode of life they show.
2. Organ system level of body organization.
3. Body bilaterally symmetrical, triploblastic and metamerically segmented.
4. Each segment basically bears a pair of lateral jointed appendages adapted for food ingestion, locomotion, respiration, copulation etc.
5. Exoskeleteton of dead chitinous cuticle which sheds at intervals, the process called ecdysis or moulting for growth and development.
6. Body is divisible into head, thorax and abdomen. Head and thorax are often fused to form a cephalothorax.
7. True coelom is reduced, only seen in excretory and reproductive organs. It is replaced by blood filled haemocoel.
8. Digestive system is complete. Mouth parts adapted for various modes of feeding habits.
9. Open blood vascular system with sinus.
10. Respiration by gills (aquatic form) or tracheae or book lungs (terrestrial forms) or by diffusion through body surface in some.

11. Excretion by coelomoducts or specialized green or coxal glands or by malpighian tubules.

12. Nervous system typically annelidan, with a dorsal brain connected with a nerve ring to a double ventral nerve cord.

13. Sensory organs comprise of eyes (simple and compound), chemo and tactile receptors and statocyst and auditory organs etc.

14. Mostly dioecious with sexual dimorphism, fertilization internal; Usually oviparous or ovoviviparous.

15. Development direct or indirect with one or many larval stages.

16. Parental care is often well marked.

• 14.3 CLASSIFICATION

On the basis of body shape, degree of segmentation and regionation and presence or absence of certain appendages this phylum is divided into three subphyla.

Subphylum 1 : Trilobita : (Gr; tri, three + lobos, lobe)

(i) They are most primitive arthropods. Mostly marine and bottom dwellers.

(ii) Found in cambrian to permian era.

(iii) Body 3 lobed, due to 2 long longitudinal furrows Body is covered by a hard segmented shell.

(iv) Abdominal region of 2 to 29 somites and a fused caudal plate or pygidium.

(v) Biramous appendages on all segments except the last one.

Examples : Triarthrus, Dalmanites etc.

Subphylum 2 : Chelicerata : (Gr; chele claw +keros, horn + tata, group)

(i) Body divided into an anterior cephalothorax (prosoma) and a posterior abdomen (opeisthosoma).

(ii) Prosomatic appendages 6 pairs. First pair of preoral chelicerae with claws followed by postoral pedipalps and 4 pairs of walking legs.

(iii) Respiration by gills, book lungs, and tracheae.

(iv) Excretion by malpighian tubules or coxal glands or both.

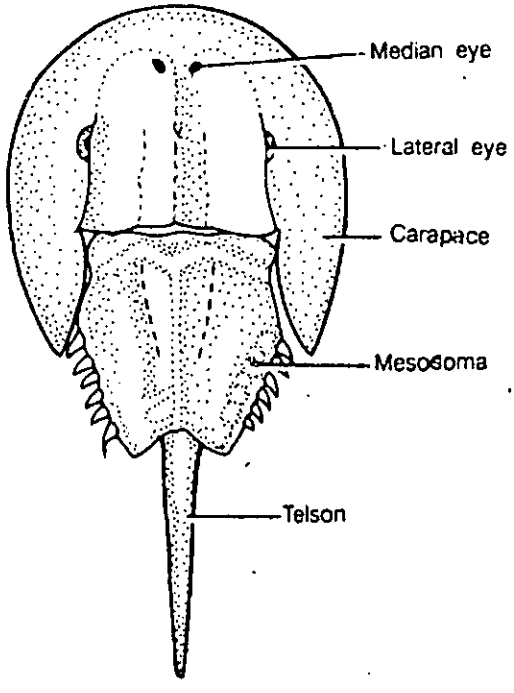

Fig. 1 ***Limulus***

Class 1 : Merostoma

(i) Marine cephalotherax with lateral compound eyes and six pairs of usual appendages.

(ii) Abdomen with 5 to 6 pairs of gill bearing appendages. Respiration is by these book-gills.

(iii) Abdomen ending in a sharp telson or spine.

(iv) Excretion by coxal glands.

Examples : Limulus (king crab), Eurypterus etc.

Class 2 : Arachnida (Gr; Arachne; spider)

(i) Terrestrial or aquatic, Eyes simple.

(ii) Respiration by book lungs or tracheae.

(iii) Abdomen without appendages.

(iv) Many with poison glands, poison fangs, stings etc.

(v) Usually spiders, scorpions, mites, ticks etc.

Examples : Palamneaeus (scorpion), Lycosa (spider), Ixodes etc.

Class 3 : Pycnogonida or pentapoda

(i) Small sized marine spiders.

(ii) Cephalothorax 3 segmented, abdomen vestigeal.

(iii) Suctorial mouth on top of a long proboscis.

(iv) Head usually with 4 pairs of appendages and 4 eyes.

(v) No special respiratory or excretory organs.

Examples : Nymphon, Pycnogonum etc.

Subphylum 3 : Mandibulata or Antennata

(L. Mandibulata, mandible + ata, group)

(i) Body divisible into head, thorax and abdomen.

(ii) Cephalic region has 1 or 2 pairs of antennae, 1 pair of jaws or mandibles and 1 or 2 pairs of maxillae.

(iii) Compound eyes commonly found.

Class 1 : Crustacea

(i) Mostly aquatic. Body is divided into cephalothorax and abdomen.

(ii) Dorsally cephalthorax covered by a thick exoskeletal carapace.

(iii) Appendges are typically bimarous.

(iv) Abdominal somites usually distinct with a posterior telson.

(v) Respiration through body surface or by gills.

(vi) Development involves nauplius larva.

Examples : Palaemon, Cancer, Cyclops etc.

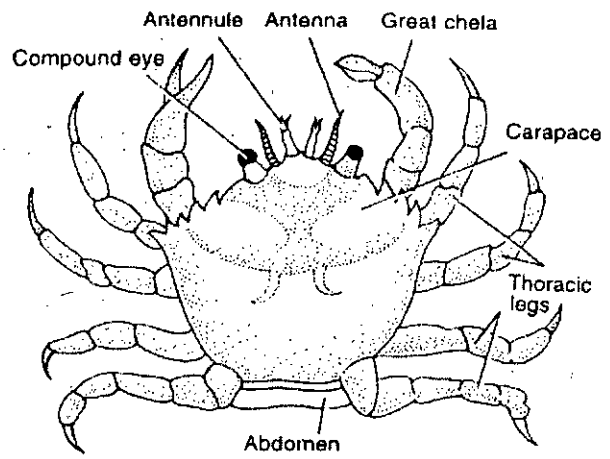

Fig. 2. *Carcinus* (Crab)

Class 2 : Insecta : (L. insectus, cut or divided)

(i) Body made of head (6 fused segments) thorax (3 segments) and abdomen (upto 11 segments).

(ii) Head with compound eyes (1 pair), antennae (1 pair), mandibles (1 pair) and maxillae (2 pairs).

(iii) Thorax with typically 3 pairs of jointed legs and one or 2 pairs of wings may or may not be present.

(iv) Respiration by branched tracheae.

Examples : Periplanata, Musca, Mosquitos etc.

Class 3 Diplopoda :

(i) Terrestrial. Body, long, cylindrical and worm like.

(ii) 5 segmented head with 1 pair, of short antennae, mandibles and maxillae.

(iii) Thorax bears 4 segments, each except the first segment with a pair of jointed legs.

(iv) Abdomen 9 to 100 or more segments each bears 2 pairs of legs, spiracles ostia and nerve ganglia.

(v) Respiration by tracheae.

(vi) Excretion by malpighian tubules.

Examples : Thyroglustus (millipede), Scolopendra, Lithobius etc.

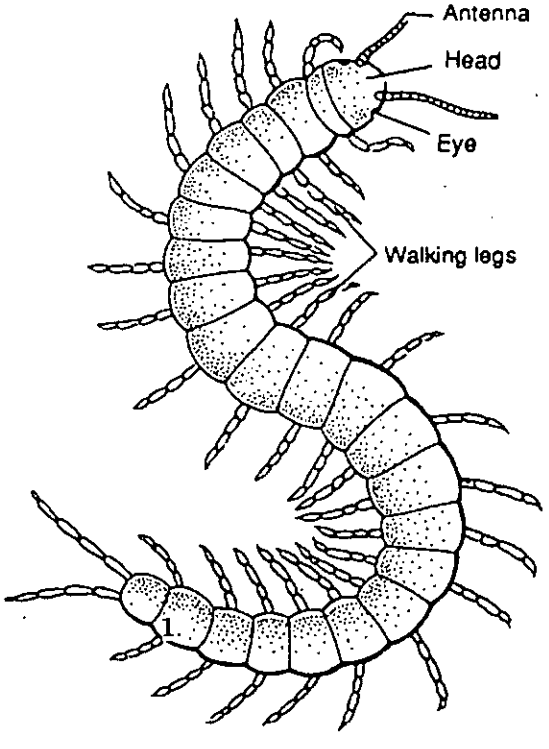

Fig. 7. *Scolopendra* (Centipede)

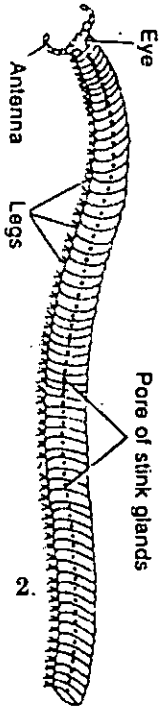

Fig. 8. Millipede

Subphylum 4 : Onychophora (Gr; onychos, claw + phoros, bearing)

(i) Terrestrial, primitive worm like unsegmented.

(ii) Single pair of antennae, eyes and jaws.

(iii) Numerous stumpy, unjointed clawed legs.

Example : Peripatus.

• 14.4 ECONOMIC IMPORTANCE OF INSECTS

Economically insects play an important role in the life of man. They ae beneficial and produce a number of valuable things for man. On the other hand they cause a large

amount of damage to the man in different ways. We can describe their versatile role under following headings.

• 14.5 INJURIOUS INSECTS

(1) Pests of plants, fruits and stored grains : There is a variety of insects that cause damage to different parts of plants, fruits stored products and grains. Chewing insects chew and swallow the external parts of vegetable plants. Grasshopers and locusts invade green crop plants and can damage the whole crop. Plant bugs, aphids, scale insects and others suck up the juice of green plant tissues.

Bark beetles destroy timber in the forests while termites destroy wood and wooden furniture.

(2) Household pests : Bedbugs, mosquitos, houseflies and stable flies are found much annoying and irritating to man. Ants, crickets, cockroaches, weevils fruitflips and silverfish etc. spoil the food, clothes and books. Cloth moths and carpet bectles damage carpets and clothes badly.

(3) Insects cause injury to domestic animals : Most of the insects and flies live more or less as parasites either externally such as flees, lice, bugs, mosquitos etc., or internally such as larvae of boltfly in sheep. In cattles thy cause severe damage to hide and flesh.

(4) Disease carriers : Many insects play a great role in spreading serious diseases of man and domestic animals. They often act as vectors for transmitting various diseases. Anopheles, culex, aldes and mosquitos etc. spread various kinds of fever. Various species of flies such as tse-tse fly, sandfly, housefly, takanus fly etc. act as vectors for the organisms of severe diseases.

(5) Poisnous insects : Some of the insects like honey bees, wasps hornets, fire ants, bedbugs, mosquitos and a few lepidopterous nd larvae inject poisonous substance during biting or touching into the skin of man. It cause skin pain, redness, and swelling on the affected area.

• 14.6 PRODUCTIVE INSECTS

Some insects are very beneficial to man as they produce valuable and useful products. Some of them are as follows :

(1) Honey : It is produced by Honey bee (Apis) and is an important component of food and medicine.

(2) Beeswax : Wax is another product obtained fromHoney-bees and is used in polishes, modelling, thread waxing and in beauty products.

(3) Raw silk : It is produced by some species of silk worms (Bombyx). Silk threads are obtained from cocoon of the silkworm and are used in manufacture various kinds of clothes and other items.

(4) Lac : It is obtained by the secretions of female lac insects or scale insects. It is useful in official work, bangle industry and other ornamental products.

(5) Dyes : Certain kinds of dyes like tannin, cochineal and crimson lake are obtaind from the dried bodies of certain scale insects.

(6) Medecinal Products : Certain medicinal products are also obtained from casects.

• 14.7 HELPFUL INSECTS

(i) Pollinators of flowers : Plants depend upon certain insects for cross-pollination or cross fertilization which is very necessary for their fertility and vigour. Various insects and flowers are mutually dependent since many insects feed upon their vector and pollen grains. Chief polldinating insects are bees, wasps, beetles, ants, flies etc.

(2) Scavengers : Some insects feed upon waste material such as dead bodies and debris of plants and animals and act as scavengers for man. Common examples of insect

scavengers are silver-fish (depisma), termites, housefly, blowfly, maggots, dung beetles, carrion beetles, flees, cockroaches and many larvae.

(3) Insects as food : Most of the animals and even plants are insectivorous and depend on insects for their food. Blue birds, meadow larks and housesparrows depend chiefly on insects. Moles, shrews, armadillas and ant eaters live wholly upon small insects. Man also consumes many insects and their larvae, eggs etc., only accidentally with fruits and other foods.

(4) Insects in medicine : Cochineal insects are used in the treatment of neuralgia and whooping cough, blowfly larvae are used in treating decay of tissues. Cantheridin oil obtained from blister-beetles serves as hair restorer. the body extract of silkworm (Bombyxmori) is used for checking profuse menstruation and in treating leucorrhoea and chromic diarrhoea. Bee-venom has been used with some degree of success in treatment of some forms of arthritis. Beeswax is used as a base for ointment.

(5) Biological control of pests : Some predator insects feed upon insects that are harmful to man and crops. The larvae of lady bird beetles feed upon Aphids and scale insects. Predatory tiger beetles and nocturnol carnivorous ground beetles are also considered beneficial as they destroy serious insect pests and large number of determental slugs and suails.

(6) Insects in recreation and fine arts : The sound of some insects is supposed to be of musical use for some people. Japanese celebrate an annual function the 'festival of the singing insects'.

Beautifully coloured elytra and wings of some coleoptera and Lapidoptera are used in making jwellery pictures, crafts, embroidory and other items.

• SUMMARY

Phylum Arthropoda includes extremely successful animals which bear jointed feet. They are metamerically segmented and each segment of the body bears a pair of jointed locomotory appendages. Body is divisible into head, thorax and abdomen, sensory organs are well deneloped. It is the biggest phylum and contains 9 lacs species. On the basis of body, shape degree of segmentation this phylum is divided into four subphylums and six classes. Class Insecta contains all kinds of insects bearing 3 pairs of jointed legs. Economically these insects are both harmful, pathogenic and beneficial to human beings.

Key words : Jointed feet, head, thorax, abdomen, sensory organs insecta.

• STUDENT ACTIVITY

1. Make a chart to show outline classification of phylum Arthropoda.

• TEST YOURSELF

1. Write characterstic features of phylum Arthropoda
2. Give an account of classification of phylum Arthropoda with its distinct characters.
3. Write an account of economic importance of Insects.
4. Give characters of class Insecta
5. Give some details of productive insects
6. Objective type questions
   (1) Jointed legs are found in
   (a) Annelida (b) Mollusca
   (c) Arthropoda (d) Protozoa
   (2) The biggest phylum of animal kingdom is
   (a) Mollusca (b) Chordata
   (c) Arthropoda (d) Porifera
   (3) Trilobites are
   (a) Advanced Arthropodsa (b) Primitive Arthropods
   (c) Molluscs (d) Echinoderms
   (4) Which is not a productive insect
   (a) Silkworm (b) Lac insect
   (c) Honey bee (d) Earthworm
   (5) Body of Arthropods is divided into
   (a) Three regions (b) Four regions
   (c) Seven regions (d) Single region

Ans. (1) c (2) c (3) b (4) d (5) a

UNIT

15

MOLLUSCA

STRUCTURE

LEARNING OBJECTIVES

After going through this unit you will learn :

- About Mollusca in appropriate detail including its distinguishing features and classification.

• 15.1 INTRODUCTION

Mollusca is the second largest phylum after Arthropoda and contains 80,000 living and 35,000 extinct species. Molluscs are among the most abundant animals. Molluscs (L., Mollis or molluscs, soft bodied) are basically bilateral and protostomial eucoelomate eumetazoans, whose soft body is unsegmented and enclosed within a skin fold (Mantle) covered by shell. They include mainly clams, snails, slugs, squids, octpods etc. The presence of '*radula*' and '*mantle*' is the unique feature of phylum Mollusca.

Evolutionary Characters : They show some primitive characters :

1. Some molluscans are herbivorous while others are carnivourous. The digestion is largely extracellular.

2 They mostly have ganglionated nervous system and the ganglia have a tendency to become concentrated at the anterior end.

3. Nephridia are of primitive type.

4. The Gonads have lost their primitive association with the pericardial cavity and have mounted on special axis to the outside.

• 15.2 DISTINGUISHING FEATURES

1. Mostly marine, some freshwater, some terrestrial in damp soil. Creeping, free swimming, burrowing or adhered to rocks.

2. Triploblastic, unsegmented (except in Monoplacophora). Body is covered by a skin fold, called mantle, which often secretes a calcareous shell.

3. Body basically bilateral, but may secondarily become coiled and asymmetrical due to torsion.

4. Coelom reduced and represented mainly by pericardial cavity, gonadial cavity and kidney.

5. Digestive system complete with a digestive gland or liver (hepatopancreas), a rasping organ, *radula* is usually present.

6. Open type of blood vascular system. Respiratory pigment is usually haemocyanin.

7. Respiration direct by surface or by gills (ctenidia) or by lungs or by both.

8. Excretion by paired metanephridia (kidneys).

9. Nervous system of paired ganglia, connectives and nerves.

10. Sensory organs mainly eye, statocyst and receptors for touch, smell and taste.

11. Dioecious or monoecious, one or two gonads with gonoducts, opening into renal ducts or to exterior.

12. Fertilization external or internal. Development direct or with some larval stage which may be veliger, trochophore or glochidium etc.

• 15.3 CLASSIFICATION

On the basis of body shape, symmetry and characterstics of foot, mantle, respiratory organs etc molluscs are divided into six classes :

Class 1 : Monoplacophora : (Gr. Monos, one + plax, plate + pherein, bearing)

(i) Body bilateral symmetrical with a dome shaped mantle.

(ii) Flattened limpet-shaped shell with spirally coiled protoconch.

(iii) Foot broad and flat with 8 pairs of pedal retractor muscles.

These animals possess some annelidan characters : as

(i) 5 or 6 pairs of gills and nephridia show segmental arrangement.

Presumably these *molluscs* are a *connecting link*, between annelids and molluscs.

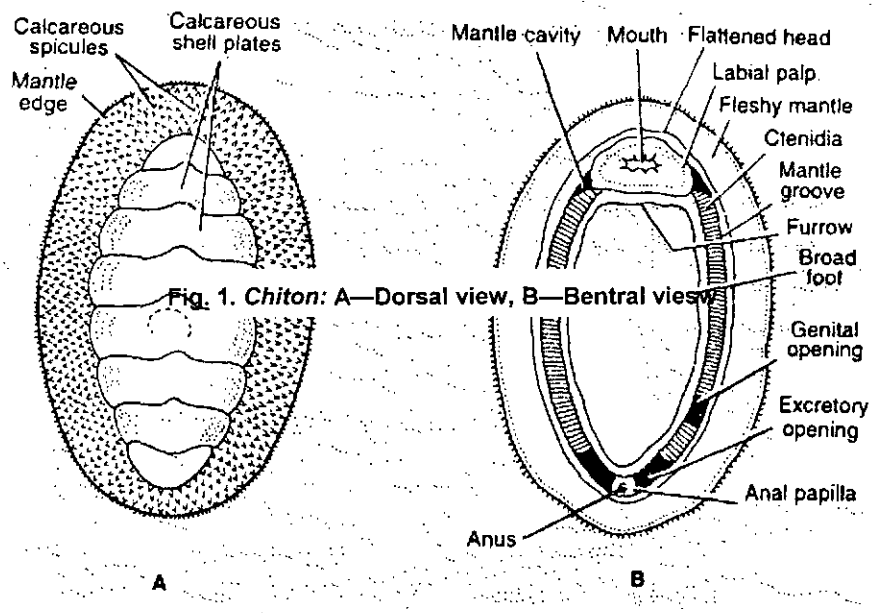

Fig. 1. *Chiton:* A—Dorsal view, B—Bentral view

Fig. 1 *Chiton:* A—Dorsal view, B—Ventral view

Example : Neoplina.

Class 2 : Amphineura (Gr., amphi, both + neuron, nerve)

(i) Elongated body with reduced head.

(ii) Radula present.

(iii) Shell as 8 dorsal plates or as spicules.

(iv) Foot ventral large flat and muscular.

(v) Non-ganglionated nerve ring around mouth, 2 pairs of interconnected nerve cord.

(vi) Fertilization external, larva trochophore.

Example : Neomenia, Chiton, Chaetopleura etc.

Class 3 : Scaphopoda (Gr., Scapha, boat + podos, foot)

(i) Tusk shells.

(ii) Body within a tubular shell open at both ends.

(iii) No head, mouth with tentacles, no eyes.

(iv) Foot conical, radula present, no gills.

(v) Kidneys paired, gonad single.

(vi) Dioecious, larva trochophore.

Examples : Dentalium, Cadulus, Pulsellum etc.

Class 4 : Gastropoda : (Gr., gaster, belly + podos, foot)

(i) They are mainly snails and slugs.

(ii) Torsion of body occurs sometimes.

(iii) Well developed head with eyes and tentacles. Radula is present.

(iv) Foot large and flat.

(v) Shell present or absent, univalve and usually coiled.

(vi) Mostly marine, some freshwater or terrestrial.

Examples : Patella, Pila, Doris etc.

Class 5 : Pelecypoda : (Gr., Pelepus, hatchet + podos, foot)

(i) Body enclosed in a bivalve shell and laterally compressed.

(ii) No Head, tentacles, eyes, jaws and radula.

(iii) Foot often hatchet-shaped and extending between mantle lobes.

(iv) Mostly filter feeding.

(v) Usually dioecious, veliger or glochidium larva.

(vi) Mostly marine, a few freshwater.

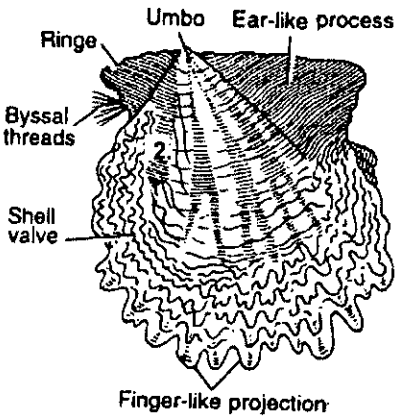

Fig. 6. Pearl oyster

Examples : Mytilus, Unio, Teredo, Lamellidens etc.

Class 6 : Cephalopoda : (Gr. Kephale, head + podos, foot)

(i) Body dorosoventrally elongated.

(ii) Shell external, internal or absent.

(iii) Head distinct and large with well developed eyes. Foot as tentacles and siphon, radula present.

(iv) Dioecious, development direct.

(v) Marine and free swimming.

Example : Nautilus, Octopus, Sepia, Loligo etc.

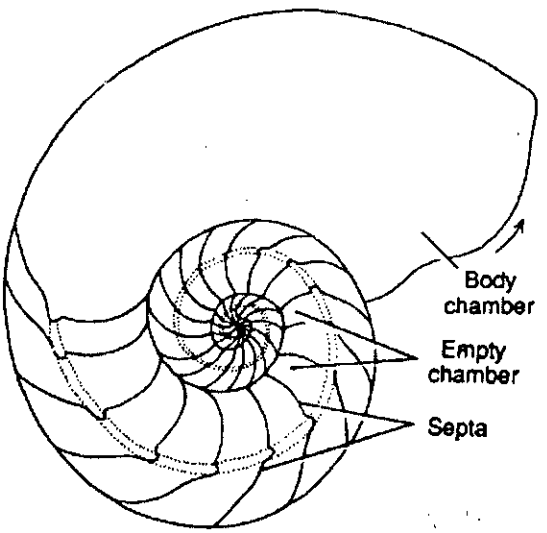

Fig. 2. *Nautilus* shell

• SUMMARY

Mollusca is the second largest phylum after Arthropoda and contains 80,000 living and 35,000 extinct species. They are soft bodied animals and are enclosed within a skin fold (Mantle) covered by shell. Body is unsegmented. A rasping organ radula is usually present. On the basis of body shape, symmetry and characterstic of foot, mantle, respiratory organs etc. molluscs are divided into six classes. Pearl oysters also belong to this phylum which yield precious pearls for man.

Key words : Mollusca, extinct, mantle, shell, radula.

• STUDENT ACTIVITY

1. Make a chart of some molluscs that are very common to man

• TEST YOURSELF

1. Give outline classification of phylum Mollusca with its characterstic features.
2. Describe the distinguia shing features of the phylum Mollusca.
3. Objective Type Questions

(1) Soft bodied an als are included in
(a) Annelida (b) Porifera
(c) Mollusca (d) Echinodermata

(2) Mantle (skin fold) is found in
(a) Protozoa (b) Porifera
(c) Nematoda (d) Mollusca

(3) Velliger larva is found in
(a) Arthropoda (b) Annelida
(c) Mollusca (d) None of these.

(5) Pearls are obtained from
(a) Pearl Oyster (b) Chiton
(c) Pila (d) Fresh water mussles

Ans. (1) c (2) d (3) a (4) c (5) a

UNIT

16

PILA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- What is Pila, along with its Habit, External features and nervous system.

• 16.1 INTRODUCTION

Pila, the apple snail, belongs to the biggest class, gastropoda of Mollusca. This is a freshwater snail and is represented in India by eight species. Most common species found in Northern India is *Pila globosa*.

• 16.2 HABIT AND HABITAT

It is found in all kinds of fresh water bodies and rivers of northern India except Punjab. It is abundant in waters which harbour succulent aquatic plants like Vallisnaria and Pistia, forming the food of this snail.

Pila is adapted for amphibious life. It is provided with a pulmonary sac for aerial respiration and a gill or ctenidium for aquatic respiration. It undergo summer sleep or aestivation in summers.

• 16.3 EXTERNAL FEATURES

(i) Shell : Outer skin fold called mantle secretes a calcareous exoskeleton called shell. It is hard, globose shaped, and lemon-yellow or brownish in colour. It is univalved

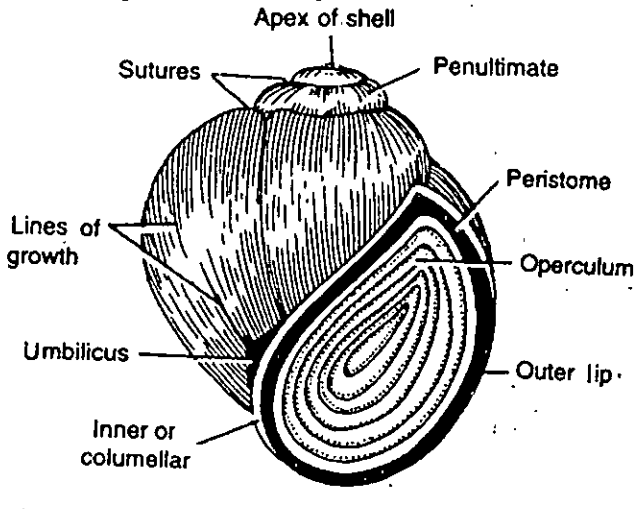

Fig. 1. Ventral view of the shell of *Pila*

(single piece) consisting of tubular whorls coiled around a central axis called the columella. There are usually 6.5 whorls in the shell of P. globosa. Smallest and the oldest whorl lies at the apex of the shell called *protoconch* laid down by the larva. Other whorls are successively increased in size and the lowest whorl is the largest. All the whorls communicate freely, there is no partition between them. Such a shell is called *unilocular*. Externally successive whorls are demarkated by lines called *sutures*. On the ventral surface of the shell a mouth is situated with a smooth margin called peristome. Its outer margin is called the outer lip while the inner one next to the collumella is the inner or columellar lip. Collumella is a hollow rod opens through a narrow aperture, called *umblicus*. Such a shell bearing umblicus is called umblicated or perforated shell.

Surface of shell is marked by numerous lines of growth. The coiling of shell in pila is in right hand direction and such shells are called dextral clockwise, or right handed shell.

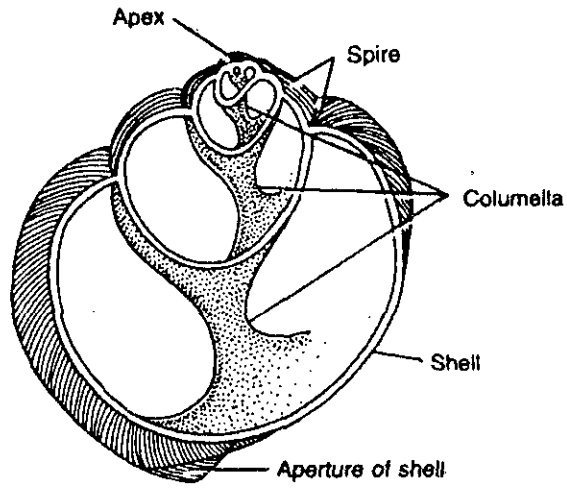

Fig. 2. Shell of *Pila* in section (dorsal view)

In the transverse section shell exhibits three distinct layers :

(a) *Periostracum :* It is outermost layer composed of conchiolin.

(b) *Ostracum :* It is the middle layer made up of $CaCO_3$.

(c) *Hypostracum or nacreous layer :* It is the innermost layer and is made up of plates of $CaCO_3$.

(ii) Operculum : It is a door-like structure attached to the hinder part of the foot, works for the closing of mouth of the shell. It is a calcareous plate formed by cuticular secretion of the glandular cells of the animals's foot. Its outer surface shows many concentric rings of growth around a small sub-central nucleus. Inner surface exhibits a distinct elliptical area of creamy colour, the *boss,* to which the opercualr muscle is attached. Boss is surrounded by a shallow groove.

(iii) Body : Body is divided into four distinct regions : head, foot, mantle or pallium and visceral mass :

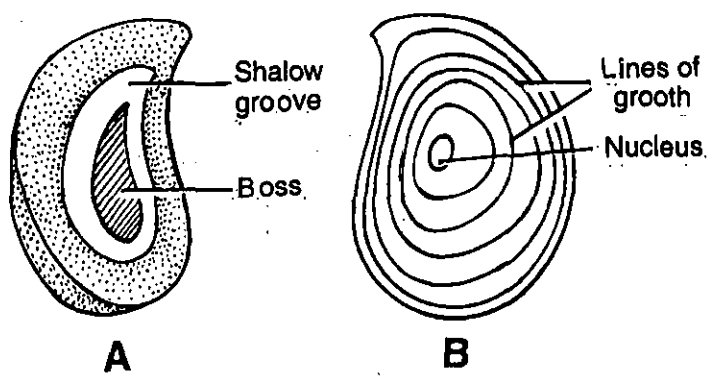

Fig. 3. Pila, operculum A–Inner surface; B–Outer surface

Head : This is the anterior part of the body prolonged into a contractile snout and bears a mouth, 2 pairs of tentacles, and a pair of eyes. First pair of tentacles arises from the sides of the head, called labial palp, they are small but highly contractile. Second pair of tentacles arises from the dorsal surface of the head behind the snout. They are long, fleshy and contractile also. Near the base of each tentacle projects a small stumpy eye-stalk or *ommatophore*, which bears a small but prominent eye at its tip.

Foot : It is large, strongly muscular ventral part of the body and triangular in shape. The grey ventral surface or sole helps the animal in creeping while the dorsal surface bears operculum. When the foot is withdrawn, operculum completely fits into the mouth of the shell and closes it. Inside the foot are present numerous pedal glands which secrete a slimy trail during locomotion. Head complex is attached to the visceral mass by a short inconspicuous neck.

Visceral Mass : Visceral mass is a spirally coiled collection of visceral organs. The coiling of mass occurs due to different rates of growth of visceral organs which is commonly called as *torsion*.

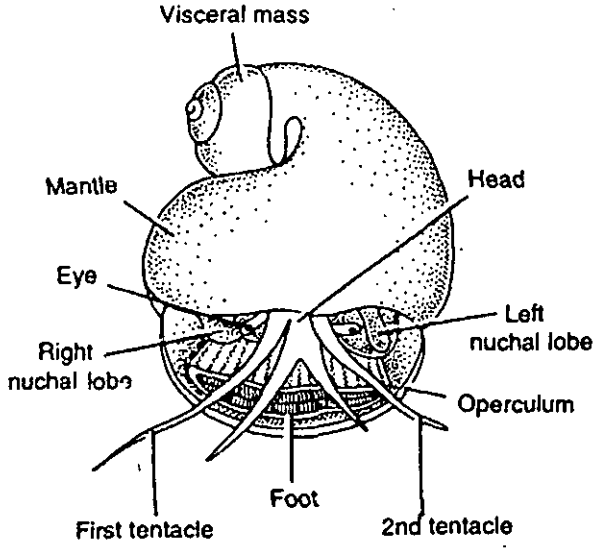

Fig. 4. Front view of *Pila* after removal of shell

Mantle : The skin fold which cover entire visceral mass is called *mantle or pallium*, a unique feature of molluscs. Anteriorly the thick free edge of mantle serves as a protective hood for head and foot complex. When the animal is retracted. This free edge becomes distinct by the presence of parallel supra-marginal grooves. Behind the groove is a thick band containing shell secreting glands. At the sides of the head the mantle is prolonged into highly contractile and fleshy process, the nuchal lobes or the *pseudepipodia*. Left one is much longer than the right and forms a respiratory siphon during aerial breathing.

• 16.4 NERVOUS SYSTEM

Nervous system of pila consists of paired ganglia, commissures and connectives, connecting them with each other and with nerves running from these central organs to all parts of the body.

1. Ganglia : Aggregations of nerve cells which are meant for same function, called ganglia. They are found in pairs. and can be described as follows :

(a) Cerebral ganglia : A pair of roughly triangular ganglia situated anteriorly one on each dorso-lateral side of the buccal mass.

(b) Buccal ganglia : A pair of small triangualr ganglia lying dorso-laterally one on either side at the junction of the buccal mass and oesophagus.

(c) Pleuropedal ganglia : A pair of large somewhat triangular ganglionic masses present one on either ventro-lateral side of the buccal mass. It is formed by fusion of an outer pleural and an inner pedal ganglion, separated by a faint notch. In the right pleuro-pedal ganglionic mass infra-intestinal ganglia is also fused.

(d) Supraintestinal ganglion : An unpaired fusiform ganglion lying in a sinus behind the left pleuro -pedal ganglionic mass.

(e) Visceral ganglia : A pair of fused visceral ganglia is situated at the lower end of the visceral mass.

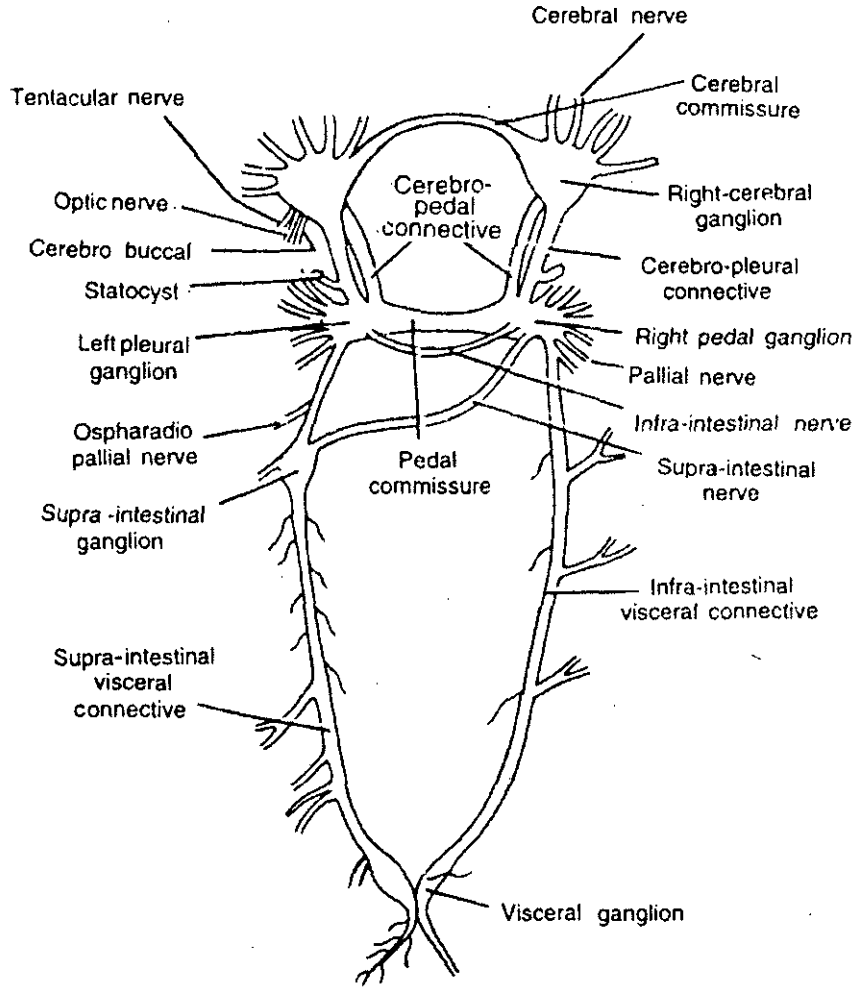

Fig. 18. Nervous system of *Pila*

2. Commissures : These are the nerves that connect two similar ganglia and are as follows :

(a) Cerebral commissure : It connects two cerebral ganglia lying dorsally over the buccal mass.

(b) Buccal commissure : It connects two buccal ganglia and runs transversely on the ventral side of the oesophagus.

(c) Pedal commissure : These are two thick nerves that lie one above the other underneath the buccal mass and connect the two pedal ganglia.

3. Connectives : These are nerves that connect two different ganglia. These are :

a. Two cerebro-buccal connectives.

b. Two cerebro-pleural connectives.

c. Two cerebro-pedal connectives.

d. Pleuro-infraintestinal connectives.

e. Infra-intestinal-visceral connectives.

f. Supra-intestinal-visceral connectives.

g. Supra-intestinal-pleural connectives.

h. Zygoneury : It is a nerve connection between the pleural part of the left pleuropedal ganglia and supra-intestinal ganglia.

4. Nerves to different parts of the body : Various ganglia send nerves to innervate different parts of the body. (i) each cerebral ganglion gives off nerves, supplying to snout skin, tentacles and buccal mass anteriorly, and eyes, statocyst posterioly. (ii) Buccal ganglia send nerves to innervate the buccal mass, radualr sac, salivary glands, oeophagus and oesophageal pouches (iii) Pedal ganglia give off nerves anteriorly as well as posteriorly to innervate the foot. Statocyst of each side is connected to pedal ganglia through connective tissue (iv) Left pleural ganglia innervates the parietal wall, mantle osphradium, left nuchal lobe, columellar muscle and anterior part of the gill (v) Right pleural ganglion innervates the parietal wall, epitenia, right nuchal lobe, copulatory organ, collumelar muscle and rectum (vi) Supra intestinal ganglion gives off a stout nerve to the mantle and the anterior part of ctenidium while its connective with the left pleural ganglia sendsa few nerves to the parietal wall (vii) Nerves from the visceral ganglion supply the renal organ, genital organs, pericardium, stomach, intestine etc.

• SUMMARY

Pila, commonly called as apple snail is classified in the class gastropoda of the phylum Mollusca. Pila is adapted for amphibious life. It is provided with a pulmonary sac for aerial respiration and a gill or ctenidium for aquatic respiration. Its shell is globose shaped and univalved. The skin fold which covers entire visceral mass is called mantle or pallium a unique feature of mollusca. Nervous system of pila is fully developed and consists of paired ganglia, commissures and conneitives.

Key words : Apple smail, gastropoda, amphibious, ctenidium, globose, pallium.

• STUDENT ACTIVITY

1. Make a model of labelled diagram of Nervous system of pila

• TEST YOURSELF

1. Give an account of Nervous system of Pila.
2. Describe the structure of Pila
3. Describe the foot of Pila
4. Describe the operculum of pila
5. Objective type Questions
   (1) The common name of Pila is
   (a) Orange snail (b) Apple snail
   (c) Fresh water mussel (d) None of these
   (2) Pila is adapted to
   (a) Only aquatic life (b) Only terrestrial
   (c) Amphibious life (d) None of these
   (3) Aquatic respiration in Pila takes place by
   (a) Skin (b) Ctenidium
   (c) Both of these (d) None of these
   (4) Operculum closes the mouth of the
   (a) shell (b) Gill chamber
   (c) Mantle cavity (d) None of these
   (5) Commissure connects
   (a) Two similar ganglia (b) Two different ganglia
   (c) Both of these (d) None of these

Ans. (1) b (2) c (3) b (4) a (5) a

UNIT

17

ECHINODERMATA

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- About Echinodermata in appropriate detail including its distinguishing characterestics and classification.

• 17.1 INTRODUCTION

Echinoderms are some of the most beautiful and most familiar sea creatures. Echinodermata literally means spiny or prickly skinned (Gr. echinos, hedgehog, + derma, skin). They are exclusively marine and largely bottom dwellers, enterocoelic coelomate animals. They have a pentamerous radial symmetry derived from an original bilateral symmertry. Their peculiar character is the presence of *water-vascular system* of coelomic origin. They contain 5300 known species.

• 17,2 DISTINGUISHING CHARACTERESTICS

1. All existing species are marine, creeping or crawling at sea bottom, rarely free swimming.
2. Triploblastic, coelomate radially symmetrical generally pentamerous.
3. Body unsegmented with globular, starlike spherical, discoidal or elongated shape.
4. Head absent, body surface is marked by five symmetrically radiating areas (ambulacral) and five alternating inter-radii, (inter-ambulacral).
5. Endoskeleton of dermal calcareous ossicles with spines covered by the epidermis.
6. Water vascular system of coelomic origin includes podia or tube feet for locomotion and usually with a madreporite.
7. Alimentary canal is straight or coiled.
8. Vascular system and haemal system, enclosed in perihaemal channels.
9. Respiratory organs include dermal branchiae, tube feet, respiratory tree and bursae.]
10. Nervous system without a brain and with a circumoral ring and radial nerves.
11. Poorly developed sense organs.
12. No excretory organs.

13. Usually dioecious, gonads large and single or multiple, fertilization external, development indirect through free swimming larval forms.

14. Regeneration of lost part, a peculiarity.

• 17.3 CLASSSIFICATION

On the basis of body shape, nature of skeleton, location of mouth and anus, functions of water vascular system and characterstics of digestive system, echinoderms are classified into two subbphyla-

Subphylum 1 : Eleutherozoa : (Gr. eleutheros, free + zoias, animal) Free living echinoderms.

Class 1 : Asteroidea (Gr. Aster, star + eidos, forms).

(i) Starfish or sea stars.

(ii) 5 radiating arms.

(iii) Tube feet with suckers.

(iv) Anus and madreporite aboral.

(v) Pedicellariae present.

Exampled : Pentaceros, Asterias etc.

Class 2 : Ophiuroidea : (Gr. Ophis, snake + eidos, form)

(i) Brittle stars and allies.

(ii) Central disc and five jointed slender and flexible (even branched in some) arms.

(iii) Anus and pedicellariae absent.

(iv) Mouth at oral surface, madreporite at aboral surface.

(v) Tube feet in two rows, not sucker like, nonlocomotory, but sensory.

(vi) Larval form *ophiopluteus*.

Examples : Basket star (Gorgnox cephalus), Brittle stars (ophiothrix) etc.

Class 3 : Echinoidea : (Gr. Echinos, hedgehog + eidos, form)

(i) Sea urchins and dollars.

(ii) Body is discoid and without arms.

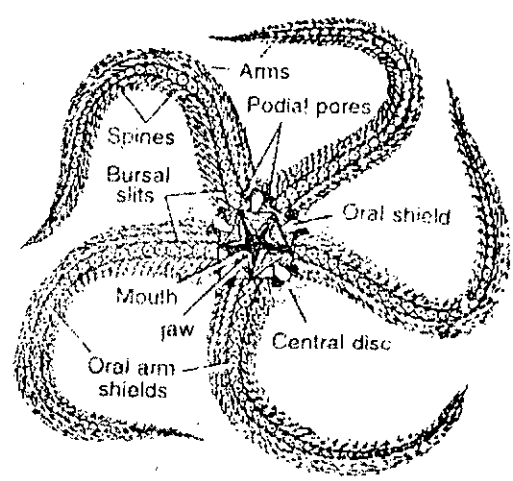

Fig. 1. Brittle Star

(iii) Mouth at lower pole covered by strong and sharp teeth, forming a biting and chewing apparatus called *Aristotle's lantern.*

(iv) Tube feet slender with suckers.

(v) Ambulacral grooves covered by ossicles and pedicellariae are 3 jawed.

(vi) Larval forms *pluteus*, and *echinopluteus*.

Class 4 : Holothuroidea : (Gr. holothurion, sea cucumber + eidoid forms):

(i) Body massive, elongated in oral and aboral axis, no arms.

(ii) Mouth at anterior end surrounded by many hollow retractile tentacles.

(iii) Tube feet usually present with suckers.

(iv) Skin leathery and soft without spines and pedicellariae.

(v) Respiration and excretion by two long and highly branched tubes (respiratory tree)

(vi) Larval form *auricularia*.

Examples : Holothuria, Cucumeria etc.

Subphylum 2 : Pelmatozoa (Gr. Pelmatos, stalk + zooios, animals) stalked sedentary echinoderms.

Class 5 : Crinoidea : (Gr. Crinon. Lilly + eidos, forms)

(i) Body distinguished into a small disc and five or more (multiple of five) branched and flexible arms.

(ii) Disc enclosed in a hard cup-shaped calyx.

(iii) Arms with pinnules but spines and pedicellariae absent in skin.

(iv) Mouth and anus on oral surface.

Examples : Antedon, Neometra etc.

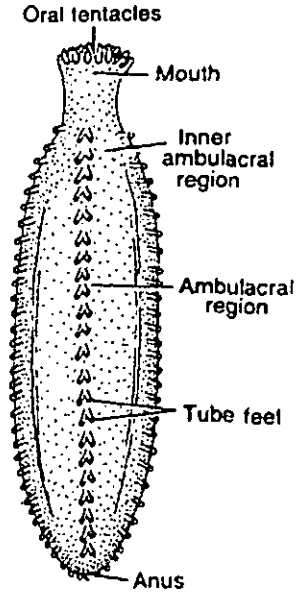

Fig. 2. *Holothuria*

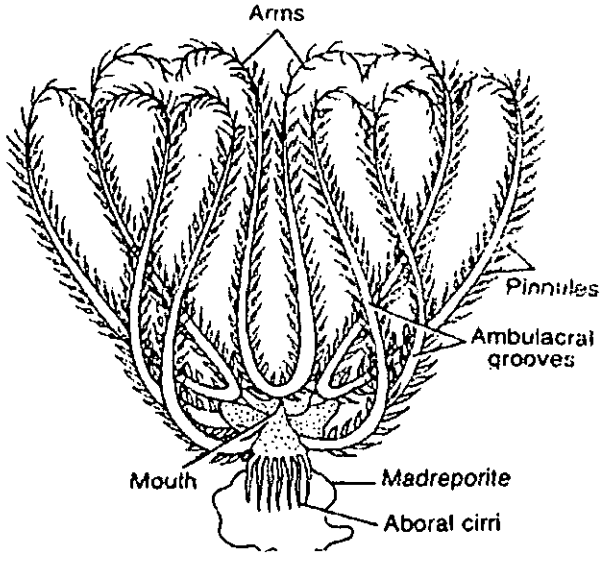

Fig. 3. *Antedon*

• SUMMARY

Echinoderms are some of the most beautiful and most familiar sea creatures. They are exclusively marine and largely bottom dewellers. Their peculiar character is the presence of water vascular system of coelomic origin, body has different oral and aboral

surface. On the basis of body shape, nature of skeleton and location of mouth, the phylum echinodermata is divided into five classes.

Key words : Dwellers, water-vascular system, oral, aboral, echinodermata.

• STUDENT ACTIVITY

1. Make a chart of some beautiful echinoderms.

• TEST YOURSELF

1. Give outline classification of phylum echinodermata with its characteristic features
2. Give distinguishing features of phylum echinodermata
3. Objective Type Questions
   (1) Echinoderms are
   (a) Spiny skinned animals (b) soft bodied animals
   (c) Round worms (d) None of these
   (2) Water vascular system is found in
   (a) Porifera (b) Protozoa
   (c) Echinodermata (d) Annelida
   (3) Echinoderms have
   (a) Bi-radial symmetry (b) pentamerous radial symmetry
   (b) Dilateral symmetry (d) None of these
   (4) Star fish is a
   (a) Protozoan (b) fish
   (c) Echinoderm (d) sponge
   (5) Sea lillies are
   (a) Annelids (b) Arthropods
   (c) Echinoderms (d) Protozoans

Ans. (1) a (2) c (3) b (4) c (5) c

UNIT 18

ASTERIAS

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- About Habits and Habitat and External Features of Asterias
- The watervascular systemin detail.

• 18.1 INTRODUCTION

Asterias, is commonly called sea star or star fish. This genus includes 150 species and consists of the most beautiful members of the sea Fauna.

• 18.2 HABITS AND HABITAT

Sea stars occur in sandy or muddy bottom of sea and are free living animals. They move slowly on hard substratum or adhere firmly to it with the help of their characterstic locomotory podia or tube feet. They are carnivorous or sometimes detritivorous.

• 18.3 EXTERNAL FEATURES

Shape, Size and Colour

Most sea stars possess a pentamerous radial symmetry. Body consists of an indistinct central disc and five radiating and elongated rays or arms.

Size averages from 10.0 to 20.0 cm in diameter with variable colours like shades of brown, yellow, orange, pink and purple. Body is strongly flattened with distinct oral and aboral surface.

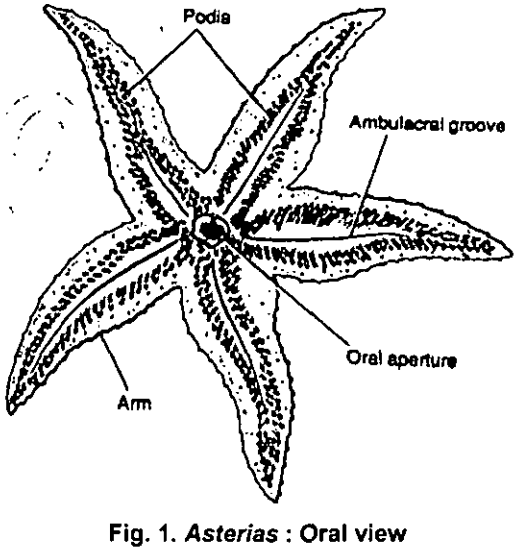

Fig. 1. *Asterias* : Oral view

Oral Surface

It is the ventral surface of the central disc which is directed to the substratum. On this oral surface, the mouth or actinosome is found at the center. Mouth is a pentagonal aperture, each angle directed towards an arm. It is surrounded by a soft perioral membrane or peristome and is guarded by five groups of oral spines or mouth papillae. Along each arm, a narrow

groove called ambulacral groove is guarded on each side by two or three rows of movable calcareous, ambulacral spines. They are capable of closing over the groove. Along the rows of these spines 3 rows of immovable spines are also found. Further, two double rows of short, tubular retractile tube feet or podia are found in each ambulacral groove. Tube feet are with suckers and serve for locomotion, capturing the food and for respiration etc.

Tip of each arm bears terminal tentacle which serves as a tactile and olfactory organ. At its base a bright red eye spot made up of several ocelli is found.

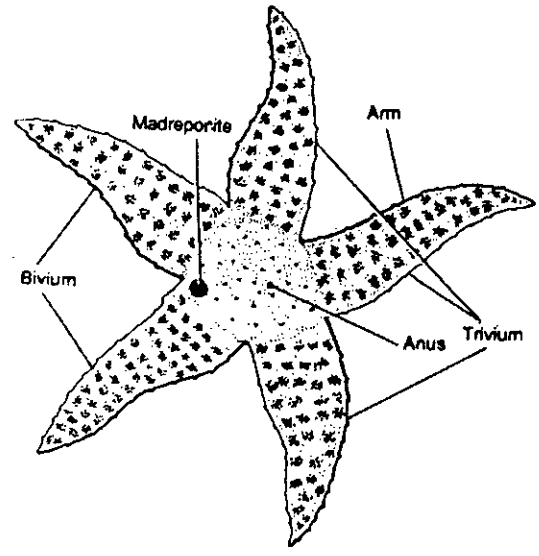

Fig. 2. *Asterias* : Aboral view

Aboral Surface

It is the upper and slightly convex dorsal surface of the body. Along the axes of arms, a large number of short immovable, *calcareous tubercles* are arranged in irregular rows. Around and in between these spines occur tiny pincer-like structures, the *pedicellariae*. These are grasping organs used for cleaning or protecting the body surface. They also occur on oral surface. On both the surfaces, minute finger-like, hollow and retractile processes, the *dermal branchiae* or *gills* or *papilae* are found. They open outside through dermal pores and serve for respiration as well as for excretion. Near the center anus is situated. In an inter-radius between

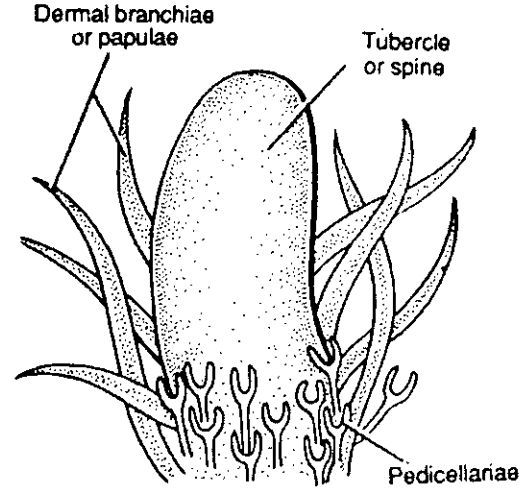

Fig. 2a. A cluster of pedicellariae, papulae and tubercles

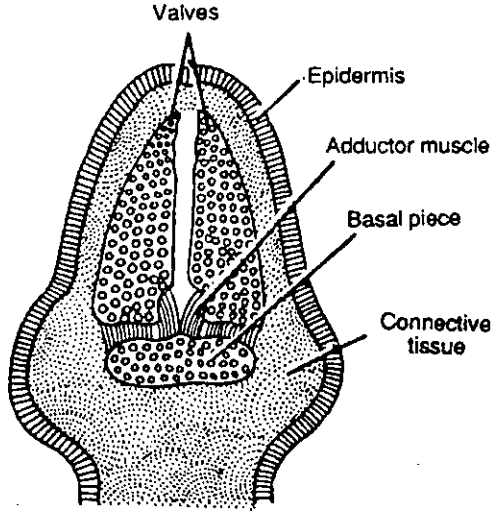

Fig. 2b. Straight type of pedicellaria

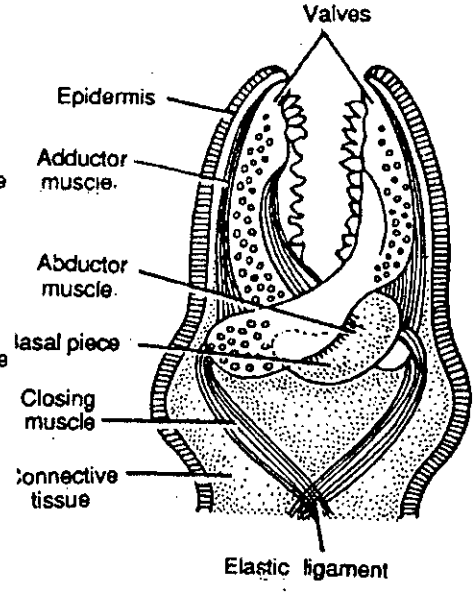

Fig. 2c. Crossed type of pedicellaria

two arms *madreporite*, a sieve like plate with numerous narrow and radiating grooves bearing pores is situated. Madreporite leads into the water vascular system.

Pedicelariae

These are minute, whitish jaw like structures found on both the body surfaces in association with spines. They may be stalked or sessile, but in Asterias stalked pedicellariae are found. Each consists of a basal plate supporting two articulating calcareous blades or valves and all the plates are situated on the stalk. Such pedicellariae (consisting of three calcareous plates) are termed *forcipulate*. Opposite surfaces of two valves are serrated which open and close with the help of one pair of abductor and two pairs of adductor muscles, respectively. According to disposition of blades, two types of pedicellariae occur in Asterias–

(i) Straight type : In these the blades or valves are straight and when closed these meet together along their entire length.

(ii) Closed type : In these the two valves cross each other like a pair of scissors. Straight type of pedicellariae occur largely among the dermal branchiae, whereas the crossed type occur in cluster at the bases of spines.

The pedicellariae help in capture and removal of debris and minute organisms such as larvae which may settle on the body surface and interfere with their function.

• 18.4 WATER VASCULAR SYSTEM OR AMBULACRAL SYSTEM

It is a unique system of echinoderms which helps mainly in locomotion but also plays an important role in the physiology of the animal. It originates from coelom consisting of a system of canals containing sea water and amoeboid corpuscles. It consists of the following parts.

(1) Madreporite : It is a thick sieve like calcareous plate situated on the aboral surface of the central disc. It bears as many as 250 minute pores on the surface and they lead into pore canals. All pore canals unite to form collecting canals within the substance of madreporite. Below the madreporite, collecting canal communicates with stone canal through ampulla.

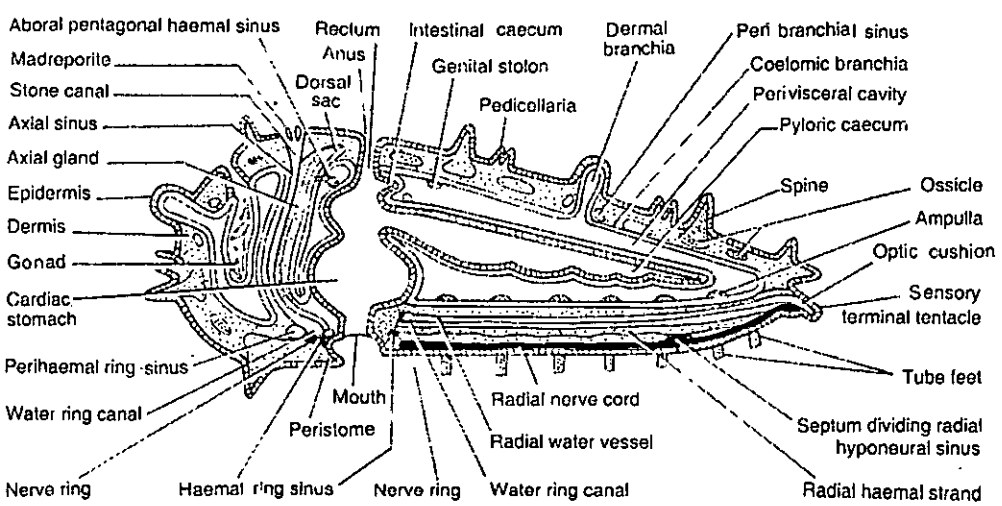

Fig. 3. *Asterias*. Diagrammatic V.S. of oral disc and arm

(2) Stone canal : It is S-shaped tube, which opens on the oral side into a ring canal around the mouth. It is also known as madreporite canal. Its walls are supported by a series of calcareous rings, hence the name stone canal. Inner lining of the wall bears cilia or flagella, which draw water into canal.

Stone canal with an axial organ is enclosed in a coelomic sac, the *axial sinus*. These together form the *axial complex*.

(3) Ring canal : it is a wide canal forming a ring around the oesophagus. The angles of the pentagonal ring lie in the radial positions.

(4) Tiedemann's bodies : These are also known as *racemose glands*.They are small rounded yellowish glandular sacs opening into ring canal on its inner side. There are total 9 tiedmann's bodies arranged in radii and inter-radii positions except the position of stone canal. It consists of a bounding peritonium enclosing a stroma of connective tissue and muscle fibers containing numerous radiating tubules. Their exact function is uncertain. Some workers consider them as filtering device, others as lymphatic glands which probably manufacture coelomocytes of water vascular system.

(5) Pollen vesicles : These are pear-shaped, thin walled contractile bladders situated along the inter-radii and open into the ring canal on the outer side. They help in the regulation of pressure of sea water. In *Asterias*, however it is absent.

(6) Radial canals : They arise from the ring canal and extend along each arm up to the tip. Radial canals lie below the ambulacral ossicles and terminate as the lumen of the terminal tentacles.

(7) Lateral canals : Each radial canal in its corresponding arm gives out two series of narrow lateral or podial canals along its entire length. Each lateral canal opens into a tube foot. The opening being provided by a valve to prevent back flow of fluid into radial canal.

(8) Tube feet : There are two double rows of tube feet in each arm. Each tube foot has the form of a close thin walled tube, distinguished into three regions-(i) a rounded sac like ampulla situated above the ambulacral ossicle and projecting into the coelom. (ii) a middle tubular podium extending through the ambulacral groove and (iii) a cup like sucker at the lower end of the podium. Wall of the tube foot possesses strong longitudinal muscles. In addition, the walls of the ampulla also possess circular muscles while those of the podia possess rings of inelastic connective tissue.

Function : Most peculiar and interesting role of water vascular system is in locomotion by providing a hydraulic pressure mechanism. Thin walls of tube feet may serve for respiratory exchange of gases. Tube feet also help in anchoring the body to the substratum and in capturing and handling the food.

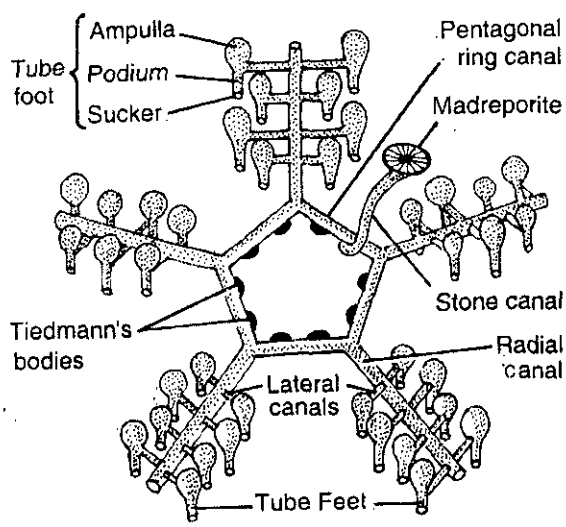

Fig. 6. *Asterias*. Water-vascular system.

• SUMMARY

Asterias is commonly called sea star or star fish. It is marine bottom dweller and is a beautiful member of sea fauna. Its body consists of an indistinct central disc and five radiating ambulacral arms. Specialized muscluar structures called pedicelariae are found at both cral and aboral surface of the body. They help in keeping the body surface clean. Water vascular system of coelomic origin is present in echinoderms which helps mainly in loomotion. It also plays an important role in the physiology of the animal.

Key words : Star fish, Asterias, ambulacral, pedicellariae, water vascular system

• STUDENT ACTIVITY

1. Make a model to show the structure of star fish.

• TEST YOURSELF

1. Describe the external features, habit and habitat of starfish
2. Give an account of water vascular system of starfish and its importance
3. Describe pedicellariae in starfish
4. What are Tube feet
5. Write a short note on locomosion in seastar
6. Objective type Questions
   (1) Asterias is a
   (a) Starfish (b) Silver fish
   (c) Dogfish (d) None of these
   (2) Pedicellariae are
   (a) Grasping organs (b) Rasping organs
   (c) Feeding organs (d) Sensory organs
   (3) Water vascular system plays an important role in
   (a) Reproduction (b) Locomotion
   (c) digestion (d) None of the above
   (4) Tube feet are found in
   (a) Annelida (b) Porifera
   (c) Echinodermata (d) Mollusca
   (5) Pollen vesicles are found in
   (a) Protozoa (b) Plants
   (c) Echinodermata (d) Porifera

Ans. (1) a (2) a (3) b (4) c (5) c

UNIT

19

BALANOGLOSSUS

STRUCTURE

LEARNING OBJECTIVES

- After going through this unit you will learn :
- About Balanoglossus in apt detail along with thir habits and Habitat
- Affinities and systematic position related to them.

• 19.1 INTRODUCTION

Balanoglossus, commonly called acorn worm or tongue worm. Acorn (fruit of oak) refers to the proboscis of balanoglossus projecting from collar. It has world-wide distribution. About 20 species occur all over the world especially in the tropical and subtropical seas.

• 19.2 HABIT AND HABITAT

It is a marine, tubicolous or burrowing animal inhabits shallow coastal waters of inter-tidal zone. But a few hemichordates occur in deeper waters.

Burrow

Balanoglossus lives inside a U-shaped tube or burrow with two vertical limbs 50.0-75.0 cm deep and the two openings 10.0-30.0 cm apart.

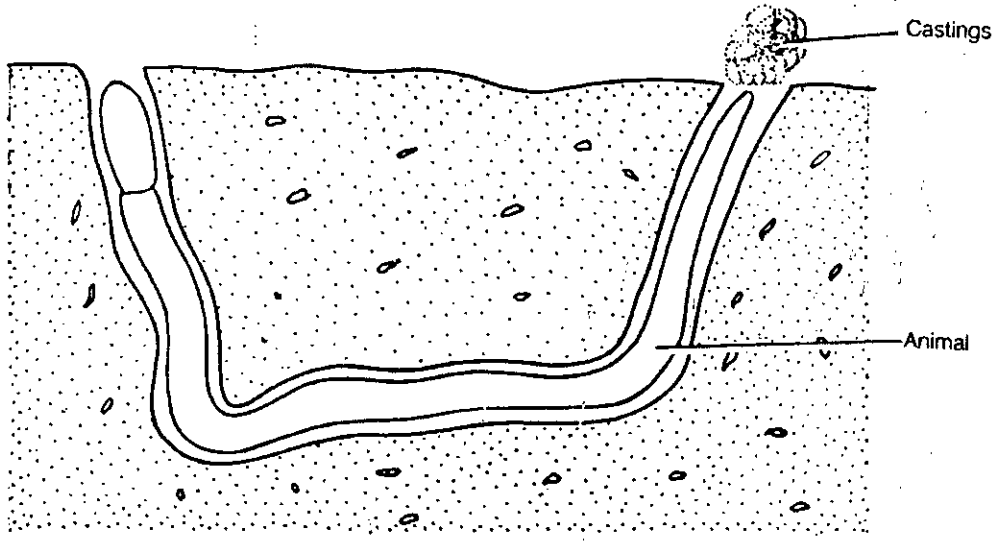

Fig. 1. *Balanoglossus* in U-shaped burrow

Protective Device

Inner wall of the fragile tube is cemented made up of sand and mucus, secreted by the skin mucus glands of the animal. It prevents the burrow from collapsing and save the animal from burial. Balanoglossus secretes a foul-smelling odour to keep away the enemies.

Movement

It is sluggish and moves in its burrow with the help of cilia found on its body surface. Most active part of the body is proboscis.

Feeding and Breeding

It swallows sand or mud to obtain diatoms, protozoan, other micro-organisms and organic detritus on which it feeds.

External Features

Body is soft, elongated worm like, cylindrical and bilaterally symmetrical. It measures 10.0 to 50.0 cm in length. Colour is bright or drab with reddish or orange tints.

Divisions of Body

Body is unsegmented but divisible into three regions or *parts - proboscis, collar* and *trunk.*

(1) Proboscis : It is the anterior most part of the body. It has muscular wall and encloses a cavity called, proboscis coelom. It opens outside through a minute proboscis pore situated mid-dorsally near its base. Its posterior neck forms a slender neck or proboscis stalk through which it is attached to the collar. Below the proboscis stalk, a U shaped ciliated epidermal depression, *preoral ciliary organ* is situated. It tests the quality of food and water, entering the mouth.

(2) Collar : It is the middle short region of the body. Its flap like or funnel like anterior margin is termed collarrette, which completely covers the proboscis stalk. Ventrally below the stalk the collarette encloses, a permanent wide aperture,

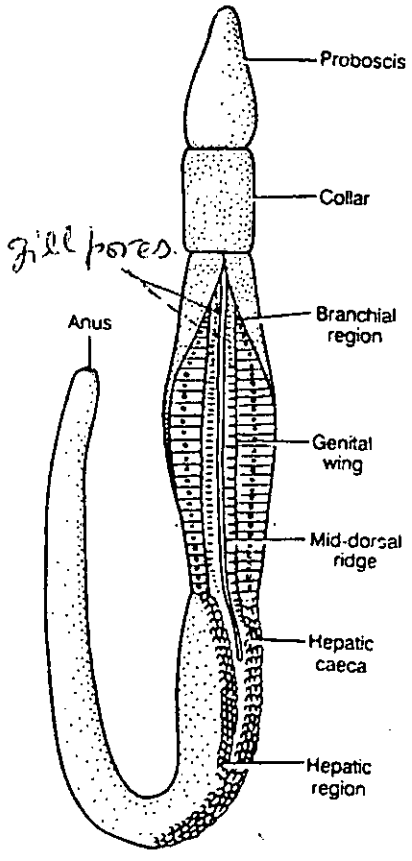

Fig. 2. *Balanoglossus*

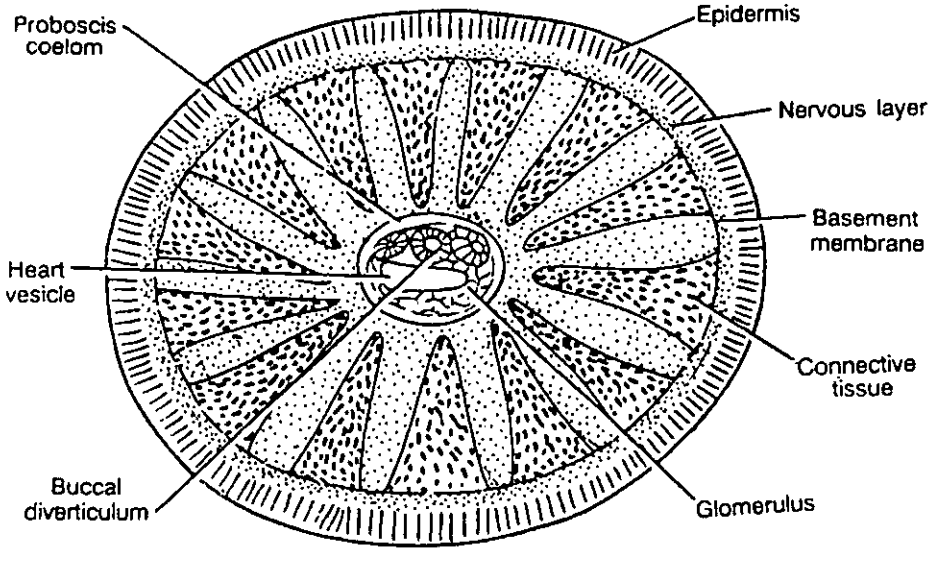

Fig. 3. T.S. of *Balanoglossus* through proboscis region

the mouth. It leads into buccal cavity inside the collar. Collar is highly muscular and encloses a cavity, the *collar coelom*. It opens outside through a pair of collar pores into the first pair of gill pouches behind.

(3) Trunk : It is the largest and posterior part of the body. It is rather flat and appears annulated due to circular constriction on the surface. All along its length, trunk bears a mid-dorsal and a mid-ventral ridge, each accommodating its corresponding nerve and blood vessels. It is further differentiated into three regions.

(a) Branchiogenital region : This region of trunk is marked by a pair of lateral, thin, flat and longitudinal genital wings. Gonads are enclosed in the wings and open outside by a microscopic gonopore. On either side of the mid-dorsal ridge, two longitudinal ridges bearing two rows of branchial aperture or gill pores are found. Number of gill pores increases with the age of animal and can be hidden by the closing of genital wings.

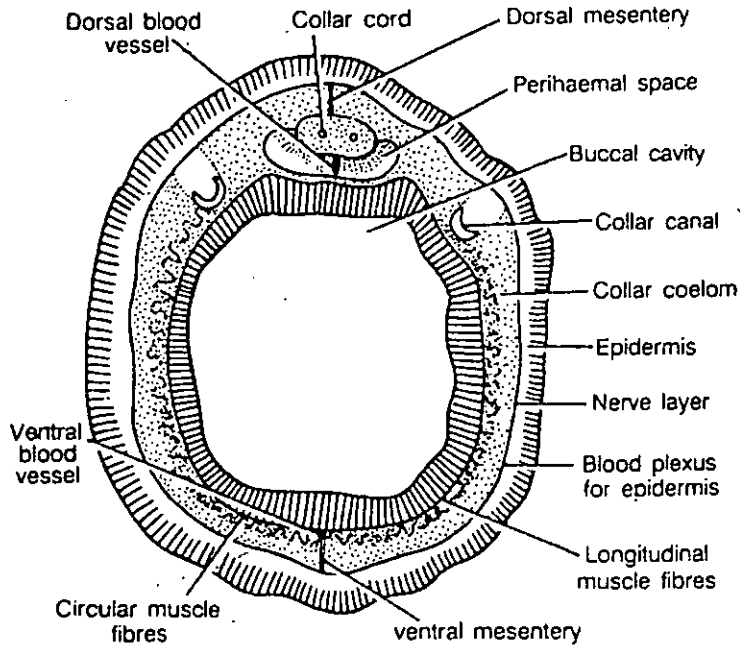

Fig. 4. T.S. of *Balanoglossus* through collar region

(b) Hepatic region : It is smaller middle region of the trunk and bears numerous irregular intestinal sacculations or hepatic caeca on the dorsal surface.

(c) Post hepatic region : It is the posterior most and longest part of the trunk also called abdomen or caudal region. It is more or less uniform in diameter but its posterior end slightly tapers and bears a terminal anus.

Coelom

Balanoglossus has an enterocoelic coelom lined with coelomic epithelium. Regionwise, the coelomic cavities are separated from one another. It is represented by five cavities, one in proboscis, two in collar and two in the trunk.

(1) Proboscis coelom : It is unpaired and greatly obliterated by connective tissue and muscle strands except for a small central space which is occupied by the proboscis complex. Proboscis complex includes the buccal diverticulum, central sinus, heart versicle and glomerulus. Proboscis coelom leads into proboscis canal and opens outside through proboscis pore at the base of proboscis stalk.

(2) Collar coelom : It is represented by two lateral cavities partitioned by incomplete mid-dorsal and mid-ventral mesentries. Collor coelom opens into the first gill sac of its side through a collar canal and collar pore.

(3) Trunk coelom : These are paired closed cavities, separated by an incomplete dorsal and complete ventral mesentery. In the branchiogenital region each cavity is

further divided by a lateral septum into a dorsolateral and ventrolateral compartment. Trunk coelom is partitioned from the collar coelom by a collar trunk septum.

Coelomic fluid : Proboscis and collar coelom communicate with the exterior and are largely filled with sea water which keeps them turgid. Trunk coelom is filled with a watery coelomic fluid containing amoeboid coelomocytes, each with a single large vacuole.

• 19.3 AFFINITIES AND SYSTEMATIC POSITION

Due to their peculiar anatomical organisation and embryology, hemichordates have been considered to be closer to the chordates as well as to the most non-chordate phyla by different zoologists from time to time.

(1) Affinities with chordata

Earlier Zoologists like *William Bateson* (1885) proposed close affinities with chordates on the basis of three fundamental characters :

(a) a notochord

(b) a dorsal hollow nerve cord and

(c) Pharyngeal gill slits

On the basis of these similarities hemichordates have been considered as a subphylum of chordata. But this view has faced the following objections-

(a) Notochord of hemichordates is not homologous to the true notochord. In fact it is a hollow projection of the fore gut and is preferably called *buccal diverticulum*.

(b) Nervous system is of primitive type, which resembles with invertebrates.

(c) Gill slits are numerous and on dorsal side of Balanoglossus, which do not resemble with chordates.

(2) Affinities with Rhynchocephalia

Balanoglossus resembles with Nemertines in the following characters–

(a) Elongated vermiform body with terminal anus and smooth skin.

(b) Unicellular glands and ectodermal nerve plexus.

(c) Feeding and burrowing habits.

But Nemertines differ, in lacking a dorsal nerve cord and a protrusible proboscis.

(3) Affinities with Phoronida

Balanoglossus bears resemblances, with Phoronis in the following characters–

(a) Similar nature of epidermal nervous system.

(b) Gastric diverticula of Phoronis resembles with buccal diverticulum of Balanoglossus.

(c) Similarities in ciliary band, hydropore, sensory organs and eye spots between the *actinotorch larva* of Phoronis and *tornaria larva* of Balanoglossus.

(d) Both have great power of regeneration

Objections : The characters which differ from each other are the following.

(a) Pharyngeal gill slits of Balanoglossus are absent in phoronis.

(b) Paired nephridia of Phoronis are absent in Balanoglossus.

On the basis of other developmental differences the relationship of these two groups has been rejected.

(4) Affinities with Pogonophora

Marcus (1958) tried to relate Hemichordata with Pogonophora on account of the following similarities.

(a) Enterocoelic coelom.

(b) Body and coelom divided into three regions.

(c) Mesosome and metasome are separated by a septum.

(d) Nervous system subepidermal.

(e) Gonads are found in trunk.

Objections : (a) Protocoelic nephridial coelomoducts and

(b) Lacking of an alimentry canal in Pogonophora rejects any close relationship between the two groups.

(5) Affinities with Annelida

Spengel (1893) suggests the following affinities

(a) Body vermiform.

(b) Tubiculous, burrowing and ingesting mud which is passed out as castings.

(c) Similarities between collar of Balanoglossus and clitellum of annelids.

(d) Proboscis and prostomium are similar and preoral in position.

(e) Similarity in blood vascular system.

(f) Dorsal position of heart.

(g) Similarities between *tornaria* and *trochopore* larva .

Objections : They differ fundamentally in the following characters-

(a) Pharyngeal gill slits and buccal diverticulum of Balanoglossus are absent in annelids

(b) Ventral nerve cord and nephridia of annelids are absent in Balanoglossus.

(c) Development of trochophore and tornaria show great difference in many characters.

Thus the relationship between both the groups has been rejected.

(6) Affinities with Echinodermata

Balanoglossus show following similarities with Echinoderms.

(a) Coelom is enterocoelic and divides into three cavities.

(b) Heart vesicle and glomerulus of enteropneusts are homologous to dorsal sac and axial gland of echinoderms.

(c) Nervous system is primitive in both the groups.

(d) Both groups are similar in proteins and phosphogens.

(e) Both the groups show great power of regeneration.

(f) Larva of both the groups bear identical ciliated bands and their twisted movement.

(e) Presence of protocoel and hydropore in tornaria resemble with hydrocoel of dipleurula larva.

Objections : The presence of apical plate with sensory hairs, eye spots and telotorch in the tornaria larva makes difference with echinoderm larva. Protocoel is single in tornaria but is paired in echinoderm larva.

(7) Systematic Position and Phylogeny

The systematic position of Balanoglossus is conspicuous and controversial due to some peculiar anatomical characters. Earlier Hemichordata has been considered as a subphylum of phylum Chordata which includes primitive chordates. But in reality, they bear only a single chordate character, the pharyngeal gill slits. In other characters they are rather more similar to invertebrates. Therefore, some recent workers like Vander Host (1939) Dowydoff (1948), Marcus (1958) and Hymen (1959) have chosen to remove hemichordates from the phylum chordata and treat them as an independent invertebrate phylum.

Regarding phylogeny, of this group the close affinity with Echinodermata, Phoronida, Pogonophora, and chordata, has led to the conclusion that the Hemichordates have arisen from a common ancestral stock.

• SUMMARY

Balanoglossus is commonly called acorn worm or tongue worm. It is a marine and tubicalous animal. Its body is divided into three regions proboscis, collar and trunk. A