NATIONAL OPEN UNIVERSITY OF NIGERIA

COURSE CODE : BIO 207

COURSE TITLE: LOWER INVERTEBRATES

Course Code & Course Title: **BIO 207: Lower Invertebrates**

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THE LOWER INVERTEBRATES

General Introduction

Earlier, you studied all animals together under the broad subject Animalia. From this level on, we shall be examining their classification, characteristics and economic importance. All animals along with the animal like organisms can be classified into two main groups, namely invertebrates - animals (and animal-like organisms) without backbone and vertebrates - animals with backbone.

The invertebrates are grouped into two; the lower invertebrates and the higher invertebrates. The lower invertebrates are those invertebrates without specific organs. Take for example Porifera which does not live on the tissue level of organization. Cnidarians and Ctenophorans have simple tissues but are not advanced enough to form organs. Finally you arrive at the phylum platyhelminthes which does form simple organs but lacks a tube within the digestive system (acoelomate). A false coelem is first seen in the Nematodes. Higher developed invertebrates have a true coelem like mollusks, annelids, echinoderms, and arthropods.

In this course, we shall introduce you to the lower invertebrates' morphology and levels of organization, by examining their classification and characteristics. We shall also be examining the adaptive features to mode of life and the general aspects of the vital functions of some of these organisms.

MODULE 1: TAXONOMY OF INVERTEBRATES

Unit 1 Classification of Organisms

1.0 Introduction

Classification is a system in which information on organisms are gathered and stored in an orderly manner for easy retrieval. The aspect of Biology that deals with the classification of organisms is called taxonomy. It includes the naming of organisms or nomenclature, and the systematic assignment of organisms to groups called taxa; this is referred to as systematics. Taxonomy and systematics are very often interchanged.

2.0 Objectives

By the time this lecture unit is completed, the student should:

- have a clear knowledge of the basis of grouping organisms together.
- be able to classify organisms in a hierarchical manner.
- be able to use and apply the basic rules of the binomial system of nomenclature.

3.0 Main Content

3.1 Classification

There are two main types of classification:

- Artificial classification.
- Natural classification.
  - An artificial classification is based on one or more easily observable characteristics such as colour, mode of locomotion, habitat etc.
  - A natural classification may be phylogenetic and reflects possible evolutionary relationships based on ancestry and descent. In phylogenetic classification, organisms belonging to the same taxa are believed to have a common ancestor. This may be represented by a cladogram (family tree).
  - Phenetic classification is based on evidence from data compiled on morphological (structural), cytological (cellular) and biochemical similarities or differences between organisms.
  - Biological nomenclature is based on the binomial system, which was introduced by the Swedish naturalist Carl Von Linnaeus (1707-1778), who gave two Latin names to each organism. The first name is the generic name, which begins with an upper case alphabet and the second is the specific name, which begins with a lower case alphabet. Both names must be underlined or italicized e.g. Clarias gariepinus or Clarias gariepinus. Animals are named following rules set out in the International Code of Zoological Nomenclature (ICZN). Following the rules of nomenclature, there can only be one *Clarias gariepinus*, etc.

- Organisms are assigned to groups at various hierarchical levels, based on easily observable morphological features that they share e.g. shape, number of limbs, position of limbs etc. The major taxa employed in this system include the following categories in descending order of size:
- Rank Example

  Kingdom Animalia

  Phylum Arthropoda

  Class Insecta (Hexapoda)

  Order Diptera

  Family Culicidae

  Genus Anopheles

  Species gambiae

- Each taxon usually contains a number of taxa below it; for example, one phylum may contain five classes or a class may contain ten orders, etc. However, each taxon can only belong to the single taxon immediately above it e.g. a class can only belong to the phylum above it.

- NB. Five kingdoms of organisms are currently recognized as opposed to the former two Kingdoms, Plantae and Animalia. The five kingdoms are: Prokaryotae, Protoctista, Fungi, Plantae and Animalia; the latter four are under the Super Kingdom Eukaryotae. Protoctista now contains algae, protozoa, some former fungi and slime molds. It has become necessary to classify organisms into more kingdoms than the traditional two because the two-kingdom system does not quite reflect phylogenetic relationships.

4.0 Conclusion

Classification is a system in which information on organisms is gathered, documented and stored in an orderly manner for easy reference. Animals with animal-like organisms are separated into two groups, invertebrates and vertebrates based on the absence or presence of a backbone.

5.0 Summary

- The two main types of classification are: artificial classification, in which easily observable characteristics are used, and natural classification, which reflects possible evolutionary relationships, based on ancestry (phylogeny). All organisms are classified in a hierarchical order.
- Every kind of organism is given two names (binomial system of nomenclature), following the rules in the ICZN. The generic name is the first, and it begins with an uppercase letter and the second is the specific name, which begins with a lower case letter. Both names are either underlined or italicized.

6.0 Tutor-Marked Assignment (TMA)

- Outline the criteria that are used in the classification of organisms.
- Define the following:
  - Taxonomy
  - Systematics and
  - Nomenclature.
- Name the two main types of classification.

7.0. References/Further Readings

Barnes, R.D. (1980). *Invertebrate Zoology* (4th Edition) 1,089pp. (Hong Kong, Holt-Saunders).

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Unit 2: General Classification of Invertebrates

1.0 Introduction

As we learnt earlier, the invertebrates are a group of animals (and animal-like organisms) that do not have a backbone. They are by far the most numerous animals on Earth. An estimate of about 2 million species has been identified to date. These 2 million species make up about 98 percent of all the animals identified in the entire animal kingdom. It is believed that the true number of invertebrate species may be as high as 100 million. They are divided into four groups, based on their cellular composition and organization.

In this lecture unit, we will examine the general classification of invertebrates, and mention the four groups of invertebrates.

2.0 Objectives

By the time this lecture unit is completed, the student should:

- ❖ have a clear understanding of the basis of the classification of invertebrates.
- ❖ appreciate the four groups of invertebrates.
- ❖ become familiar with the names and features of some common invertebrates.

3.0 Main Content

3.1 Types of Invertebrates

- ♦ The invertebrates are a group of animals (and animal-like organisms) that do not have a backbone.
- ♦ The group of invertebrates without specific organs is referred to as the lower invertebrates. For example, Protozoans and Porifera, while the higher developed invertebrates have a true coelem like mollusks, annelids, echinoderms, and arthropods.
- ♦ Generally, the invertebrates are divided into four groups, based on their cellular composition and organization, namely Protozoa, Mesozoa, Parazoa and Metazoa

3.1.1 Protozoa

- They are for the most part of their lives unicellular, i.e. made up of one cell
- They are also described as being acellular i.e. not divided into cells (non-cellular).
- Their vital functions are carried out by organelles.

3.1.2 **Mesozoa** (Greek: mesos = middle; zoon = animal)

- The name was given because mesozoans are thought to be intermediate between true multicellular animals and protozoans (single-celled/acellular organisms).
- Their bodies are cellular.

- They do not have more than two cell 'layers'; the outer layer ciliated and the inner reproductive.
- They are bilaterally symmetrical.
- They have no organs.
- They have no body cavity.
- Gametes and agametes are produced from special cells, which form the central mass of the body.
- Their life cycles involve the alternation of asexual and sexual generations.
- They are marine.
  There are two classes and three orders.

3.1.3 Parazoa

- Multicellular invertebrates, which possess collared flagellated cells that make them unique among the other multicellular invertebrates.
- The many cells in their body are not organized into tissues and organs.
- They are therefore at the cellular level of organization.

3.1.4 Metazoa

- Invertebrates with marked cellular differentiation.
- There are two levels of organization in this group:

  - ✓ Diploblastic – includes animals with two cell layers showing tissue level of organization, where the body is composed of an inner endoderm and outer ectoderm.

  - ✓ Triploblastic – includes animals with three layers showing organ level of organization; they possess a third body layer, the mesoderm between the outer ectoderm and inner endoderm.

The mesoderm is bulkier than either of the other layers; it forms a greater part of the body and contains important organs and definite systems of spaces.

4.0 Conclusion

The invertebrates are a group of animals (and animal-like organisms) that do not have a backbone. They have been classified into several major groups, which are divided into four subgroups, based on their cellular composition and organization.

Among the simplest invertebrates are the sponges (phylum Porifera). Other major invertebrate phyla include the cnidarians (phylum Cnidaria), echinoderms (phylum Echinodermata), and

several different groups of worms, including flatworms (phylum Platyhelminthes), roundworms (phylum Nematoda), and annelids (phylum Annelida).

5.0 Summary

In this unit, we have learnt that:

- ♦ invertebrates (animals without a vertebral column) are separated into Protozoa, Mesozoa, Parazoa and Metazoa.
- ♦ The protozoans are unicellular/acellular and the mesozoans and parazoans multicellular. The cells of the latter two are not organized into tissues and organs.
- ♦ The metazoans are also multicellular organisms but their cells are organized into tissues and organs.

6.0 Tutor-Marked Assignment (TMA)

- Into how many groups are the invertebrates classified? Name them.
- Give two distinguishing features of each group.

7.0 References/Further Readings

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Unit 3: A Systematic Approach to Lower Invertebrate Structure and Levels of Organization

1.0 Introduction

As we learnt earlier, invertebrate refers to any animal lacking a backbone. The lower invertebrates on the other hand are animals without specific organs. For example, Protozoans and Porifera do not live on the tissue level of organization. Cnidarians and Ctenophorans have simple tissues but are not advanced enough to form organs. The phylum platyhelminthes does form simple organs but lacks a tube within the digestive system (acoelomate). A false coelem is first seen in the nematodes. Higher developed invertebrates have a true coelem like mollusks, annelids, echinoderms, and arthropods.
In this lecture unit, we will examine the characteristics and outline classification of the protozoans, which are unicellular/acellular animal-like protoctists. We shall also examine the distinguishing features of Phylum Rhizopoda and Phylum Apicomplexa.

2.0 Objectives

By the time this lecture unit is completed, the student should:

- understand the basis of the classification of the protozoans.
- become familiar with the names and features of members of the phyla Rhizopoda and Apicomplexa.
- become familiar with the economic importance of the phylum apicomplexa.

3.0 Main Content

3.1 Structure and Levels of Organization of Protozoans

- The lower invertebrates are animals that lack specific organs.
- The protozoans and porifera are examples of animals that do not live on the tissue level of organization.
- Cnidarians and Ctenophorans have simple tissues but are not advanced enough to form organs.
- The phylum platyhelminthes does form simple organs but lacks a tube within the digestive system (acoelomate).
- A false coelem is first seen in the nematodes.
- Higher developed invertebrates have a true coelem like mollusks, annelids, echinoderms, and arthropods.

3.2 Characteristics of the Protozoans

- These organisms are animal-like.
- They are simple and primitive.
- They occur in watery or moist environments.
- They are found in the sea, freshwater, soil, body fluids etc.
- They are cosmopolitan (distributed worldwide).
- They are at the protoplasmic level of organization i.e. specialized portions of the cytoplasm called organelles carry out particular functions within their single cell.
- Their organelles include cilia, flagella, pseudopodia, contractile vacuoles etc. (Fig.1.1)

3.3 Classification of the Protozoans

The protozoans belong to the Superkingdom Eukaryotae and Kingdom Protoctista.They are broadly divided into four[†] phyla based mainly on their organelles and modes of locomotion as follows:

- ♦ Phylum Rhizopoda
- ♦ Phylum Apicomplexa
- ♦ Phylum Sarcomastigophora
- ♦ Phylum Ciliophora

3.3.1. Phylum Rhizopoda (Sarcodina)

- They lack chromatophores.
- They possess a single nucleus.
- They do not have definite shape due to the absence of a rigid pellicle.

[†] For simplicity, four of the major phyla of the Protozoa have been selected here. Several phyla, which will be discussed in future, at a higher level, are currently recognized.

- Asexual reproduction is by binary fission.
- They possess pseudopodia (false feet) as locomotory organelles; the pseudopodia can be formed in any position on the body and can be withdrawn into the body.
- E.g. *Arcella, Amoeba, Entamoeba*, etc. (Fig. 1.1)

3.3.2. Phylum Apicomplexa[§]

- They have an apical complex (see figure of *Toxoplasma gondii*)
- They lack external locomotory organelles.
- They are therefore characterized by their reproductive process rather than by their locomotory organelles as in the other two groups (Fig. 1.1).
- They are parasitic and absorb food in solution from their host.
- They are uninucleate.

[§] Members of what used to be the class Sporozoa have now been assigned to four phyla: Apicomplexa, Microspora, Myxozoa and Ascetospora. Only the first of the four phyla (Apicomplexa) will be discussed at this stage.

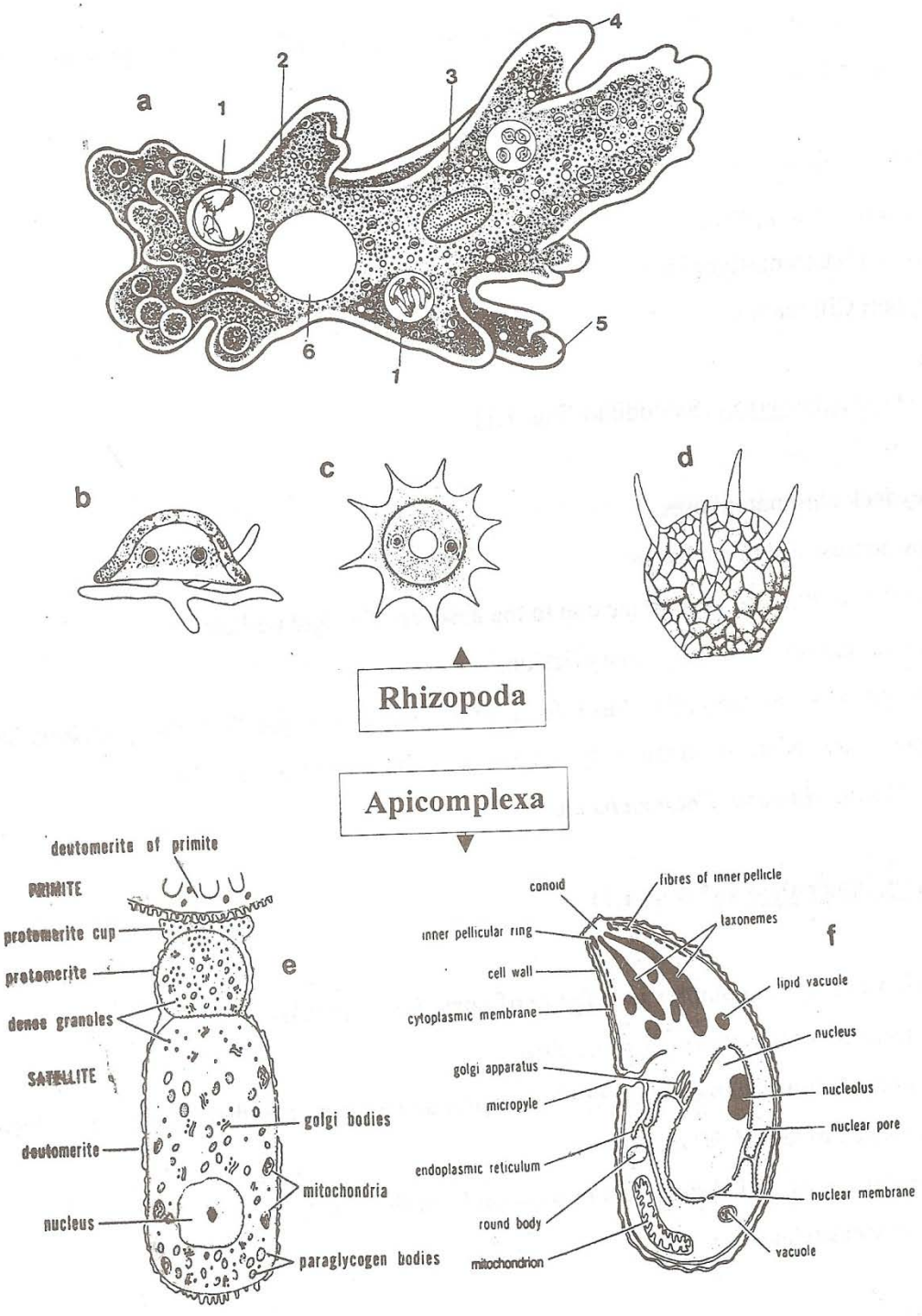

Fig. 1.1. Phylum **Rhizopoda**: **a,** *Amoeba* (1, food vacuole; 2, granular endoplasm; 3, nucleus; 4, pseudopodium; 5, clear ectoplasm; 6, contractile vacuole); shelled Rhizopoda: **b,** *Arcella vulgaris*; **c,** *Arcella dentata*; **d,** *Difflugia corona.* Phylum **Apicomplexa**: **e,** *Gregarina polymorpha*; **f,** *Toxoplasma gondii.*

- They form many spores during asexual and sexual reproduction. This is their most distinctive characteristic.
- They are economically important in that:
- ➢ They cause diseases in humans and in organisms useful to humans.
- ➢ The skeletons of *Foramininfera* (Rhizopoda) make up much of the limestone and chalk on the Earth.

- ➢ Flagellates are the primary component in the marine food chain *Trypanosoma gambiense* (sleeping sickness).

- E.g. *Plasmodium* causes malaria, *Eimeria* causes coccidiosis, *Toxoplasma* causes toxoplasmosis, etc.

4.0 Conclusion

The lower invertebrates are animals without specific organs. The protozoans and porifera are examples of animals that do not live on the tissue level of organization. Cnidarians and Ctenophorans have simple tissues but are not advanced enough to form organs. The phylum platyhelminthes does form simple organs but lacks a tube within the digestive system (acoelomate). A false coelem is first seen in the nematodes. Higher developed invertebrates have a true coelem like mollusks, annelids, echinoderms, and arthropods.

5.0 Summary

In this lecture unit, we have learnt that:

- ➢ The Protozoa is a collective name for animal-like, single-celled organisms, some of which may form colonies.
- ➢ In its classification, protozoa are placed in the kingdom Protista with other single-celled organisms that have membrane-enclosed nuclei.
- ➢ Protozoa have little or no differentiation into tissue systems.

6.0 Tutor-Marked Assignment (TMA)

- List the groups of animals that do not live on the tissue level of organization
- How many types of Protozoans are there?
- State the differences between the Phylum Rhizopoda and Phylum Apicomplexa.
- The largest phylum of Protozoans is _____.

7.0. References/Further Reading

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http://www.biology.ualberta.ca/courses.hp/zool250/Labs/Lab03/Lab03.htm

Unit 4: Phylum Sarcomastigophora

1.0 Introduction

The phylum Sarcomastigophora gets its name from the combination of "Sarcodina" (which is an older term used for amoeboids) and "Mastigophora" (which is an older term for flagellates). It belongs to the Protist kingdom, which includes many unicellular or colonial, autotrophic, or heterotrophic organisms. The two main subphyla are Mastigophora and Sarcodina. A third is Opalinata. It is polyphyletic, and it is not a universally recognized classification. It places great significance upon method of locomotion in generating the taxonomy. However, members are divided into two classes which are Phytomastigophorea and Zoomastigophorea.
In this lecture unit, we will examine the outline classification of the Sarcomastigophora. We shall also examine the distinguishing features of members of the Phylum Sarcomastigophora.

2.0 Objectives

By the end of this lecture unit, the student should:

- understand the basis of the classification of the Sarcomastigophora.
- become familiar with the names and features of members of phylum Sarcomastigophora

3.0 Main content

3.1 Characteristics of members of phylum Sarcomastigophora

- Some members possess chromatophores while others do not. Chromatophores are cup-shaped masses of protoplasm of a green, yellow or brownish colour, due to the presence of the pigments: chlorophyll, xanthophylls, carotene etc. (Fig. 1.2)
- The cell is covered by a pellicle and it is semi-rigid.
- They usually have a definite shape.
- Adults use flagella as a means of locomotion.
- They possess a single nucleus.
- Asexual reproduction is by longitudinal binary fission.

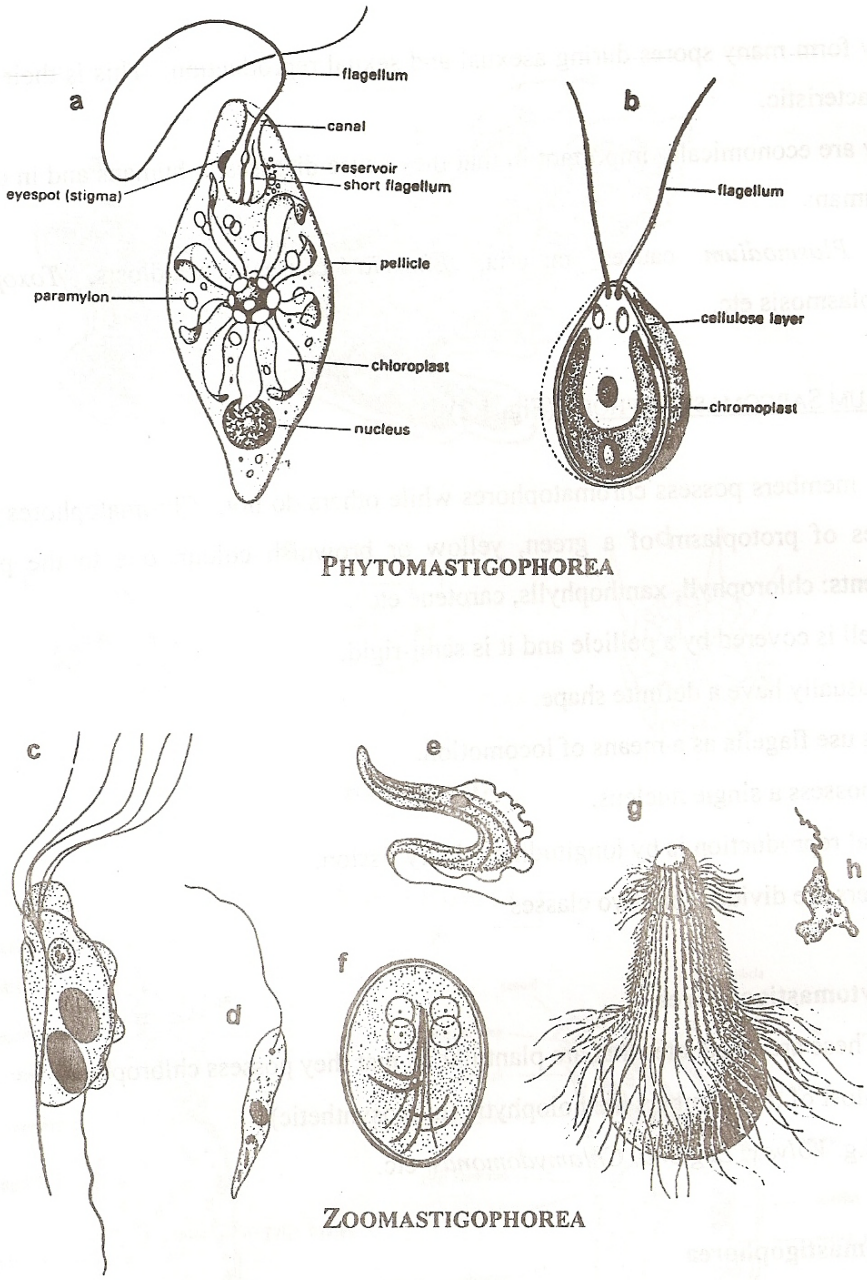

Fig. 1.2. Phylum **Sarcomastigophora**, Class **Phytomastigophorea**: **a,** *Euglena viridis*; **b,** *Chlamydomonas*. Phylum **Sarcomastigophora** Class **Zoomastigophorea**: **c,** *Trichomonas hominis*; **d,** *Leishmania donovani*; **e,** *Trypanosoma*; **f,** cyst of *Giardia lamblia*; **g,** *Trichonympha*; **h,** *Mastigamoeba*

3.2 Classification of phylum Sarcomastigophora

Members are divided into two classes, Phytomastigophorea and Zoomastigophorea

3.2.1 Phytomastigophorea

- These are flagellates that are plant like in that they possess chlorophyll.
- Most of the members are holophytic (photosynthetic).
- E.g. Volvox, Euglena, Chlamydomonas, etc.

3.2.1 Zoomastigophorea

- They are animal-like and lack chromatophores.
- They are holozoic (food is ingested through temporary or permanent openings).
- There is sexual reproduction in a few groups.
- Some members of this class are parasitic.
- They may possess one to many flagella.
- There are amoeboid forms with or without flagella.
- E.g. *Mastigamoeba, Trichonympha, Trypanosoma, Leishmania* etc.

4.0 Conclusion

The phylum Sarcomastigophora is a derivative of "Sarcodina" (which is an older term used for amoeboids) and "Mastigophora" (which is an older term for flagellates). The phylum includes many unicellular or colonial, autotrophic, or heterotrophic organisms. The members have generally been grouped into two classes, which are Phytomastigophorea and Zoomastigophorea.

5.0 Summary

- We have learnt in this lecture unit that the Sarcomastigophora are separated into Phytomastigophorea and Zoomastigophorea.
- They are flagellated organisms that are plant like in that they possess chlorophyll, while the Zoomastigophorea are animal-like and lack chromatophores.

6.0 Tutor-Marked Assignment (TMA)

- Into how many groups are the Sarcomastigophora classified? Name them.
- What is the single criterion that is used to divide Sarcomastigophora into its component classes?
- Give two distinguishing features of Phytomastigophorea and Zoomastigophorea.

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Unit 5: Phylum Ciliophora

1.0 Introduction

As we learnt earlier, Sarcomastigophora are unicellular or colonial, autotrophic, or heterotrophic organisms. They have two main classes which are Phytomastigophora and Zoomastigophora. Some members possess chromatophores, while others do not.

In this lecture unit, we are going to study the outline classification and characteristics of the members of the Phylum Ciliophora. As their name suggests, most members of the phylum Ciliophora (also called ciliates) have great amounts of cilia. Ciliates may also have structures called trichocysts, organelles which can be discharged from the cell. Trichocysts may be used to anchor the organism or to capture prey by paralyzing it with a trichocyst with a poisoned tip.

2.0 Objectives

At the conclusion of this lecture unit, you should be able to:

- ❖ recognize Ciliophora by most of their diagnostic features.
- ❖ identify common ciliates.
- ❖ recognize paramacium both as members of the phylum Ciliophora and the class Ciliata.

3.0 Main Content

3.1 Structure and Level of organization of Phylum Ciliophora

- The Phylum Ciliophora (Ciliates) consists of a wide array of Protists characterized by the presence of cilia over at least some of their cell surface during at least part of their life cycle. Cilia are similar to flagella except they are generally much shorter than the length of the cell. Cilia, like flagella may be used for locomotion in which case their action is similar to the arms of a swimmer in that there is a power stroke followed by a return stroke.
- Ciliates are generally predators or bacterial feeders and the cilia as in the case of bacterial feeders such as Paramecium, sweep food particles into a gullet where they are taken into the cell in a vacuole. The darker clumps in the picture are food vacuoles in a very well fed Paramecium! A few ciliates have symbiotic algae or have "captured" chloroplasts and thus obtain energy either directly or indirectly from photosynthesis.
- Ciliates come in a wide range of shapes from the slipper shaped Paramecium to stalked forms such as the *Vorticella* shown here. This a common ciliate often found attached to the surfaces of aquatic plants. The stalk has a contractile fiber running through its center and when disturbed, the organism retracts itself by contracting the stalk like a coiled spring.
- The Ciliophora have complex cells and are characterized by having two different types of nuclei in their cells. The large macromolecules is specialized for protein synthesis and other day to day activities of the cell. The much smaller micromolecules is involved in sexual

reproductive activities.

3.2 Phylum Characteristics

- This phylum constitutes the largest group of protozoans.
- They exhibit a high level of organelle development.
- They possess cilia as locomotory organelles.
- They have a constant body shape due to the presence of a firm pellicle covering the body.
- They possess nuclei of two types, a large meganucleus, which controls all cell activities, except reproduction, and a micronucleus, which controls sexual reproduction.
- Asexual reproduction is by transverse fission while sexual reproduction is by conjugation, which involves fusion of nuclei and not cells.
- Most of the ciliates are free-living and solitary, a few are colonial and some are sessile; very few are parasitic.
- They feed on small organic particles or prey on microscopic organisms.
- E.g. *Paramecium, Vorticella, Balantidium* etc. (Fig. 1.3)

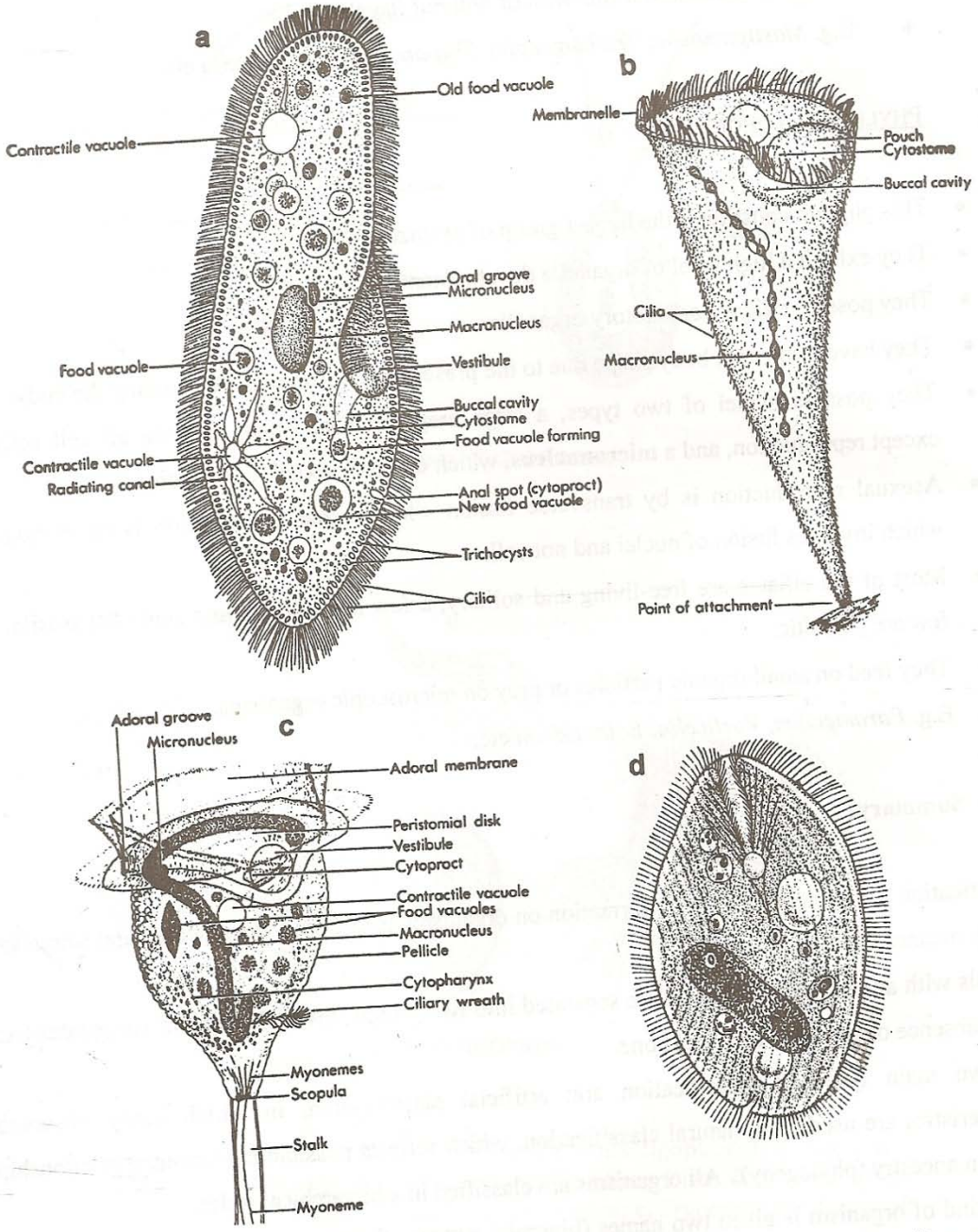

Fig. 1.3. Phylum **Ciliophora**: **a,** *Paramecium*; **b,** *Stentor*; **c,** *Vorticella*; **d,** *Balantidium coli*

4.0 Conclusion

The phylum ciliophora also called ciliates bear so many cilia. Ciliates are equipped with trichocysts which anchor the organism or used to capture prey by paralyzing it with a trichocyst with a poisoned tip. The ciliates are also characterized by having two different types of nuclei in their cells. The large macronucleus is specialized for protein synthesis and other day to day activities of the cell. The much smaller micronucleus is involved in sexual reproductive activities.

5.0 Summary

- ❖ We have seen in this lecture unit that the Ciliophora (Ciliates) consists of a wide array of unicellular organisms which are characterized by the presence of numerous cilia over at least some of their cell surface during at least part of their life cycle.
- ❖ The cilia, like flagella may be used for locomotion in which case their action is similar to the arms of a swimmer in that there is a power stroke followed by a return stroke.
- ❖ Ciliates come in a wide range of shapes from the slipper shaped *Paramecium* to stalked forms such as the *Vorticella*

6.0 Tutor-Marked Assignment (TMA)

- Take a named ciliophoran and classify it to species.
- Name the two types of nuclei found in ciliophora
- State two functions of the trichocysts.

7.0 References/Further Readings

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MODULE 2: The Structure and Level of Organization of the Mesozoa, Parazoa and Metazoa

Unit 1: Mesozoa

1.0 Introduction

In the last lecture unit, we looked at the classification and characteristics of the Phylum Ciliophora. We saw the features like cilia, which have structures called trichocysts that may be used to anchor the organism or to capture prey by paralyzing it with the poisoned tip of the trichocyst.

In this lecture unit, we shall study the classification and characteristics of the members of the mesozoa. Mesozoa were once thought to be evolutionary intermediate forms between Protozoans and Metazoans, but now they are thought to be degenerate or simplified metazoa. Their ciliated larva are similar to the miracidium of trematodes, and their internal multiplication is similar to what happens in the sporocysts of trematodes.

2.0 Objectives

By the time this lecture unit is completed, the student should:

- ❖ have a clear understanding of the basis of the classification of Mesozoa.
- ❖ appreciate the two classes/orders of mesozoa.
- ❖ become familiar with the names and features of some members of the Mesozoa

3.0 Main Content

3.1 Level of Organization of Mesozoa

- ♦ The mesozoa (From the Greek *Mesos* for middle and *zoon* an animal) are minute parasitic animals of marine invertebrates, particularly squids and octopuses.
- ♦ They comprise two orders of small, wormlike organisms, the Rhombozoa and the Orthonectida.
- ♦ The body consists of a single layer of ciliated cells enclosing one or more reproductive cells. These body cells are rather constant in number and arrangement for any given species.
- ♦ The internal cells do not correspond to the entoderm of other animals, as they have no digestive function.
- ♦ The life cycles are complex, involving both sexual and asexual generations (metagenesis).
- ♦ Scientists are unsure whether they represent a still existing remnant from the early stages of the development of multicellular animals, or a degenerate form descended from the Platyhelminthes.

- ♦ No fossil mesozoans are known and very little research has been done on them, so consequently we know very little about them.
- ♦ The 50 or so known species are divided into two classes which some experts believe are not actually related at all.
- ♦ Apart from differences in life cycles the two classes are easily separated by looking at their respective asexual parasitic phases (forms).
- ♦ In the Rhombozoa, this stage is long thin and ciliated
- ♦ In the Orthonectida it is shaped more like an amoeba,but lack cilia.
- ♦ Mesozoans have no gaseous exchange organs, no circulatory system, no nervous system and no digestive system.

3.2 General Characteristics of Mesozoa

- Bilaterally symmetrical.
- Has no organs or tissues
- Body contains no internal cavity
- Body possesses no digestive tract (gut).
- Body only two cell layers in most places.
- Has no nervous system
- Has some cells develop inside other cells (see Fig. 2.2)**.**
- Reproduction is quite complex involving both sexual and asexual aspects.
- All are endoparasites on other marine invertebrates.

3. 3 General Classifications Mesozoa

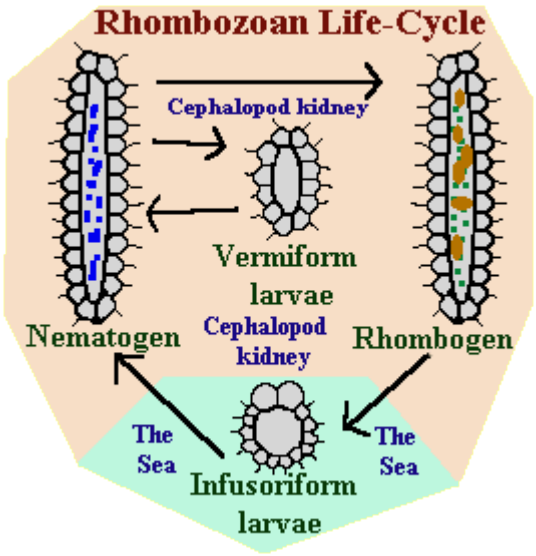
- ♦ The two main mesozoan groups are the Rhombozoa (Dicyemid) and the Orthonectida. Other groups sometimes included in the Mesozoa are the Placozoa and the Monoblastozoa.
- ♦ Monoblastozoans consist of a single description written in the 19th century of a species that has not been seen since. As such, many workers doubt that they are a real group. As described, the animal had only a single layer of tissue.

3.3.1 Rhombozoans

- Rhombozoans, sometimes called Dicyemida in some older texts are parasites of cephalopods (Octopus and Squid), they live in the animals kidneys. Rhombozoans have a more complicated life cycle. Their basic body plan is a long thin central cell, called an axial or tube cell, surrounded by a coat of smaller ciliated cells which are arranged spirally around the axial cell. Some authors equate this with a two cell-layer body plan.
- The axial cell contains smaller cells called axoblasts. These axoblasts give rise to either, vermiform(long and thin) asexual larvae called nematogens sexually reproducing individuals called rhombogens.
- The two forms are physically identical as far as are they known. The only difference being that in the nematogen stage, the axoblasts produce more nematogens and in the

rhombogen stage they produce infusorigens which serve as the animals gonads (organs which produce eggs and sperm).

- The eggs are fertilised inside the axial cell where they develop into infusoriform larvae which quickly develop the adult number of cells. Each species has a definite number of cells in its adult form.
- This infusoriform larvae then leaves the axial cell and the hosts body, with its urine. They then sink to the sea floor where they grow by means of cell enlargement rather than by cell addition. It is not currently know how these larvae re-enter their hosts and become nematogens.



Rhombozoan Life cycle

3.3.2 The Orthonectida

- The Orthonectida are parasites on a wide range of marine invertebrates including Platyhelminthes, Echinodermata, Mollusca and Annelida. During the sexual stage they are gonochoristic (male and female).
- During this phase they have no central tube-cell, instead the space within the layer of ciliated cells is filled with eggs or sperm.
- The males release their sperm into the sea. The sperms enter the body of any females they find and fertilise her eggs.
- These fertilised eggs grow into a ciliated larva (consisting of only a few cells). This larva now leaves the mothers body and enters the body of a suitable host.
- Inside the host it loses its cilia and grows larger to form a plasmodium (something a bit like a multicellular amoeba). This plasmodium has many nuclei and is called

multinucleate. Bits of this plasmodium break off and form new plasmodia. Eventually the plasmodia give rise to the sexual which soon leave the host and the life cycle is complete.

4.0 Conclusion

The Mesozoa are a small phylum of small and poorly understood animals. They have very simple bodies, often consisting of less than 50 cells. All known species are internal parasites of marine invertebrates.

5.0 Summary

In this lecture, we learnt that:

- The mesozoa are minute parasitic animals of marine invertebrates.
- There are two main groups, Rhombozoa (Dicyemid) and the Orthonectida.
- Their body consists of a single layer of ciliated cells are rather constant in number and arrangement depending on the species.
- In their life cycle, the sexual generation alternates with the asexual generation (metagenesis).

6.0 Tutor-Marked Assignment (TMA)

- Name the two main groups of the mesozoa
- State the major differences between the two groups
- What do you understand by the phrase 'Metagenesis'?

7.0. References/Further Readings

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Unit 2: The Parazoa

1.0 Introduction

In the previous lecture, we learnt outline classification and characteristics of the members of the Phylum Mesozoa. We went on to outline and briefly discuss the characteristics of members of the Mesozoa.

During this lecture, we shall examine the general classification of the Parazoa and have an overview of the phylum porifera. The parazoans are the simplest and most primitive multicellular animals, because, despite their multicellular nature, their component cells are not organized into tissues and organs.

2.0. Objectives

At the conclusion of this lecture, the student should be able to:

- understand the structure and the organization of the Parazoa.
- appreciate the differences between the multicellular organization of the Parazoa.
- classify the Parazoa and the component phyla.
- have an overview of the poriferans.

3.0 Main Content

3.1 Overview of the Parazoa

- The Parazoa are an ancestral subkingdom of animals, literally translated as "beside the animals". Parazoans differ from their choanoflagellate ancestors in that they are macroscopic and have differentiated cells, but unlike "true animals" (Eumetazoa), they do not have tissues.
- The only surviving parazoans are the sponges, which belong to the phylum porifera. Some include Placozoa, a phylum that consists of only one species, *Trichoplax adhaerens*, in the division, but they are also sometimes placed in the subkingdom Agntozoa.
- Parazoa are asymmetrical (meaning they display no symmetry), all other animals will display some sort of symmetry. There are currently 5000 species, 150 of which are freshwater. Larvae are planktonic and adults are sessile.

3.2 General Description of Phylum Porifera (Latin: porus = pore; ferre = to bear) (Figs. 2.1, 2.2 & 2.3)

- Members of this phylum are commonly known as sponges. Sponges are relatively simple animals. They are said to be at the cellular level of organization because their bodies are not composed of true tissues or organs.

- Instead they are little more than a colony of several distinctive cell types that serve different functions. One of the distinctive cell types is the choanocyte or collar cell.
- This cell type lines the internal chambers of sponges. Its flagellum creates the water current that the sponge uses to filter very tiny food particles from the water.

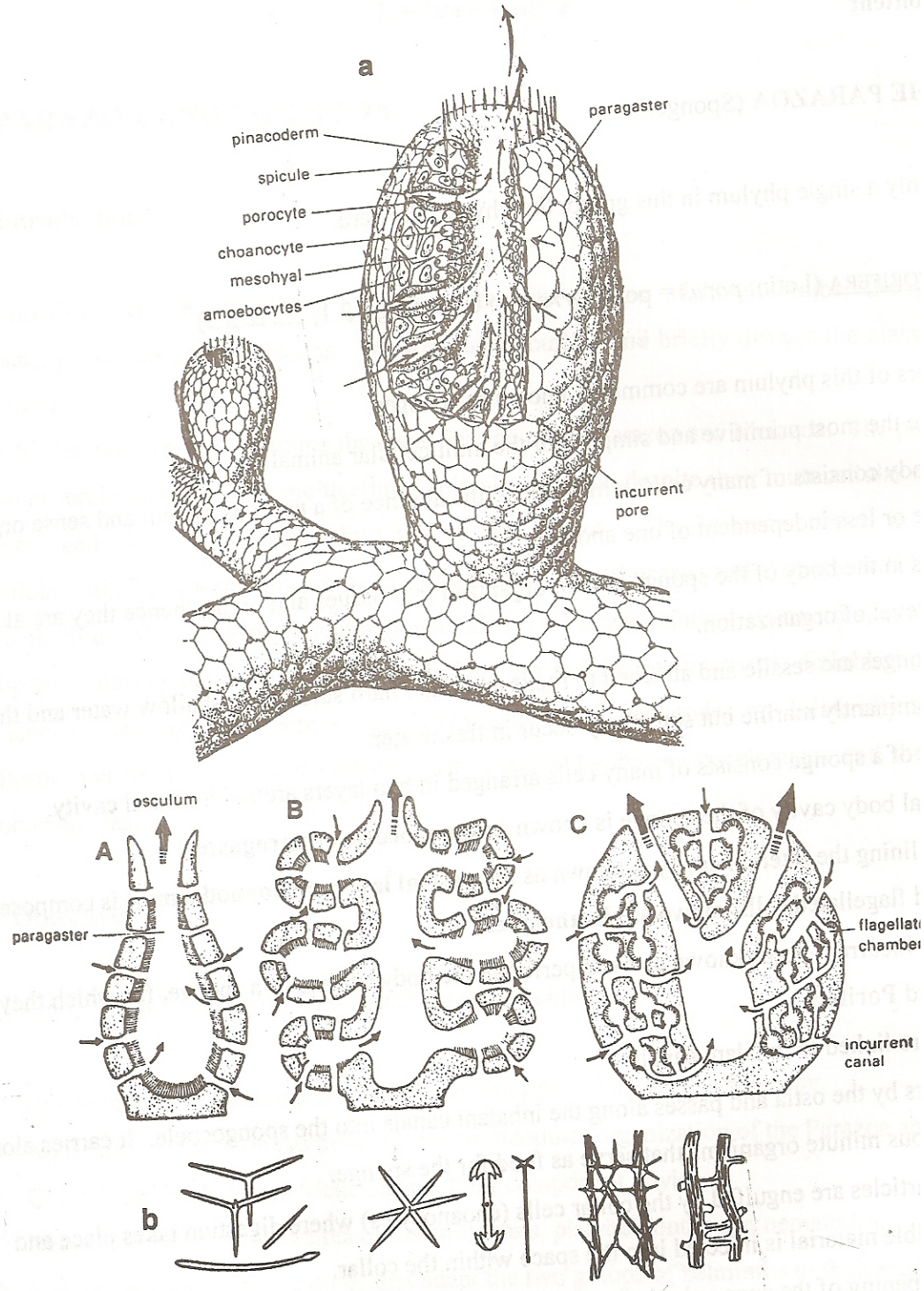

Fig. 2.1. Phylum **Porifera**: **a,** Morphology of a sectioned asconoid sponge. Morphological types of sponges: **A.** Asconoid; **B.** Syconoid; **C.** Leuconoid. **b,** Some sponge spicules.

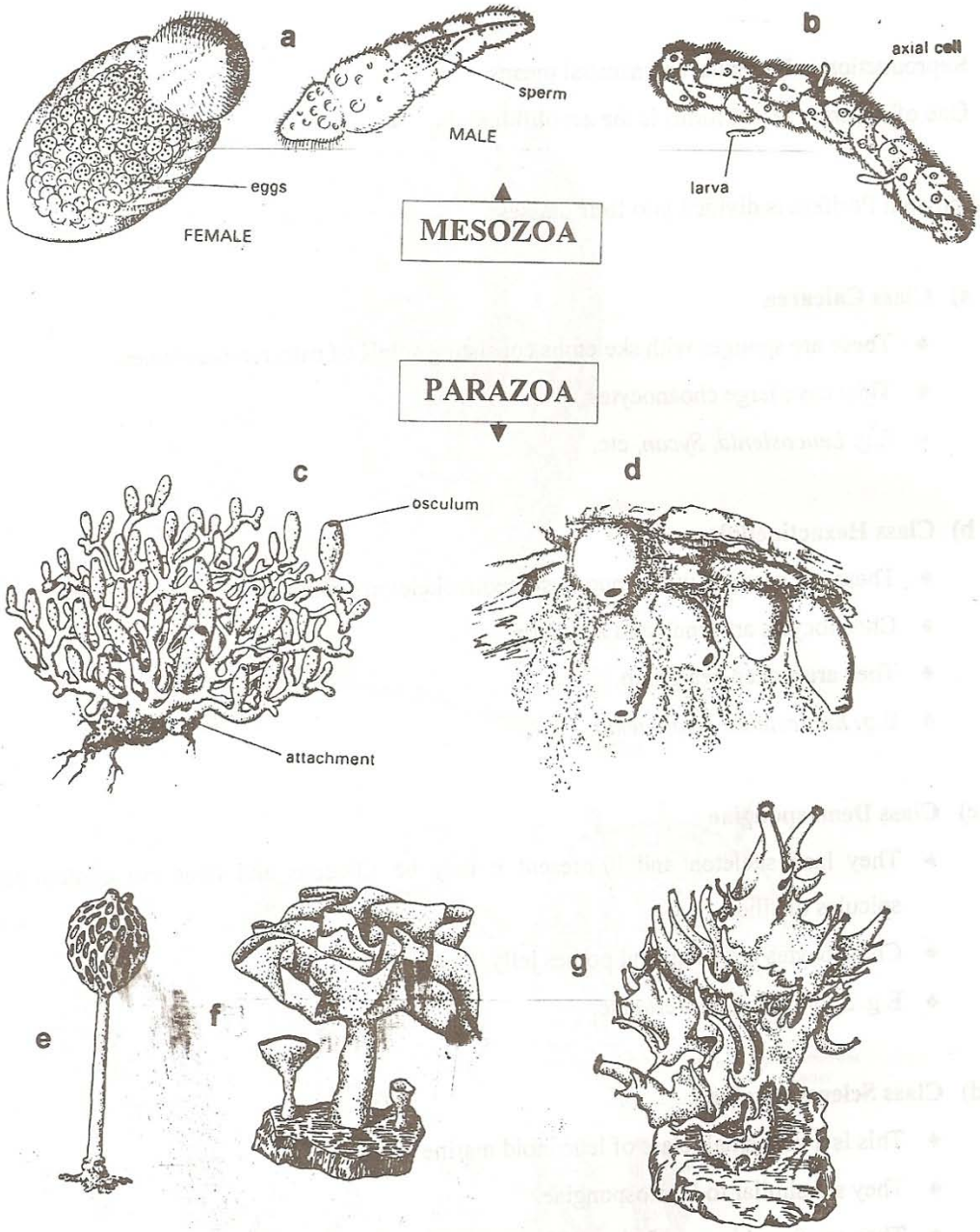

Fig. 2.2. Mesozoa: **a,** Male and female orthonectids; **b,** adult dicyemid. **Parazoa**, Phylum **Porifera**, Class **Calcarea**: **c,** *Leucoslenia complicata*; **d,** *Grantia compressa;* **e,** *Clathrina;* **f,** *Grantia labyrintheca;* **g,** *Leuconia.*

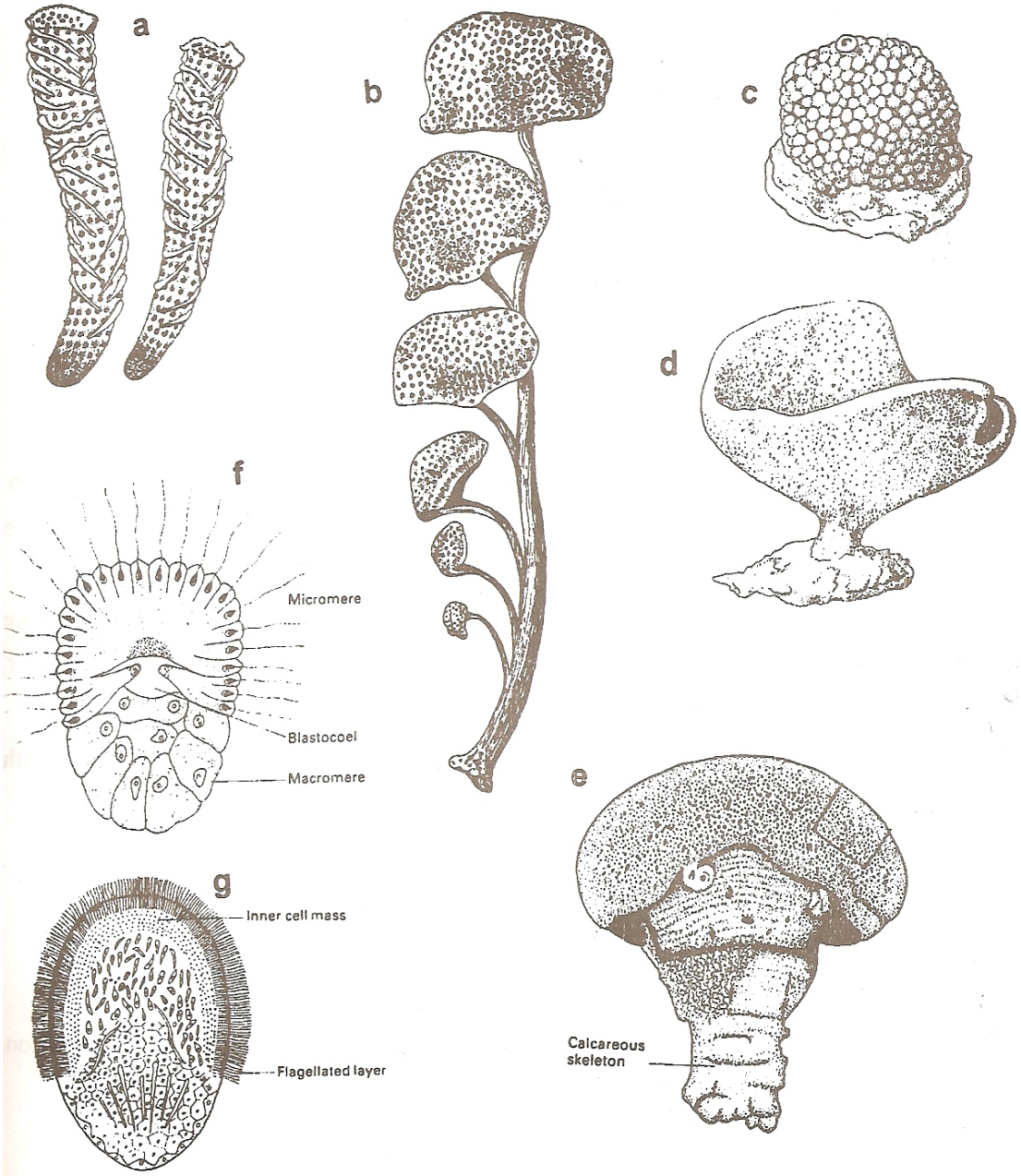

Fig. 2.3. Class **Hexactinellida**: **a,** *Euplectella* (Venus flower basket). Class **Demospongiae: b,** *Esperiopsis challengeri*; **c,** *Tethya*; **d,** *Phakellia ventilabrum*; **e,** **Sclerospongiae**; **f,** An **amphiblastula** larva; **g,** A **parenchymula** larva.

- The collar that surrounds the flagellum acts like a fine sieve, filtering about bacteria-size food particles. Thus the choanocyte creates the filtering current and captures the food particles which are ingested via phagocytosis.
- Another cell type found in some, but not all, sponges is the pinacocyte which is a flat cell that forms a thin external covering.
- Porocytes, found only in the simplest of sponges, are donut-shaped cells that form the incurrent pores called ostia.
- Archaeocytes are ameboid cells that move about through the body of the sponge and carry out various functions. Some archaeocytes differentiate into the cells responsible for secreting the skeletal elements.
- These skeletal elements may be mineralized spicules (either calcareous or siliceous) and/or spongin fibers. In addition, some cells secrete collagen fibrils in the intercellular matrix.
- Sponges are filter feeders because they create a current of water and filter out suspended food particles, typically bacteria and tiny phytoplankton.
- Water enters the body through the tiny ostia and leaves through the larger oscula. Most sponges are marine. However a few are freshwater.

4.0 Conclusion

Members of the phylum Porifera, commonly known as sponges are multicellular, but without true tissues and organs. Their body is little more than a colony of distinctive cell types; mesohyl separates the two layers of cells. They are either asymmetric or radially-symmetric, benthic filter feeders. They lack digestive tract, rather body consists of choanocyte-lined chambers connected to the exterior via various pores and/or chambers. Digestion in the sponges is intracellular. The skeleton involves an extracellular matrix of fibrillar collagen with mineralized spicules and/or spongin fibers. The sponges are known to exhibit both asexual (gemmules) and sexual reproduction (usually hermaphroditic).

5.0 Summary

- Parazoa consists of a single phylum, Porifera (sponges). Although sponges are made up of many cells, they are still at the cellular level of organization.
- The phylum is divided into four classes: Calcarea, Hexactinellida, Demospongiae and Sclerospongiae.
- The cells of sponges are multicellular but not organized into tissues and organs.

6.0 Tutor-Marked Assignment (TMA)

- List the differences between the Parazoa and the Metazoa with special reference to their organization
- Why are the parazoans called sponges?
- State the differences between the parazoans and the choanoflagellate ancestors

7.0. References/Further Readings

Barnes, R.S.K., Calow, P. and Olive, P.J.W. (1989). *The Invertebrates: A new Synthesis*. 582pp. (London, Blackwell Scientific Publications; Hong Kong, Holt-Saunders).

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Unit 3: Classification and Characteristics of the Poriferans.

1.0 Introduction.

In the last lecture, we examined the general classification of the Parazoa and had an overview of the phylum porifera. The parazoans are the simplest and most primitive multicellular animals because, their component cells are not organized into tissues and organs.

In this lecture unit, we shall study the general characteristics and examine the classification of the Poriferans. The phylum Porifera is divided into four classes: Calcarea, Hexactinella, Demospongiae and Sclerospongiae

2.0 Objectives

By the time this lecture unit is completed, the student should:

- ❖ have a clear understanding of the basis of the classification of Phylum Porifera.
- ❖ appreciate the classes that make up the Poriferans.
- ❖ become familiar with the names and features of some members of the Porifera

3.0 Main Content

The phylum poriferans are simple, multicellular animals with tissues but no distinct organs. They are commonly known as sponges.
They typically attach to rocks, shells, or coral. Most sponges have an irregular shape supported by a skeleton composed of calcareous crystals, silicon spicules, or spongin fibers.
Most sponges have an internal water canal system that moves water through the body, providing a constant supply of food particles and oxygen to all cells and removing wastes. Sponges reproduce sexually. They regenerate lost or injured body parts. They are classified into four classes

3.1 General characteristics of the Poriferans

The sporozoa has only a single phylum called Phylum Porifera.

- Members of this phylum are commonly known as sponges.
- They are the most primitive and simplest of the multicellular animals.
- Their body consists of many cells, which due to the absence of a nervous system and sense organs are more or less independent of one another.
- The cells in the body of the sponge are not organized into tissues and organs hence they are at a cellular level of organization; body is little more than a colony of distinctive cell types; mesohyl separates the two layers of cells
- Adult sponges are sessile and attached to rocks and other hard surfaces in shallow water and they are predominantly marine but some may occur in freshwater.
- The body of a sponge consists of many cells arranged in two layers around a central cavity.
- The central body cavity of the sponge is known as spongocoele or paragaster.

- The layer lining the internal cavity is known as the gastral layer or choanoderm; it is composed of collared flagellated cells known as choanocytes.
- Numerous incurrent pores known as ostia perforate the body surface of a sponge, for which they were named Porifera.
- The ostia are linked to inhalant canals.
- Water enters by the ostia and passes along the inhalant canals into the spongocoele. It carries along with it various minute organisms that serve as food for the sponge.
- The food particles are engulfed by the collar cells (choanocytes) where digestion takes place and the indigestible material is injected into the space within the collar.
- The major opening of the sponge body is an exhalant and not a mouth; this is the osculum.
- They are often coloured due to interaction with symbiotic algae.
- Individuals are hermaphroditic.
- Reproduction is by sexual and asexual means.
- One of different larval forms is the amphiblastula.

3.2 Class Calcarea

- These are sponges with skeletons consisting solely of calcareous spicules.
- They have large choanocytes.
- E.g. *Leucoslenia, Sycon,* etc.

3.3 Class Hexactinellida

- These are sponges with a purely siliceous skeleton composed of six-rayed spicules.
- Choanocytes are small and lack jelly.
- They are a deep-sea group.
- E.g. *Euplectella, Hyalonema.*

3.4 Class Demospongiae

- They lack skeleton and if present it may be siliceous and does not contain six-rayed spicules of silica.
- Choanocytes are small and posses jelly.
- E.g. *Spongilla, Oscarella,* etc.

3.5 Class Sclerospongiae

- This is a very small class of leuconoid marine sponges.
- They are similar to Demospongiae.
- They are found in association with coral reefs.
- Their skeleton is made up of siliceous spicules and spongin fibres confined to a thin superficial layer on top of a huge mass of calcium carbonate.

4.0 Conclusion

The poriferans (sponges) are simple, multicellular animals with tissues but no distinct organs. They typically attach to rocks, shells, or coral. The members of the poriferans are differentiated from one another by the composition of their skeleton. They regenerate lost or injured body parts.

5.0 Summary

- The Phylum porifera commonly known as sponges are divided into four classes: Calcarea, Hexactinellida, Demospongiae and Sclerospongiae.
- The Calcarea are sponges with skeletons; Hexactinellida have siliceous skeleton composed of six-rayed spicules.
- The Demospongiae generally lack skeleton, while the Sclerospongiae is a very small class of leuconoid marine sponges.

6.0 Tutor-Marked Assignment (TMA)

- List the differences between the Demospongiae and the Sclerospongiae
- How is the Skeleton of the Calcarea different from that of Hexactinellida?

7.0. References/Further Readings

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Unit 4: The Metazoa

1.0 Introduction

In the previous lecture, we learnt that the Parazoa consists of a single phylum, Porifera (sponges), consisting of four classes, which are made up of many cells; and are still at the cellular level of organization.

During this lecture, we shall have an overview of the metazoans. The phyla in the Metazoa include: Cnidaria, Platyhelminthes and Nematoda (lower invertebrates); Annelida, Mollusca, Arthropoda and Echinodermata (Higher invertebrates). We shall also examine the general characteristics of the Cnidarians.

2.0 Objectives

At the conclusion of this lecture, the student should be able to:

- ❖ understand the structure and the organization of lower metazoans.
- ❖ appreciate the differences between the members of the cnidarians.
- ❖ appreciate features of the Cnidarians.

3.0 Main Content

3.1 Overview of Metazoans

- The metazoans are group of multicellular animals, apart from parazoans and mesozoans.
- Members of the metazoans differ from parazoans in the following ways:
  - ➢ Their bodies consist of many cells that co-operate with one another.
  - ➢ Choanocytes are absent in metazoans.
  - ➢ They possess sense organs and nervous system.
  - ➢ The principal body opening in metazoans is inhalant.
  - ➢ Endoderm cells, not choanocytes, line their body cavity.
- There are of two grades of organization: diploblastic and triploblastic.
  - ✓ In diploblastic organization, the body wall is composed of two layers: ectoderm and endoderm, and a layer of secreted jelly, the mesoglea/mesogloea, between the two layers.
  - ✓ The diploblastic body is attained by the cnidarians.
  - ✓ In triploblastic organization, there is a third layer, the mesoderm between the ectoderm and endoderm. The mesoderm is more extensive and forms most of the body. Other invertebrate phyla belong to this group.

3.2 The General Characteristics of the Phylum Cnidaria (Coelenterata) (Figs. 2.4 & 2.5)

- They are diploblastic animals.
- They have tissue grade organization.

- They possess a single cavity in the body known as enteron, which serves for ingestion and egestion.
- They lack an anus.
- Their mouth is surrounded by tentacles.
- They produce nematocysts which serve for defence and food capture.
- They are radially symmetrical.
- They are either sedentary (seated) or free-swimming.
- They exhibit polymorphism, occurring either as hydroid (polyp) or medusoid type.
- The medusoid forms are free swimming and solitary while the polyp forms are sedentary and may be solitary or colonial.
- Their nervous system is an irregular network of cells.
- Asexual reproduction is by budding producing colonial zooids.
- Sexual reproduction produces a ciliated larva known as the planula.

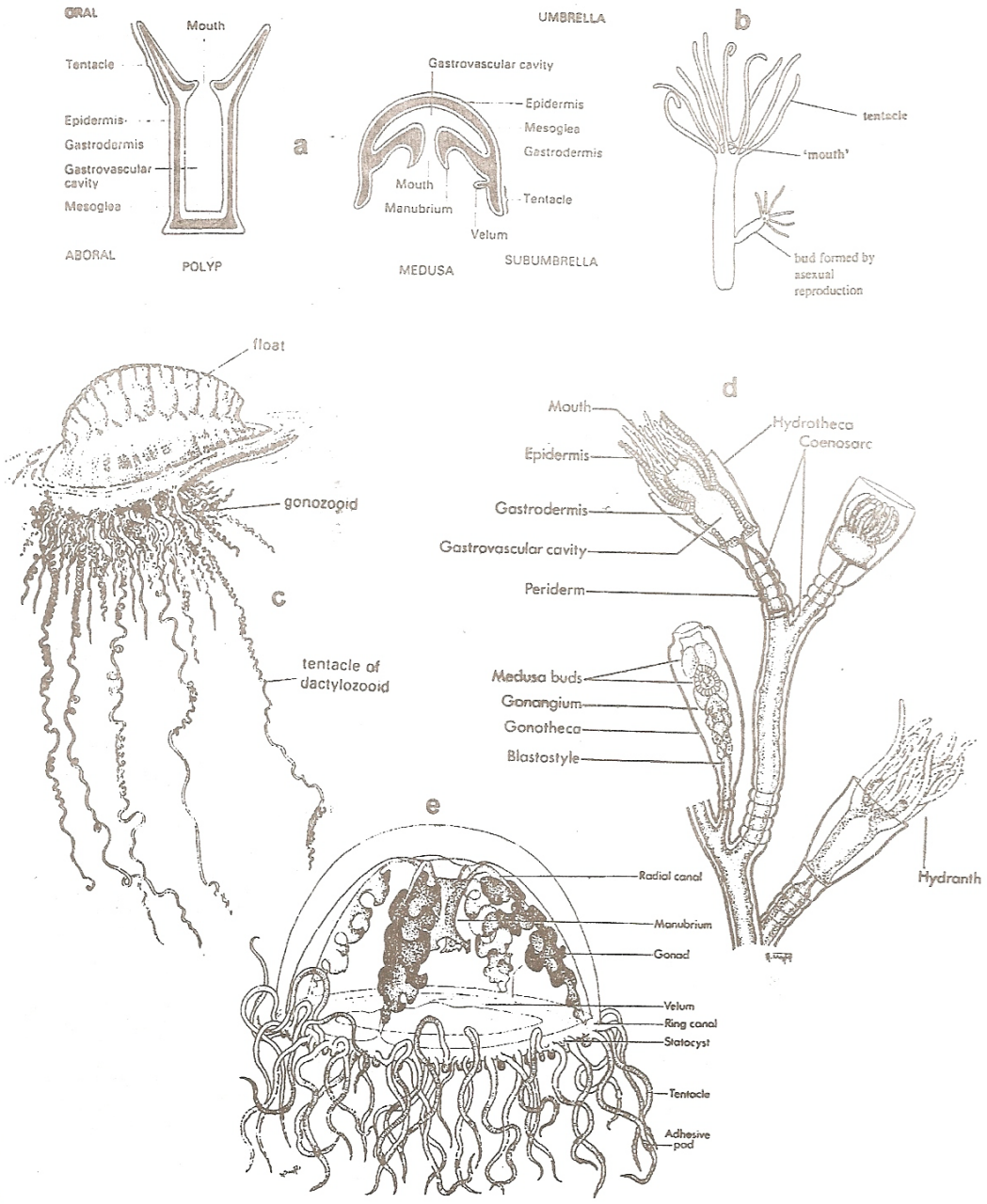

Fig. 2.4. Phylum **Cnidaria**: **a, Pôlyp** and **Medusoid** forms. Class **Hydrozoa**: **b,** *Hydra* with **bud; c,** *Physalia* (Portuguese man-of-war); **d,** *Obelia*; **e,** *Gonionemus*.

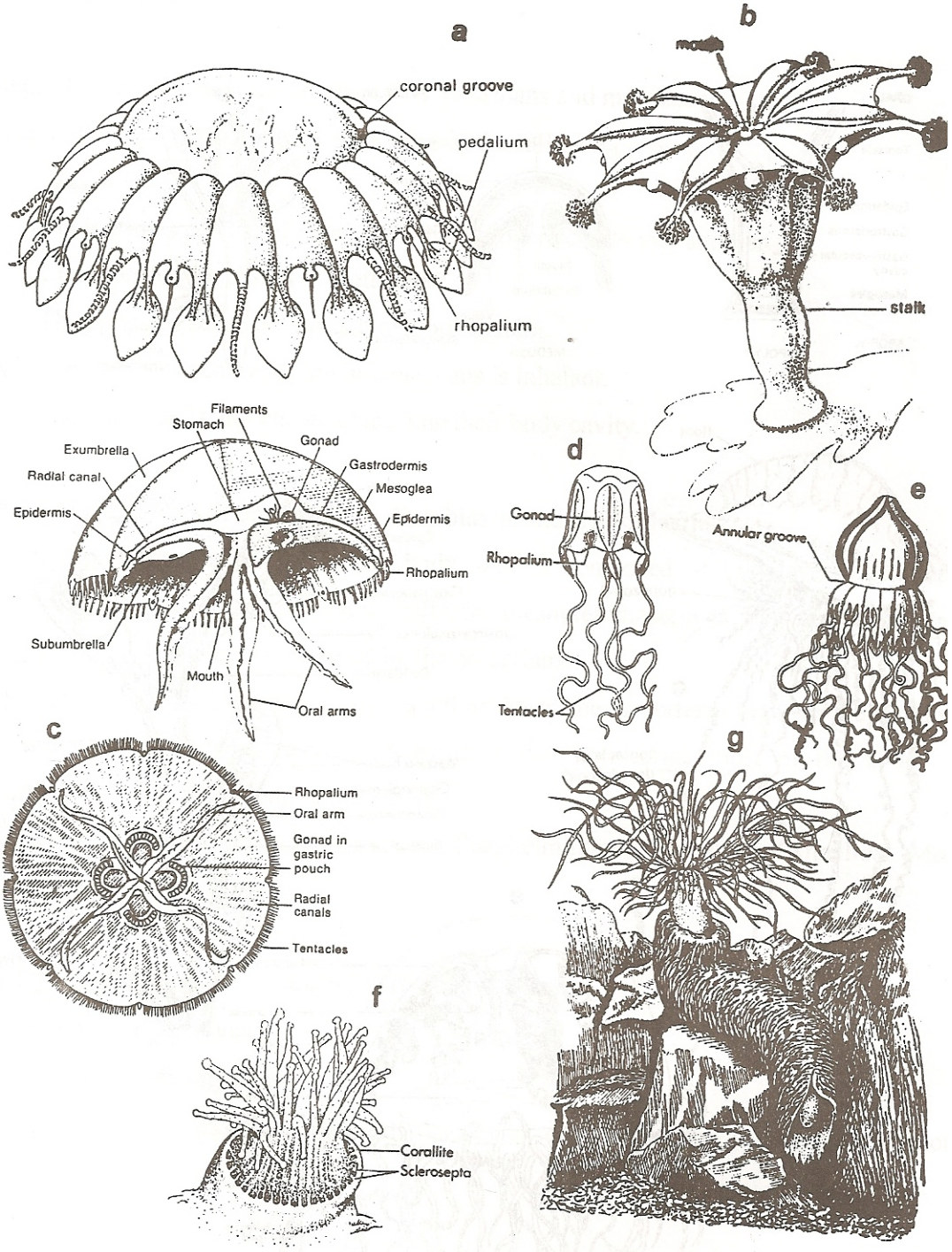

Fig. 2.5. Class **Scyphozoa**: **a,** *Nausithoe*; **b,** *Haliclystus*; **c,** Part Internal view of *Aurelia* (top), ventral view (bottom); **d,** *Charybdea*; **e,** *Periphyla*. Class **Anthozoa**: **f,** *Astrangia*; **g** *Actinaria*.

4.0 Conclusion

Like the sponges, the metazoans are multicellular organisms but unlike the sponges, their cells are organized into tissues and organs. There are two levels of organization among the metazoans, namely, diploblastic and triploblastic.

5.0 Summary

- In this lecture unit, we have learnt that:
- the Metazoa is a group of multicellular animals other than the parazoans and mesozoans. Like the sponges, the metazoans are multicellular organisms but unlike the sponges, their cells are organized into tissues and organs.
- there are two levels of organization among the metazoans, namely, diploblastic and triploblastic. The cnidarians are sedentary or free-swimming diploblastic animals that exhibit polymorphism. They have a body cavity (enteron) that has a single opening to the exterior.
- the opening is surrounded by tentacles. The group is divided into the classes: Hydrozoa, Scyphozoa and Anthozoa, traditionally.

6.0 Tutor-Marked Assignment (TMA)

- In what ways are the metazoans different from the parazoans?
- State the differences between diploblastic organisms and triploblastic organisms.

7.0. References/Further Readings

Barnes, R.S.K., Calow, P. and Olive, P.J.W. (1989). *The Invertebrates: A new Synthesis*. 582pp. (London, Blackwell Scientific Publications; Hong Kong, Holt-Saunders).

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Unit 5: The phylum Cnidaria

1.0 Introduction

In the previous lecture, we had an overview of the metazoans. Cnidaria, Platyhelminthes and Nematoda are lower invertebrate members of the Metazoans.

During this lecture, we shall examine the characteristics of the different classes of the Cnidaria. The name Cnidaria comes from the Greek word "cnidos," which means stinging nettle. Casually touching many cnidarians will make it clear how they got their name when their nematocysts eject barbed threads tipped with poison.

The phylum Cnidaria is a diverse group of very simple-bodied animals includes corals, sea anemones, hydras, jellyfishes, and their relatives. About 9,000 living species are known. The Cnidaria are the simplest Metazoa, and do not even possess organs. All they have is a stomach and a mouth surrounded by tentacles.

2.0 Objectives

At the conclusion of this lecture, the student should be able to:

- ❖ understand the characteristics of the different members of the cnidarians.
- ❖ Classify the Cnidarians.

3.0 Main Content

3.1 Diversity of the Cnidarians

- o Cnidarians are incredibly diverse in form, as evidenced by colonial siphonophores, massive medusae and corals, feathery hydroids, and box jellies with complex eyes.
- o Yet, these diverse animals are all armed with stinging cells called nematocysts. Cnidarians are united based on the presumption that their nematocysts have been inherited from a single common ancestor.
- o Many thousands of cnidarian species live in the world's oceans, from the tropics to the poles, from the surface to the bottom. Some even burrow. A smaller number of species are found in rivers and fresh water lakes.

3.2 Classification of the Cnidarians

There are four main groups of cnidarians, Hydrozoa, Cubozoa, Scyphozoa and Anthozoa.

3.2.1 Class Hydrzoa

- They are the most diverse group of cnidarian with siphonophores, hydroids, fire corals, and many medusae;

- They have the polyp and medusa forms in their life cycle.
- The polyp is the predominant stage while the medusa is the simple stage.
- They reproduce by alternation of the asexual and sexual phases of their life cycles. e.g. *Hydra, Obelia, Physalia* (Portuguese man-of-war), *Bougainvillea* etc.

3.2.2 Class Scyphozoa

The Scyphozoa are considered the true jellyfish.

- In this class, the polyp stage may either be reduced to a small larva or it may be absent; if present, it gives rise to medusae by transverse fission.
- They lack a gullet.
- Nematocysts are present in the ectoderm.
- They are exclusively marine.
- e.g. *Aurelia* (jelly fish), *Pelagia* etc.

3.2.3 Class Anthozoa

- They are exclusively marine cnidarians.
- They constitute the largest class.
- They occur only as polyps.
- Nematocysts are present in the endoderm.
- E.g. Actinia (sea anemone), Astrangia (coral), and sea pens etc.

3.2.4 Class Cubozoa.

They are referred to as the amazing box jellies with complex eyes.
They produce potent toxins

4.0 Conclusion

There are four major groups of cnidarians: These are Anthozoa, which includes true corals, anemones, and sea pens; Cubozoa, the amazing box jellies with complex eyes and potent toxins; Hydozoa, the most diverse group with siphonophores, hydroids, fire corals, and many medusae; Scyphozoa, the true jellyfish.

5.0 Summary

In this lecture unit it has been shown that:

- ✓ The cnidarians are sedentary or free-swimming diploblastic animals that exhibit polymorphism.
- ✓ They have a body cavity (enteron) that has a single opening to the exterior.
- ✓ The opening is surrounded by tentacles.
- ✓ The group is divided into the classes: Hydrozoa, Scyphozoa and Anthozoa, traditionally.

6.0 Tutor-Marked Assignment (TMA)

- Give an outline classification of the cnidarians.
- Give two distinguishing features of each class.

7.0. References/Further Readings

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MODULE 3: STRUCTURE AND LEVELS OF ORGANIZATION OF THE PLATYHELMINTHES

Unit 1: The Phylum Platyhelminthes

1.0 Introduction

In the last lecture unit, we examine the characteristics of the four major groups of cnidarians. The members are all armed with stinging cells called nematocysts. Cnidarians are united based on the presumption that their nematocysts have been inherited from a single common ancestor.

In this lecture unit, we shall have an overview and study the general characteristics of the phylum platyhelminthes. The platyhelminthes (flatworms) are bilaterally symmetrical and triploblastic i.e. composed of three fundamental cell layers. They have no body cavity other than the gut (and the smallest free-living forms may even lack that!) and lack an anus; the same pharyngeal opening both takes in food and expels waste.

2.0 Objectives

At the conclusion of this lecture, the student should be able to:

- ❖ understand the characteristics of the different members of the platyhelminthes.
- ❖ classify the platyhelminthes.

3.0 Main Content

3.1 An Overview of the Platyhelminthes

- The platyhelminthes are the simplest animals that are bilaterally symmetrical and triploblastic (composed of three fundamental cell layers). They are flatworms lacking body cavity other than the gut (and the smallest free-living forms may even lack that) and lack an anus; the same pharyngeal opening both takes in food and expels waste. Because of the lack of any other body cavity, in larger flatworms the gut is often very highly branched in order to transport food to all parts of the body.
- The lack of a cavity also constrains flatworms to be flat; they must respire by diffusion, and no cell can be too far from the outside, making a flattened shape necessary.

- Flatworms were once divided into three groups. The mostly free-living Turbellaria include the planarian, Dugesia; these are found in the oceans, in fresh water, and in moist terrestrial habitats, and a few are parasitic.
- The Trematoda, or flukes, are all parasitic, and have complex life cycles specialized for parasitism in animal tissues. Members of one major taxon of flukes, the Digenea -- which includes the human lung fluke which passes through a number of juvenile stages that are parasitic in one, two, or more intermediate hosts before reaching adulthood, at which time they parasitize a definitive host.
- The Cestoda, or tapeworms, are intestinal parasites in vertebrates, and they also show anatomical and life history modifications for parasitism.

- It now seems likely that the first two of these groups are paraphyletic; that is, they contain some but not all descendants of a common ancestor.

- Recent molecular studies suggest that the Platyhelminthes as a whole, may even be polyphyletic, having arisen as two independent groups from different ancestral groups.

- If this latter view is correct, then most of the flatworms may belong to the Lophotrochozoa, a large group within the animal kingdom that includes molluscs and earthworms, while the rest belong near the base of animal diversity.

- Platyhelminths have practically no fossil record. A few trace fossils have been reported that were probably made by platyhelminths, and fossil trematode eggs have been found in Egyptian mummies and in the dried dung of Pleistocene ground sloth. Trematode larvae that parasitize molluscs may leave pits or thin spots on the inside of the shell, and these pits may be recognized on fossil shells. If the mollusc is irritated by the presence of trematode larvae, it may be able to surround them with layers of shelly material - and thus do parasites become natural pearls.

3.1.1 General Characteristics of the Platyhelminthes

- These are flatworms because they are dorso-ventrally flattened.
- Many of the most important morphological features found in complex higher animal groups were first observed in the flatworms. These features include:
  - Cephalization and bilateral symmetry.
  - Triploblastic organization.
  - Organ-system level of organization.
- They are acoelomates i.e. the mesoderm is solid with no space between the ectoderm and the gut.
- They possess a central nervous system.
- They lack blood vascular (circulatory) and respiratory systems.
- Respiration and excretion are mainly by diffusion through the body surface.
- They possess a unique excretory and osmoregulatory system of branched protonephridial tubes that end in flame cells.

- The gut (when present) has only one opening, the mouth; no anus.
- They are hermaphrodites.

4.0 Conclusion

The platyhelminthes are commonly called flatworms. Some of the most important features of the higher animals such as cephalization, bilateral symmetry, possession of a central nervous system and triploblastic organization, were first observed in this group. The phylum contains four classes: the Turbellaria (free-living), and, the Monogenea, Trematoda and Cestoidea (parasites).

5.0 Summary

We have studied in this unit that:

- The Platyhelminthes are bilaterally symmetrical and triploblastic organisms i.e. composed of three fundamental cell layers.

- They are the flatworms with no body cavity other than the gut, and lack an anus; the same pharyngeal opening both takes in food and expels wastes.

6.0 Tutor-Marked Assignment (TMA)

- List some of the important morphological features of higher animals that were first observed in the platyhelminths.
- Outline the differences between paraphyletic and polyphyletic.

7.0 References/Further Readings

Barnes, R.S.K., Calow, P. and Olive, P.J.W. (1989). *The Invertebrates: A new Synthesis*. 582pp. (London, Blackwell Scientific Publications; Hong Kong, Holt-Saunders).

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Unit 2: The Turbellaria.

1.0 Introduction

In the last lecture unit, we had an overview and studied characteristics of the platyhelminthes. The members are bilaterally symmetrical and triploblastic (composed of three fundamental cell layers). Platyhelminthes have no body cavity other than the gut (and the smallest free-living forms may even lack that) and lack an anus; the same pharyngeal opening both takes in food and expels wastes. The phylum is divided into four classes, which are Turbellaria, Monogenea, Trematoda and Cestoidea.

During this lecture, we shall examine the classification and characteristics of the class Turbellaria and class Monogenea. The Turbellarians are a large class of ribbon-shaped flatworms found primarily on the bottoms of oceans. While most are drably colored, some marine species are vivid and brilliantly patterned. The Monogeneans are parasitic flatworm that spends its entire life cycle on the outside of the same fish.

2.0. Objectives

At the conclusion of this lecture, the student should be able to:

- ❖ understand the general characteristics of the members of the class Turbellaria and Monogenea.
- ❖ Classify the Turbellaria and Monogenea.

3.0 The main content

3.1 Structure and characteristics of the Turbellarians

- o The Turbellarians are a group of flatworms known for their remarkable ability to regenerate lost body parts. Most species are free-living and aquatic, and feed on small invertebrates or dead organisms. The few land-dwelling species are restricted to moist environments. Turbellarians probably gave rise to the parasitic flatworm classes, the tapeworms and the flukes.

- Turbellarian species vary greatly in size from microscopic up to 60 cm (24 in) in length, although most are less than 1 cm (0.4 in). They have no need for a circulatory system (to distribute food or oxygen) or an excretory system (to remove wastes). Rather, the flattened shape permits direct exchange of oxygen and wastes between the body cells and the aquatic environment.
- The mouth is on the underside of the body and leads to the pharynx and gut. Turbellarians are classified according to the shape of the gut: simple and saclike, branched, divided, three-lobed, or entirely absent. A primitive brain and sense organs are located in the head. Two or more eyespots can sense light, and there are cells in the head specialized for sensing chemicals, touch, and water current. The body is covered with moving, hairlike structures, or *cilia*, especially on the underside. The cilia are used in movement and are aided by cells called *rhabdoids* that secrete a mucous blanket on which the worm glides. Muscular motions also assist in movement.
- Generally, the class Turbellaria lack cuticle, and suckers are rarely present. e.g. Dugesia, etc. (Fig. 2.6).
- Turbellarians are simultaneous hermaphrodites, meaning that they can produce both eggs and sperm at the same time. A single individual cannot fertilize itself; instead, mating is reciprocal, with each of two individuals exchanging both eggs and sperm. Reproduction may also be asexual, by splitting or fission. Environmental conditions such as light and temperature influence whether reproduction will be sexual or asexual.
- Substances are produced in the brain that inhibit head formation and promote tail formation. These substances are strongest near the head and become weaker towards the tail. When the body is cut, the concentration of the substance provides each body piece with information on where it originated. For example, if a planarian is cut in half crosswise, the head end will regenerate a new tail, and the tail end will regenerate a new head. If the head end is sliced lengthwise, each half will generate the missing half, resulting in a two-headed individual.

3.2 Classification of Turbellaria

Turbellarians make up the class Turbellaria in the flatworm phylum, Platyhelminthes. The planarian belongs to the genus *Dugesia*.

3.3 General Characteristics of the Monogenea (Fig. 2.6)

- They are mostly ectoparasites of fish, turtles and amphibians.
- A few are endoparasitic.
- They have simple life-cycles and have only one host.
- Possess hooked attachment structures.
- The large posterior attachment structure is called the haptor.
- e.g. *Polystoma sp., Macrogyrodactylus sp., Dactylogyrus sp., Gyrodactylus sp., Diplozoon sp.,* etc.

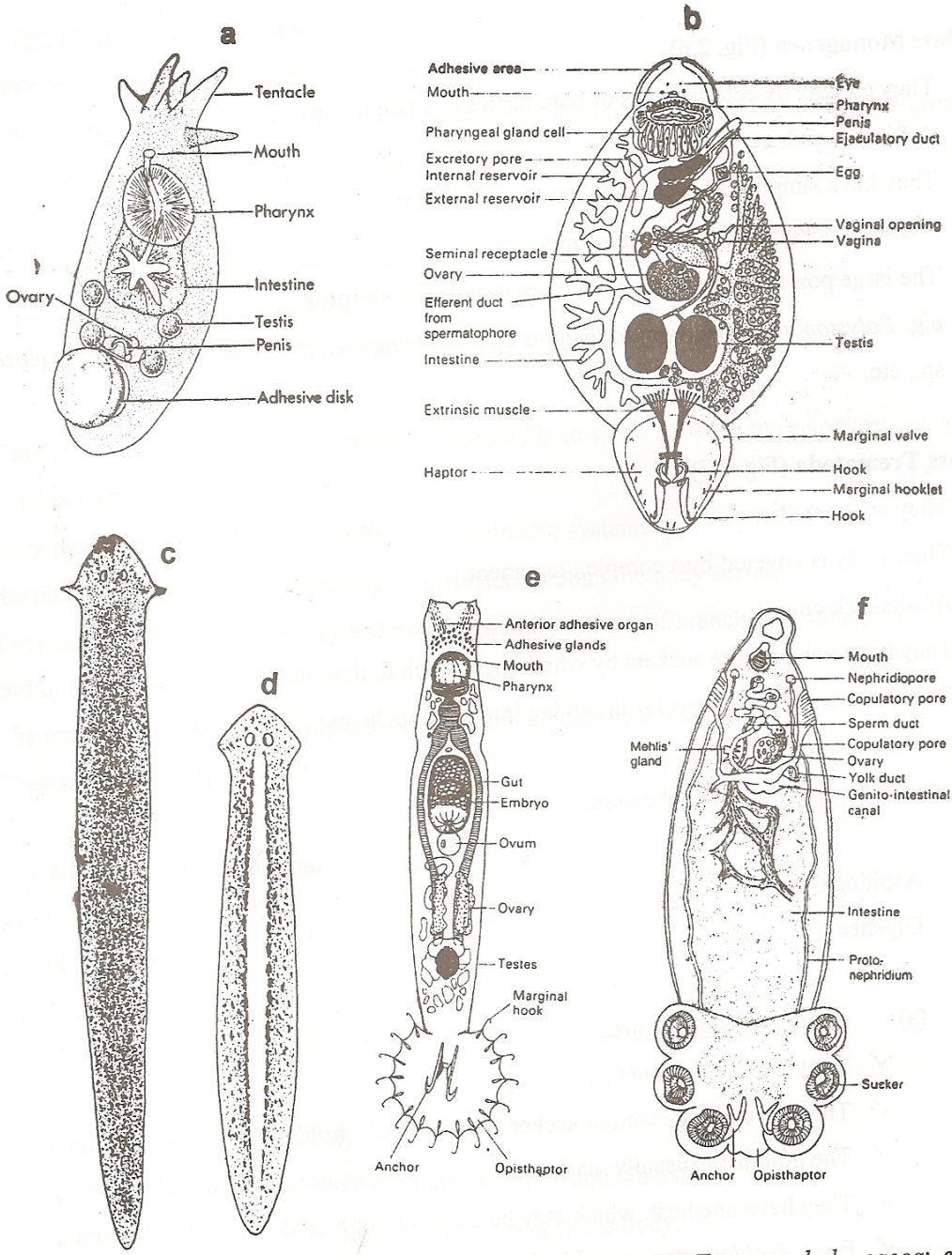

Fig. 2.6. Phylum **Platyhelminthes**: Class **Turbellaria**: **a,** *Temnocephala caeca*; **c, d,** Tw species of *Dugesia*; Class **Monogenea**: **b,** *Entobdella soleae*; **e,** *Gyrodactylus* (opisthaptor haptor); **f,** *Polystoma* (opisthaptor = haptor).

4.0 Conclusion

The Turbellarians are a group of flatworms known for their remarkable ability to regenerate lost body parts. Most species are free-living and aquatic, and feed on small invertebrates or dead organisms. The few land-dwelling species are restricted to moist environments. Turbellarians probably gave rise to the parasitic flatworm classes, the tapeworms and the flukes. The Monogenans are essentially ectoparasites with hooked attachment structures

5.0 Summary

We have studied in this lecture unit that:

- The Turbellarians are a large class of ribbon-shaped flatworms found primarily on the bottoms of oceans.
- While most are drably colored, some marine species are vivid and brilliantly patterned.
- The Monogeneans are parasitic flatworm that spends its entire life cycle on the outside of the same fish.

6.0 Tutor-Marked Assignment (TMA)

- Compare and contrast the morphological features of the turbellarians and the tapeworms.
- What do you understand by the phrase 'simultaneous hermaphrodites'?

7.0 References/Further Readings

Microsoft ® Encarta ® 2009. © 1993-2008 Microsoft Corporation. All rights reserved.

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- Winnepenninckx, B., T. Backeljau, L. Y. Mackey, J. M. Brooks, R. de Wachter, S. Kumar, & J. R. Garey. 1995. 18S rRNA data indicate that Aschelminthes are polyphyletic in origin and consist of at least three distinct clades. Molecular Biology & Evolution 12(6): 1132-1137.

Unit 3: The Trematoda

1.0 Introduction

In the last lecture, we examined the characteristics of the class Turbellaria and class Monogenea. The Turbellaria are free-living platyhelminthes, found in aquatic habitat. Among other features, they have mucous producing organ referred to as rhabdites, while the Monogeneans are parasitic flatworms that spend their entire life cycle on the outside of the same fish.
During this lecture, we shall be studying the characteristics and the classification of the class Trematoda. The Trematoda is a class within the phylum Platyhelminthes that contains two groups of parasitic worms, commonly referred to as flukes.

2.0. Objectives

By the end of this lecture, the student should be able to:

- ❖ appreciate the general characteristics of the members of the class Trematoda.
- ❖ classify the Trematoda.

3.0 Main Content

3.1 Characteristics of the Trematoda

- ❑ The Trematoda are estimated to include 18,000 to 24,000 species, and are divided into two subclasses. Nearly all trematodes are parasites of mollusks and vertebrates.
- ❑ The smaller Aspidogastrea, comprising about 100 species, are obligate parasites of mollusks and may also infect turtles and fish, including cartilaginous fish.
- ❑ The Digenea, which constitute the majority of trematode diversity, are obligate parasites of both mollusks and vertebrates, but rarely occur in cartilaginous fish.
- ❑ Formerly, the Monogenea were included in the Trematoda on the basis that these worms are also vermiform parasites, but modern phylogenetic studies have raised this group to the status of a sister class within the Platyhelminthes, along with the Cestoda.
- ❑ Almost all trematodes infect mollusks as the first host in the life cycle, and most have a complex life cycle involving other hosts.
- ❑ Most trematodes are monoecious and alternately reproduce sexually and asexually. The two main exceptions to this are the Aspidogastrea, which have no asexual reproduction, and the schistosomes, which are dioecious.
- ❑ In the definitive host, in which sexual reproduction occurs, eggs are commonly shed along with host faeces. Eggs shed in water release free-swimming larval forms that are infective to the intermediate host, in which asexual reproduction occurs.
- ❑ A species that exemplifies the remarkable life history of the trematodes is the bird fluke, *Leucochloridium paradoxum*. The definitive hosts, in which the parasite multiplies, are various woodland birds, while the hosts in which the parasite grows (intermediate host) are various species of snail.

- The adult parasite in the bird's gut produces eggs and these eventually end up on the ground in the bird's faeces. Some very fortunate eggs get swallowed by a snail and here they hatch into tiny, transparent larva (miracidium).
- These larvae grow and take on a sac-like appearance. This stage is known as the sporocyst and it forms a central body in the snail's digestive gland that extends into a brood sac in the snail's head, muscular foot and eye-stalks.
- It is in the central body of the sporocyst where the parasite replicates itself, producing lots of tiny embryos (redia). These embryos move to the brood sac and mature into cercaria.

3.2 Classification of the Trematodes

The class Trematoda contains two subclasses, one of which, the Digenea is a large and successful group with much economic importance to mankind. The second subclass is the Aspidogastrea which are a small group of absolutely no economic importance to mankind at all (Fig. 2.7).

3.2.1 The Digenea

- They are endoparasitic in all groups of vertebrates.
- Suckers are usually two; oral and ventral suckers.
- They have two or more hosts in their life-cycles.
- e.g. *Fasciola hepatica, Fasciola gigantica, Fasciolopsis buski, Schistosoma mansoni, Clonorchis sinensis, Transversotrema,* etc.

3.2.2 The Aspidogastrea

- The Aspidogastrea are an interesting group of about 80 species of parasitic Platyhelminths. They are are all aquatic and as far as we know they all have indirect life cycles, meaning they have more than one host species. Most species use some sort of mollusc or arthropod as the intermediate host and a vertebrate such as a fish or a turtle as the primary host. Some species however reach maturity in the invertebrate host, and it must be remembered that there are a number of species in this group that we know very little about.
- Aspidogastreans have more simple life cycles than their Digenean relatives as they lack the intermediate forms that make Digeneans so prodigious in terms of numbers of young resulting from one egg, for the Aspidogastreans one egg means one larvae and then one adult. They are mostly small animals ranging in size from 1 mm to several cm. They also tend lack much in the way of 'host specificity' meaning they can be infective to a wide range of hosts. They have a large posterior sucker which is used to attach to the host.

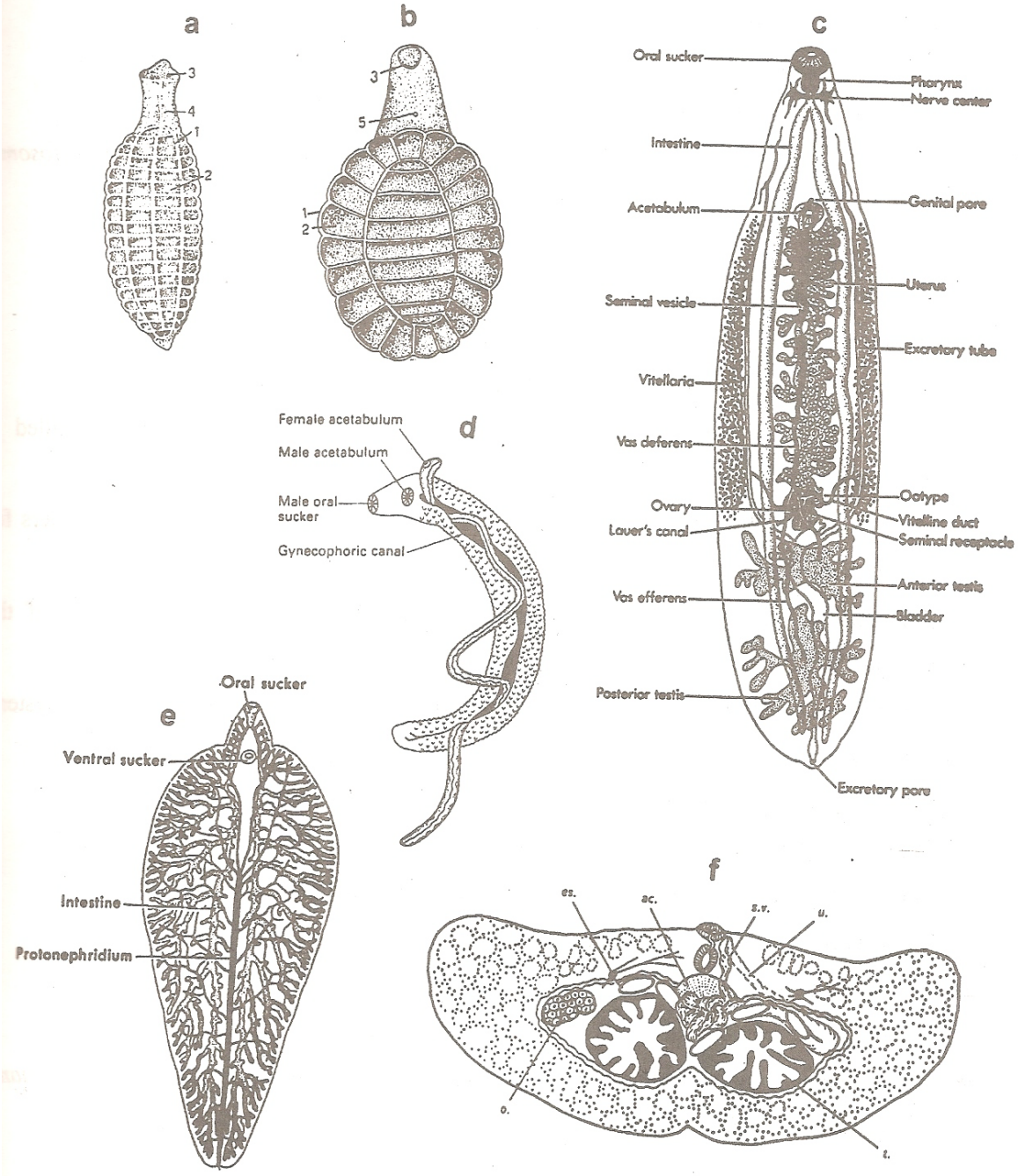

Fig. 2.7. Phylum **Platyhelminthes:** Class **Trematoda**: Subclass **Aspidogastrea**: **a,** *Aspidogaster*; **b,** *Cotylaspis* (1, sucker; 2, alveolus; 3, mouth; 4, pharynx; 5, genital pore). Subclass **Digenea**: **c,** *Clonorchis sinensis* (Chinese liver fluke); **d,** *Schistosoma mansoni*; **e,** *Fasciola hepatica*; **f,** *Transversotrema* (ac, acetabulum/ventral sucker; o, ovary; e.s., eyespot; s.v., seminal vesicle; t, testis; u, uterus).

- Eggs are laid and pass out of the host animal with its faeces. In some species, such as *Amphilina foliacea*, the eggs do not hatch until they are eaten by the intermediate host. In others such as *Austramphilina elongata* they hatch in the water and the larvae swim

4.0 Conclusion

The Trematoda is a class within the phylum platyhelminthes that contains two groups of parasitic worms, commonly referred to as flukes. The smaller Aspidogastrea, comprising about 100 species, are obligates parasites of mollusks and may also infect turtles and fish, including cartilaginous fish. The Digena, which constitute the majority of trematode diversity, are obligate parasites of both mollusks and vertebrates, but rarely occur in cartilaginous fish. Generally, the trematodes body is covered by a complex tegument. The adults lack cilia, and have one or more suckers by which they attach to their hosts. They have complex life cycles involving intermediate hosts.

5.0 Summary

In this lecture unit we have learnt that:

- The class Trematoda contains two subclasses, one of which, the Digenea is a large and successful group with much economic importance to mankind, and are endoparasitic in all groups of vertebrates. They have suckers e.g. *Fasciola hepatic* and *Fasciola gigantic*.
- The second subclass is the Aspidogastrea, which are a small group of absolutely no economic importance. They lack an oral sucker but have a large ventral sucker that is called a holdfast. The holdfast is usually made up of many suckers or several alveoli. They have one host, which may be a mollusc or a cold-blooded vertebrate.

6.0 Tutor-Marked Assignment (TMA)

- Name the types, and state the uses of suckers in the trematodes.
- Compare and contrast the morphological features of the Aspidogastrea and the Digenea.

7.0 References/Further Readings

- Littlewood, D T J; R. A. Bray (2000). "The Digenea". *Interrelationships of the Platyhelminthes*. Systematics Association Special Volume. **60** (1 ed.). CRC. pp. 168–185.
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UNIT 4: Class Cestoidea (Cestoda)

1.0 Introduction

In the last lecture unit, we studied the general characteristics of the members of the class Trematoda and Monogenea. We also classified the Trematoda and the Monogenea.

In this lecture unit, we are going to study the outline classification and characteristics of the members of the Cestoda. Cestodes or tapeworms are the most specialised of the Platyhelminthes parasites. All cestodes have at least one, and sometimes more than one, secondary or intermediate host as well as their primary host.

2.0 Objectives

At the conclusion of this lecture, the student should be able to:

- ❖ understand the characteristics of the class cestoda
- ❖ appreciate the differences between the members of the class cestoda.
- ❖ appreciate the economic importance of the class cestoda.

3.0 Main Content

3.1 Overview of Cestodes

- o Cestodes or tapeworms are the most specialised of the Platyhelminthes parasites. Parasites are animals or plants that live on or in other animals or plants, or hosts, without helping them and usually harming them.
- o All cestodes have at least one, and sometimes more than one, secondary or intermediate host as well as their primary host. While the intermediate hosts are often invertebrates of some sort, the primary host is normally a vertebrate.
- o In some cases both hosts are vertebrates, as in the common Beef Tapeworm *Taenia saginatus*, and in a few species there may be only a single host.
- o A number of tapeworms include humans in their life cycles but infection is not normally a serious health problem and can be cured.
- o There are more than 1,000 species of tapeworms known to science, and nearly every species of vertebrate is liable to infection from at least one species of tapeworm.
- o All of the known species of tapeworms are endoparasites.

3.2 Physical Characteristics of Cestodes

- ♦ Commonly called tapeworms.
- ♦ They are endoparasitic and their adults live in the gut of vertebrates.
- ♦ Body is typically elongated, tape-like and segmented; each segment is called a proglottis/proglottid (Fig. 2.8).

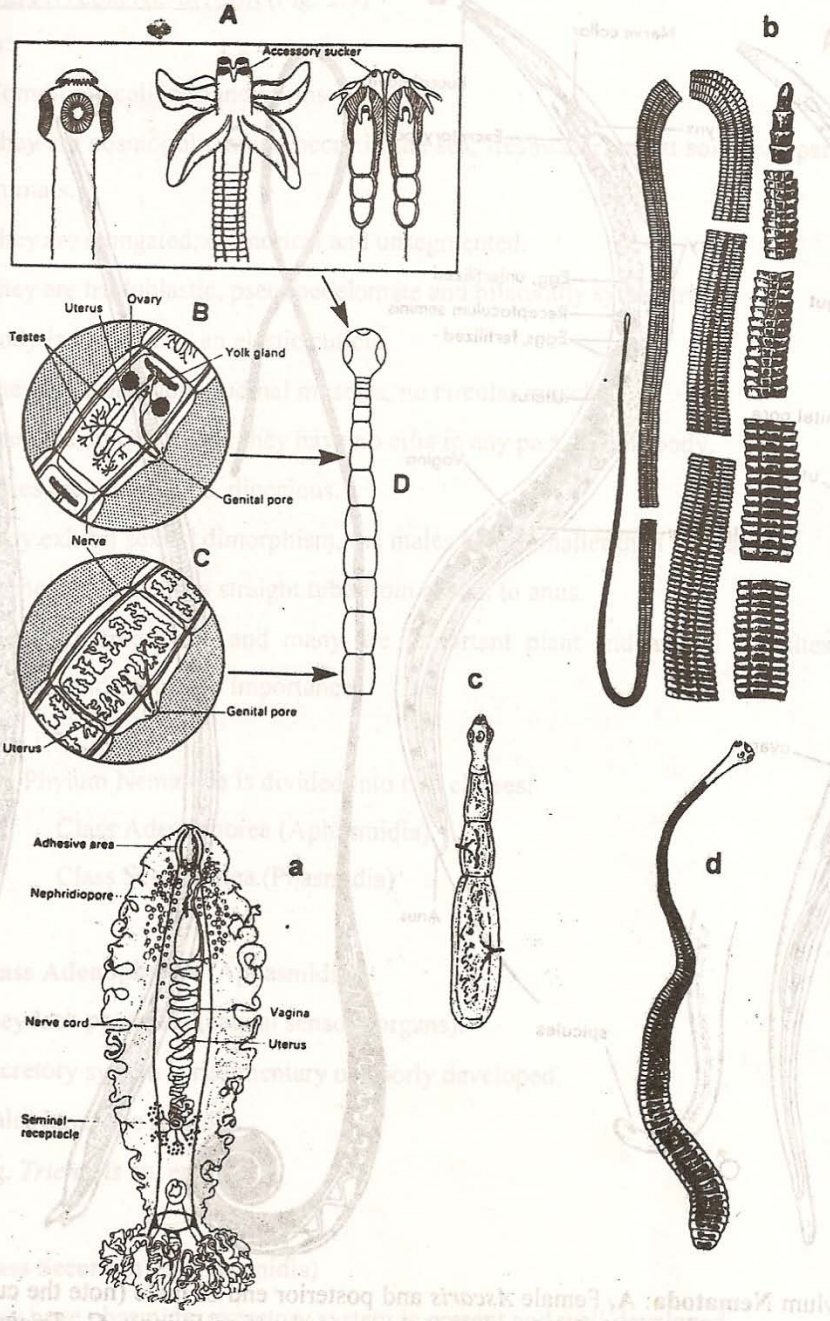

Fig. 2.8. Phylum **Platyhelminthes**: Class **Cestoidea**: **A.** The general body form of cestodes showing three different types of scolices/scolexes; **B.**, **C.**, Details of the regions indicated in **D.** **a,** *Gyrocotyle*, (cestodarian); **b,** *Diphyllobothrium latum*; **c,** *Echinococcus granulosus*; **d,** *Hymenolepis nana.*

- They have a head region known as the scolex, which mostly bears hooks and suckers for attachment to the host.
- The anterior proglottides close to the scolex are young without complement of the reproductive system.
- The middle proglottides are mature and have full complement of the reproductive system, while the posterior segments are gravid and contain ripe eggs.
- Each proglottis contains a complete set of male and female reproductive organs.
- They have no mouth and no digestive system.
- They absorb digested food from the intestine of their host through the body surface.
- Their bodies are covered by a thick cuticle.
- No cilia in adults.
- Life-cycle is complex and involves intermediate hosts.
- E.g. *Taenia solium, Taenia saginata, Echinococcus granulosus, Hymenolepis nana, Diphyllobothrium latum,* etc.
- The body of most tapeworms is flat and much longer than it is wide, so that it looks like a tape or ribbon. The length varies from 0.02 inch (0.6 millimeter) to 98 feet (30 meters), the longest worms being found in sperm whales.
- Tapeworms are parasites that have no head, mouth, or digestive system. Parasites are animals or plants that live on or in other animals or plants, or hosts, without helping them and usually harming them.
- Tapeworms have a body covering through which they absorb nutrients from the host's intestine. This covering also protects the worms from the host's immune reactions and digestive acids. Tapeworms are whitish and as internal parasites they live in darkness.
- The body of tapeworms has three regions: scolex, neck, and strobila. The scolex is the head. It has spines, hooks, suckers, tentacles, glands releasing sticky secretions, or a combination of these structures that the worm uses to attach itself to the inner wall of the intestine of the final host, also called the primary host.
- Suckers are the most common attachment tool. Suckers are usually cup shaped and have powerful muscular walls. The neck is the region of the body just behind the scolex. It is usually short.
- The strobila is behind the neck. It consists of a row of segments called proglottids. The strobila is made up of anywhere from a few to more than one thousand proglottids but usually contains several dozen.
- Each proglottid starts development at the neck, and proglottids form one by one throughout the life of the tapeworm in the final host. Just behind the neck, the proglottids are short and narrow. When a new proglottid forms at the neck, already formed proglottids are pushed toward the rear, grow, and eventually contain the reproductive organs.
- Behind the new proglottids, each strobila contains the following types of proglottids, from front to back: premature proglottids, with the beginnings of reproductive organs; mature proglottids, which contain functioning male and female reproductive organs; postmature proglottids, which contain developing eggs; and gravid proglottids, which contain ripe eggs.

- ♦ The gravid proglottids at the end of the worm break off and pass into the environment with the host's feces. A few species of tapeworms have no proglottids.

3.3 Classification and Characteristics of Cestoda

- o The Class Cestoda is divided into two subclasses, the Cestodaria and the Eucestoda. The Eucestoda contains all the animals we usually think of as tapeworms.
- o The Cestodaria contains only a few species of unusual worms, their bodies are unsegmented and roughly oval in shape, they have only one set of reproductive organs and the larvae have 10 hooks for attachment.
- o The class Eucestoda contains very few species that do not conform to the standard tapeworm body plan. The larvae have 6 attachment hooks. The adult body consists of a head, called a 'Scolex' which is distinguished by the presence of suckers and hooks, though the hooks may be absent as in *Taenia saginatus.*
- o Because they live in darkness there are no eyes, and because they do not feed in the usual manner there is no mouth. Behind the scolex is a band of rapidly growing material that produces an endless series of reproductive segments called 'Proglottids'.
- o The proglottids contain both male and female reproductive organs, making the tapeworms hermaphrodites.
- o The male organs mature before the female ones. In some species such as the Fish Tapeworm (*Diphyllobothrium latum*)can reach 20 metres in length, contain 3,000 proglottids and produce millions of eggs every day.
- o Within the Subclass Eucestoda those species which infect mankind can be found in two orders, Pseudophyllidea and Cyclophyllidea which can be recognised by their different life cycles.

4.0 Conclusion

The cestodes, or tapeworms are endoparasitic. Their adult live in the gut of the vertebrates, and lack cilia and their surface is a tegument (as in monogeneans and trematodes), but in cestodes the tegument is covered with tiny projections, microvilli, which increase its surface area and thereby its ability to absorb nutrients from a host.

5.0 Summary

In this lecture unit, we have learnt that:

- ▪ The cestodes (tapeworms) differ in a number of ways from other flatworms.
- ▪ Their bodies are long and flat, made up of many segments called proglottids, which are the reproductive units of the cestodes.
- ▪ Digestive tracts are absent completely. At the tapeworm's anterior end is a specialized segment called a scolex, which is usually covered with hooks or suckers and serves to anchor it to the host.

6.0 Tutor-Marked Assignment (TMA)

- How do tapeworms feed? Give reasons for your answer.
- Compare and contrast the morphological features of the Cestodaria and the Eucestoda.

7.0 References/Further Readings.

1. Hickman, C.P. and L. S. Roberts (1994). Animal Diversity. Wm. C. Brown, Dubuque, IA.
2. Chandler, A.C. (1961). Introduction to Parasitology. John Wiley and Sons, New York.
3. Brusca, R. C., and G. J. Brusca (1990). Invertebrates. Sinauer Associates, Sunderland, MA.

Unit 5: The Phylum Nematoda

1.0 Introduction

In the last lecture unit, we studied the general characteristics of the members of the class Cestoda. We also studied the characteristics of the two subclasses of Cestoda.

In this lecture unit, we shall be looking at classification and characteristics of the members of the Phylum Nematoda, and outline the economic importance of the nematodes. The nematodes are bilaterally symmetrical, worm-like organisms that are surrounded by a strong, flexible noncellular layer called a cuticle. Their body plan is simple.

2.0 Objectives

By the end of this lecture unit, the student should:

- understand the basis of the classification of the phylum nematoda.
- become familiar with the names and features of members of phylum Nematoda

3.0 Main content

3.1 General Characteristics of the Nematodes

- ♦ The name Nematode means, "thread form". The nematodes are also known as round worms. These animals have a cylindrical tapered bodies and range is length from few millimeter to a meter and live in diverse habitats.
- ♦ Free-living nematodes eat microorganisms; other nematodes may feed on decaying organic material. Vinegar eel is a common free-living nematode. All roundworms have a bilateral symmetry and a mouth and an anus.
- ♦ The parasitic species are: pinworms, hookworms, heartworms (in dogs), and Ascaris (intestinal roundworm). Humans can contract parasitic worms by eating under cooked beef or pork.
- ♦ Nematodes are bilaterally symmetrical, and are surrounded by a strong, flexible noncellular layer called a cuticle. Their body plan is simple. The cuticle is secreted by and covers a layer of epidermal cells. Near the body wall but under the epidermal cells are muscle cells; they run in the longitudinal direction only (Fig. 2.9)

- ♦ A true coelom is lacking, instead, nematodes have a "pseudocoel" formed directly from the cavity of the blastula (rather than as a result of the division or folding of mesoderm). The cavity of the pseudocoel is small, being mostly filled with an intestine and oviducts or testes.
- ♦ A simple nervous system consists of a ring of nervous tissue around the pharynx that gives rise to dorsal and ventral nerve cords running the length of the body.

- ♦ Nematodes move by contraction of the longitudinal muscles. Because their internal pressure is high, this causes the body to flex rather than flatten, and the animal moves by thrashing back and forth. No cilia or flagellae are present.
- ♦ Some nematodes have specialized cells that excrete nitrogenous wastes; in others, canals or canals plus these specialized cells are present. Nematodes do not have flame cells.
- ♦ Most nematodes are dioecious. Fertilization takes place when males use special copulatory spines to open the females' reproductive tracts and inject sperm into them. The sperm are unique in that they lack flagellae and move by pseudopodia, like amoebas. Development of fertilized eggs is usually direct.
- ♦ Nematodes are almost unbelievably abundant. One study reported around 90,000 individual nematodes in a single rotting apple. Another reported 236 species living in a few cubic centimeters of mud.
- ♦ The number of described species is around 12,000, but too little attention has been paid to these animals and the true number may be closer to 500,000. Some species are generalists, occuring across wide areas and in many habitats; others are much more specialized.

3.2 Classification and features of members of the Phylum Nematoda.

The Phylum Nematoda is divided into two classes:

- ✓ Class Adenophorea (Aphasmidia)
- ✓ Class Secernentea (Phasmidia)

3.2.1 Class Adenophorea (Aphasmidia)

- They lack phasmids (caudal sensory organs).
- Excretory system is rudimentary or poorly developed.
- Males have one spicule.
- E.g. Trichuris sp. etc.

3.2.2 Class Secernentea (Phasmidia)

- They have phasmids; excretory system is present and well developed.
- Males have two spicules.
- *E.g. Rhabditis, Wuchereria, Onchocerca spp.,* etc.

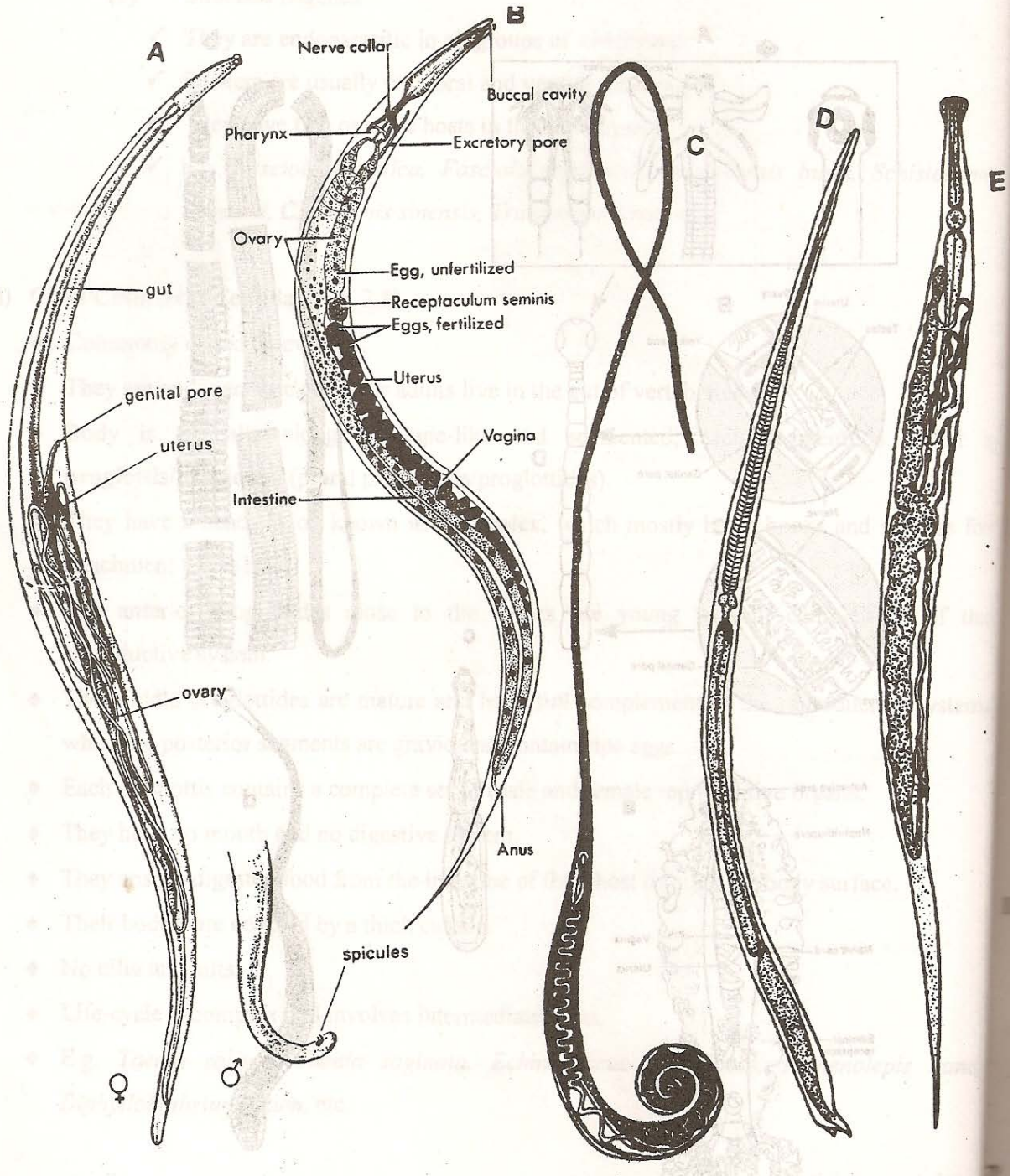

Fig. 2.9. Phylum **Nematoda**: **A,** Female *Ascaris* and posterior end of male (note the curvature and copulatory spicules); **B,** *Rhabditis*, a typical nematode (free-living); **C,** *Trichuris*; **D,** *Trichinella spiralis*; **E,** *Enterobius vermicularis* (female).

3.3 Economic importance of Nematodes

- Nematodes have colonized nearly every conceivable habitat on earth, including such unlikely places as under beer coasters in Germany (*Panagrellus redivivus*).
- Some nematodes are also extreme habitat specialists, living, for example, only in the placentas of sperm whales (*Placentonema gigantissima*), or the right kidneys of minks (*Dioctophyme renale)*
- Many nematodes are free living and play critical ecological roles as decomposers and predators on microorganisms.
- Nematodes also include parasitic species, a number of which affect humans directly or indirectly through their domestic animals.
- These include the common roundworms, which probably infest more than half the world's humans; hookworms; trichina, the worms that cause trichinosis; pinworms, another extremely common parasite, which can be transmitted from human to human by eggs floating in household dust; and filarial worms, primarily tropical parasites that cause diseases such as filariasis (elephantiasis) and onchocerciasis (river blindness).

4.0 Conclusion

The nematodes, also called roundworms, are elongated, cylindrical, unsegmented worms. They are cosmopolitan and are made up of parasitic and free-living species. The phylum contains two classes, Adenophorea (Aphasmidia) and Secernentea (Phasmidia). The two classes are separated on the basis of the presence or absence of phasmids.

5.0 Summary

- The nematodes are cosmopolitan and occur in the sea, freshwater, moist soil or as parasites in plants and animals.
- They are elongated, cylindrical, unsegmented, triploblastic, pseudocoelomate and bilaterally symmetrical. Body is covered by an elastic cuticle.
- They have only longitudinal muscles, no circular muscles, and are unique in that they have no cilia in any part of their body.
- Sexes are separate i.e. dioecious. They exhibit sexual dimorphism, the males being smaller than the females.
- Alimentary canal is a straight tube from mouth to anus. Some are free-living and many are important plant and animal parasites and are of great medical and economic importance.

6.0 Tutor Marked Assignment (TMA)

- Name the classes of the Phylum Nematoda.
- On what basis are the classes separated?
- Write briefly on the economic importance of nematodes.

7.0 References/Further Readings

Hickman, C.P. and L. S. Roberts. 1994. *Animal Diversity*. Wm. C. Brown, Dubuque, IA.

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