

EXERCISE 21 ECHINODERMATA : OBSERVATION AND CLASSIFICATION OF SPECIMENS AND STUDY OF ONE REPRESENTATIVE LARVA

Structure

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21.1 INTRODUCTION

This lab exercise is based on unit 6, (section 6.3) Block 2 of the LSE-10 course which dealt with phylum Echinodermata. You will recall that Phylum Echinodermata includes spiny skinned animals which are exclusively marine (**Gr. echinus**: spiny; **derma**: skin). They have the following characters which are not found in animals belonging to any other phylum:

- i) Bilaterally symmetrical larvae but radially symmetrical adults. Thus they exhibit secondarily pentamerous, radial symmetry found in adults.
- ii) A skeleton made of calcareous plates or ossicles, bearing projecting spines.
- iii) Small pincer-like bodies present among plates called **pedicellariae**.
- iv) Organs called "tube feet" or **podia** responsible for locomotion.

You shall be able to see the above-mentioned features when you handle echinoderms. Echinoderms also possess certain unique features which can be seen after dissecting the animals. These features are:

- (i) a system of coelomic channels forming a water vascular system with external tubular projections used in feeding and locomotion.
- (ii) a blood lacunar system called the haemal system.

In this exercise you will study the type specimens of Phylum Echinodermata and the bipinnaria larva which occurs in the life-cycle of echinoderms

Objectives

After performing this exercise you should be able to:

- identify and give the scientific and common names of *Antedon*, *Asterias*, *Ophiura*, *Echinus*, *Holothuria*.
- classify the identified Echinoderms up to the level of classes and list characters justifying their classification and mention special features, if any
- differentiate between stalked and unstalked echinoderms.
- relate the structure of echinoderms with their habitat, which is the deep sea.
- mention habitat and geographical distribution of identified echinodermata genera.
- draw labelled diagrams of the identified genera of echinoderms.
- identify, describe and draw labelled diagram of bipinnaria larva of *Asterias* from permanent slide.

21.2 MATERIAL REQUIRED

1. Preserved specimens of *Antedon*, *Asterias*, *Ophiura*, *Echinus* and *Holothuria*.
2. Permanent slide of bipinnaria larva.
3. Compound microscope.
4. Drawing sheets, pen, pencil, ruler, eraser.

21.3 SCHEMATIC CLASSIFICATION AND FEATURES OF PHYLUM ECHINODERMATA

Before you proceed with the practical on Echinodermata let us refresh your knowledge about classification of this phylum.

21.3.1 Position of Echinodermata

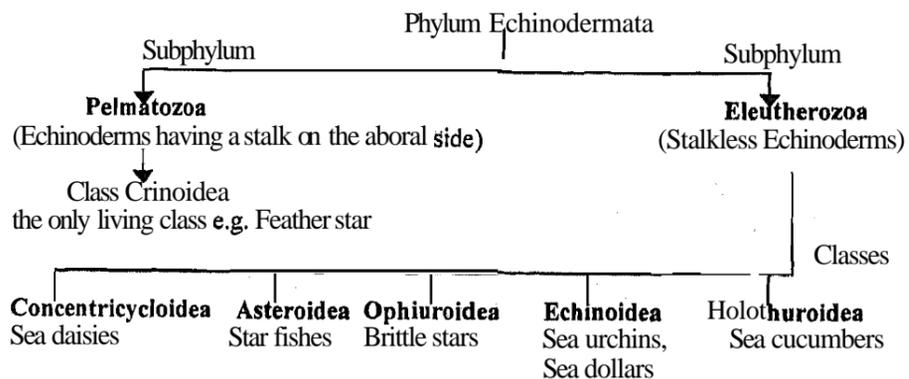
Classification with its Justification

Kingdom	Animalia	Animals, multi-cellular organisms with cells that lack a cell wall, many capable of movement or movement of some of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Sub-kingdom	Eumetazoa	Animals with tissues and organs.
Grade I	Bilateria	Bilateral animals
Division	Deuterostomia	Cleavage is radial and usually indeterminate, mouth arising some distance interiorly from blastopore. Mesoderm and coelom develop primitively from out-pocketings of the primitive gut.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates.

21.3.2 General Features of Echinoderms

- (i) Body exhibits radial symmetry.
- (ii) Animals shows pentamerous organization of different parts, that is, parts are arranged in multiples of five.
- (iii) A distinct anterior end or head is absent.
- (iv) The surface of the body bearing the mouth is termed the oral surface. The opposite surface is called aboral surface. In the natural position, the aboral surface is directed upwards and the oral surface downwards.
- (v) The radii along the arms are termed ambulacra and the alternating interradii are termed adambulacra (singular : adambulacrum).
- (vi) The tube feet are present,
- (vii) The calcareous plates are present.

21.3.3 Further Classification of Phylum Echinodermata



21.3.4 Distinguishing Features of Subphyla – Pelmatozoa and Eleutherozoa

The Phylum Echinodermata is divided into two subphyla, the Pelmatozoa and Eleutherozoa. The distinguish features of these phyla are given in table 21.1

Table 21.1: Main features of subphyla Pelmatozoa and Eleutherozoa

PELMATOZOA	ELEUTHEROZOA
Body is in form of cup or calyx, borne on aboral stalk during part or all of life;	Members of this group are free and not bound. Body is star-shaped;
Oral surface is directed upward;	Oral surface directed towards substratum that is oral-aboral
Open ambulacral grooves present;	Axis is parallel to substratum; Body with or without arms; Ambulacral grooves open or closed
Madreporite absent, both mouth and anus on oral surface;	
Several fossil classes in addition to living class Crinoidea.	

From the above table you can make out that phylum Echinodermata is divided into two subphyla of which Subphylum Pelmatozoa includes only one living class, Crinoidea. On the other hand, stalkless Subphylum Eleutherozoa includes five classes Concentricycloidea, Asteroidea, Ophiuroidea, Echinoidea and Holothuroida. So if you were to classify an echinoderm for example the starfish *Pentaceros*, you would do it as follows:

Classification with its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of some of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates, pentradiate, coelomate, with spiny skin and water vascular system.
Subphylum	Eleutherozoa	Stalkless and free-living; tube feet with suckers; mouth on the oral surface and anus on the aboral surface.
Class	Asteroidea	Body star-shaped; bases of anus not distinctly marked off from the disc; oral surface directed downwards and aboral surface upwards; ambulacra form prominent grooves provided with tube feet.
Genus	<i>Pentaceros</i>	
Common name	Star fish	

21.4 TYPE SPECIMENS OF ECHINODERMATA

Before we begin the study of the selected specimens of the following echinoderms – Feather star, Brittle star, Sea urchin, Sea cucumber and Star fish. You should be aware that though members of the various classes of echinoderms often appear to be superficially different, however their structure is fundamentally similar. For example,

21.4.1 *Antedon*

Antedon (Fig. 21.1) is commonly called "feather star" or "sea lily"

Examine the specimen and note the following features:

- (i) The body of *Antedon* is made of a central convex disc of calyx and **five** equidistant, elongated slender radiating **arms**.
- (ii) Each arm is divided into two branches at the base, so **there** are in effect ten long arms.
- (iii) The arms are slender, flexible, movable and bear small spine-like structures or **pinnules** on the two sides.
- (iv) The body has a distinct upper **oral** and lower **aboral** surface.
- (v) **Aboral** surface bears several root-like, slender, curved, jointed cirri supported by small ossicles which help to attach *Antedon* to rocks.
- (vi) Oral surface is covered with a soft and leathery skin, called **tegmen** and this surface bears the **mouth** and **anus** on the same side of the calyx. The anus is borne on a tiny papilla and is excentric whereas the mouth is in the center.
- (vii) Five **ambulacral ciliated grooves** radiate from the mouth towards the arms. Each groove divides into two and runs along the oral surface of each arm.
- (viii) The intervening body surface is the **adambulacra**.
- (ix) **Tube feet** or **podia** are without suckers and can be seen along the edges of ambulacral groove.
- (x) The exoskeleton is made of calcareous ossicles or plates.

[Sexes are separate; and gonads are present at the dilated bases of pinnules.
Development includes a pentacrinoid larva with jointed stalk.]

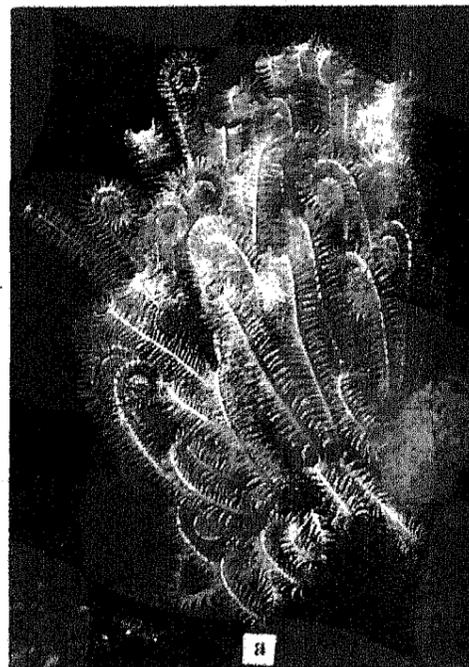


Fig.21.1: Feather star. a) A living feather star in its natural environment. b) Drawing of oral view of feather star, *Antedon*.

Habit and Habitat

Marine, attached to rocks in the sea at moderate depths

Geographical distribution

Antedon is world-wide in distribution, found in all seas. It is commonly found along Atlantic Coast.

Classification and its Justification

Kingdom	Animalia	Animals; multicellular organisms with cells that lack a cell wall; many capable of movement or movement of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates, pentaradiate, coelomate, with spiny skin and water vascular system.
Subphylum	Pelmatozoa	Stalked and fixed forms; mouth and anus both dorsal; tube feet absent.
Class	Crinoidea	Body cup-shaped; arms five and bifurcated at base.
Genus	<i>Antedon</i>	
Common name	Feather Star or Sea lily	

21.4.2 *Ophiura*

Ophiura (Fig. 21.2) is a cosmopolitan "brittle star" or "serpent star"

Study the specimen of *Ophiura* and note the following features:-

- (i) It has a flat pentagonal central disc covered with radial shields and membranous small calcareous plates.
- (ii) Five arms radiate from the disc. They are also covered with calcareous plate. The lateral plates on the arms bear spines.
- (iii) Arms are clearly demarcated from central disc.
- (iv) Mouth is present on the oral surface. It has five angles.
- (v) In each radius, there are two bursal slits.

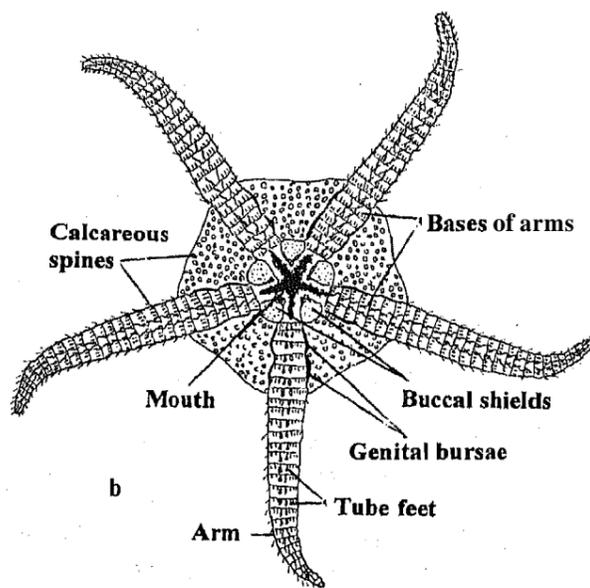


Fig. 21.2: Brittle star (*Ophiura*). a) A living specimen in its natural environment. b) Drawing of specimen (oral view).

Habit and Habitat

Marine, deep sea forms. They are carnivorous and coil their **arms** around prey.

Geographical Distribution

It is cosmopolitan in distribution

Classification with its Justification

Kingdom	Animalia	Animals; multicellular organisms with cells that lack a cell wall, many capable of movement or movement of their body parts or capable of movement at some time of their life; heterotrophic nutrition.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates, pentaradiate, coelomate, with spiny skin and water vascular system.
Subphylum	Eleutherozoa	Stalkless and free-living, tube feet with suckers; mouth on the oral surface and anus usually on aboral surface.
Class	Ophiuroidea	Oral and aboral surfaces distinct, bases of the arms distinctly marked off from the disc, ambulacral grooves, anus, and intestine absent, madreporite on the oral surface; bursae usually ten.
Genus	<i>Ophiura</i>	
Common name	Brittle Star or Serpant Star	

21.4.3 Echinus

Echinus (Fig 21.3) is commonly known as sea urchin

Examine **the** specimen and note the following features:

- (i) **Echinus** (Fig. 21.3) has a globular body which is somewhat flattened at the two poles forming a distinct oral pole and an aboral pole.
- (ii) Body is enclosed in a rigid, globular shell called test or corona which is made of closely fitting calcareous plates.
- (iii) Mouth is present in the oral pole. It is surrounded by a circular area of **soft** membrane called the peristome.
- (iv) The anus is a much smaller aperture, present on the aboral pole, and is surrounded by an area call periproct.
- (v) Entire surface of animal except for the peristome and periproct is covered with movable spines, articulated to the shell.
- (vi) In between **the** spines are found two sets of structures-(i) pedicellariae with three jaws and (ii) sphaeridia.
- (vii) Surrounding the peristome are branchiae.
- (viii) The surface of the shell has alternating ambulacral and inter-ambulacral areas.
- (ix) In the ambulacral area lie tube feet or podia in a double row. So there are five ambulacral areas and five double rows of podia.

[Sexes are separate. Gonads form five large masses. Development is through an echionopluteus larva. A special masticating apparatus made of several calcareous plates called Aristotle's lantern (Fig. 21.3 c) is present and teeth (tips of plates) protrude through the mouth.]

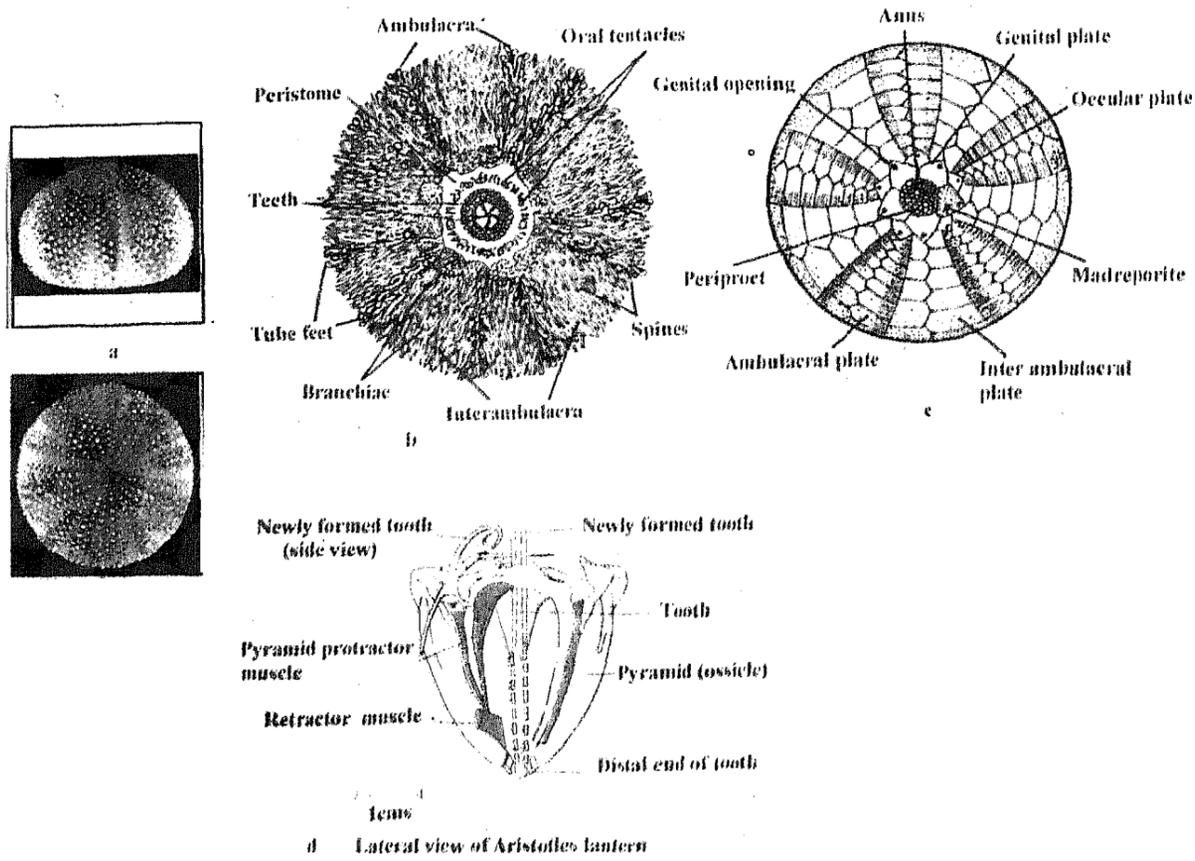


Fig. 21.3: *Echinus* (urchin). a) Skeletons or tests of dead *Echinus*. b) Drawing of specimen of *Echinus* in oral view. c) Drawing of *Echinus* in aboral view. d) Lateral view of Aristotle's lantern.

Habit and Habitat

Marine, benthic, occurs between the intertidal zone to 5000 meters.

Geographical Distribution

Echinus is widely distributed in the Atlantic, Mediterranean and Pacific ocean.

Classification with its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates, pentaradiate, coelomate, with spiny skin and water vascular system.
Subphylum	Eleutherozoa	Stalkless and free-living, tube feet with suckers; mouth on the oral surface and anus usually on aboral surface.

21.4.4 *Holothuria*

Holothuria is commonly called "Sea cucumber".

Study the specimen and note the following features:

- (i) *Holothuria* (Fig. 21.4) is black in colour and measures about 30 cms in length when fully extended.
- (ii) The body is elongated through the oral-aboral axis.
- (iii) The body is **bilaterally symmetrical**.
- (iv) The **mouth** and **anus** are at the two opposite ends of the body.
- (v) **Mouth** is anteriorly placed and surrounded by 15-30 peltate tentacles termed **oral tentacles**.
- (vi) The **madreporite** is internal.
- (vii) Body bears numerous **podia** or tube feet which are in the five ambulacral areas. Podia are locomotory on ventral surface and papillate on the dorsal surface.
- (viii) Body wall is leathery having a skeleton of minute ossicles.
- (ix) The skin is soft and without spines and pedicellariae

[Respiratory trees are well developed. Cuvierian tubules are present. Sexes are separate, gonads consist of a single tuft attached to left side of dorsal mesentery. Development includes an **auricularia larva**]

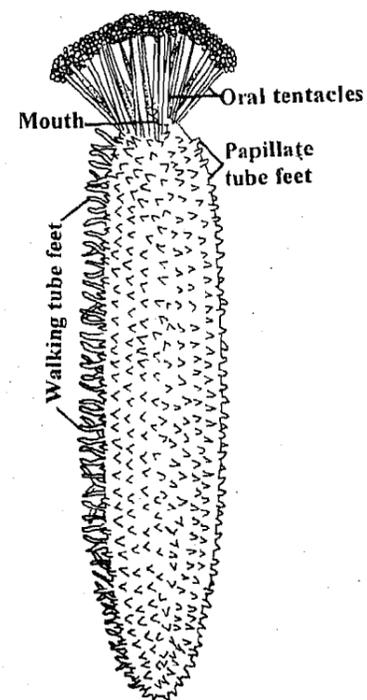
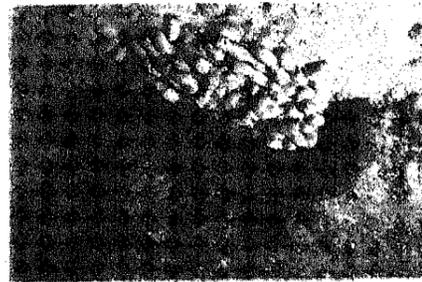


Fig. 21.4: *Holothuria* (ka cucumber). a) A living specimen of *Holothuria edulis* in its natural environment. b) Drawing of museum specimen of *Holothuria* sp.

Habit and Habitat.

Holothuria is found in the shallow tropical sub-tropical waters of Indo-Pacific sea. feeds by pushing sand containing organic food into the mouth with the help of

tentacles. When chased by a predator, *Holothuria* eviscerates or throws out contents of its body to divert the attention of the predator.

Geographical distribution

Holothuria is found distributed in India, West Indies and Florida.

Classification with its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates, pentaradial, coelomate, with spiny skin and water vascular system.
Subphylum	Eleutherozoa	Stalkless and free-living, tube feet with suckers; mouth on the oral surface and anus usually on aboral surface.
Class	Holothuroidea	Body cylindrical, elongated in oral-aboral axis.
Genus	<i>Holothuria</i>	
Common name	Sea cucumber	

21.4.5 Star fish – *Asterias*

Asterias is commonly known as sea star or star fish (Fig. 21.5).

Examine the specimen of *Asterias* and note the following features:

- (i) The body is star-shaped, consisting of a **central disc** with **5 radiating arms** which are broad at their base and tapering towards their extremities.
- (ii) Body is flat with distinct oral and aboral surfaces. Oral surface is directed downwards and aboral surface is directed upwards.
- (iii) Mouth is also called **actinostome** and is pentagonal in shape. It lies in the center of the oral disc on the oral surface and is surrounded by a membranous **peristome**.
- (iv) From the mouth leading into the arms are five **ambulacral grooves**, one in each arm. Each ambulacral groove is bordered laterally by two or three rows of movable **calcareous spines**, the **ambulacral spines**.
- (v) Each ambulacral groove contains two double rows of **podia** or **tube feet**, which serve as organ of locomotion.
- (vi) Aboral surface bears a number of short, stout spines arranged in irregular rows, numerous dermal brachiae among spines and a smaller aperture, the **anus** which is situated more or less eccentrically on the surface.
- (vii) Madreporite is a thick, calcareous circular plate situated on the aboral surface between two arms. The arms between which the madreporite is situated are called **bivium**, the other three arms are called **trivium**.
- (viii) Water vascular system is well-developed.

[Sexes are separate. Fertilization is external. Development includes a free-swimming bipinnaria larva.]

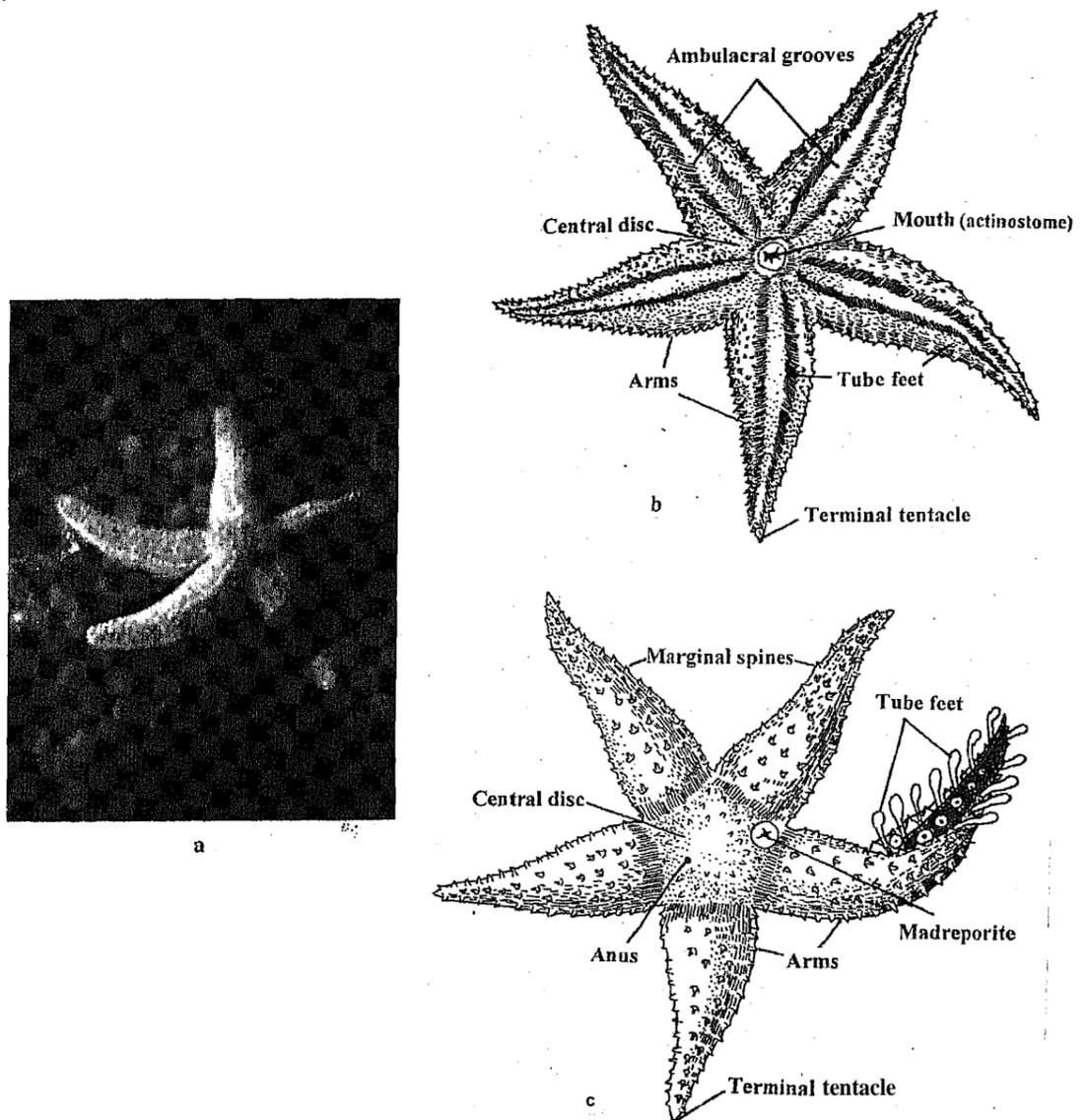


Fig. 21.5: Sea star (*Asterias*). a) A living specimen in its natural environment. b) Drawing of specimen of *Asterias* in oral view. c) Drawing of specimen of *Asterias* in aboral view.

Habit and Habitat

Asterias is a marine, carnivorous echinoderm living in the deep sea. It eats molluscs.

Geographical Distribution

Asterias is found in shallow waters in North Temperature seas and found abundantly on North Atlantic Coast. It is found in India and U.S.A.

Classification with its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of their body parts, or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Echinodermata	Secondary radial symmetry, endoskeletal plates, pentaradiate, coelomate, with spiny skin and water vascular system.

Sub phylum	Eleutherozoa	Stalk-less and free-living, tube feet with suckers; mouth on the oral surface and anus usually on aboral surface.
Class	Asteroidea	body star-shaped, bases of anus not distinctly marked off from the disc; oral surface directed down wards and aboral surface upwards; ambulacral form prominent grooves, provided with tube feet.
Genus	<i>Asterias</i>	
Common name	Sea star or starfish	

21.5 STUDY OF BIPINNARIA LARVA

Bipinnaria is the larval stage of star fish and is free living

Examine the slide of bipinnaria larva (Fig. 21.6) under the compound microscope (low power) and note the following:

- i) It is **bilaterally symmetrical** and somewhat **angular** in shape.
- ii) It is **transparent** and has **arms** or projections in the body. The arms are (a) a median dorsal arm; (b) two antero-dorsal arms; (c) two postero-dorsal arms (d) two post-oral and (e) two postero-lateral arms.
- iii) **Ciliated bands** are present on the body. Two lateral ciliary bands connect in front of the **mouth** as a **pre-oral loop**. The other band forms a **post-anal loop** around the anus.
- iv) The **alimentary canal** is **complete** and the larva feeds on diatoms.
- v) The alimentary canal consists of a **mouth** leading into **esophagus**, the **stomach** and the **intestine** opening to the outside by the **anus**.

[The bilaterally symmetrical bipinnaria larva metamorphoses into a radially symmetrical adult star fish.]

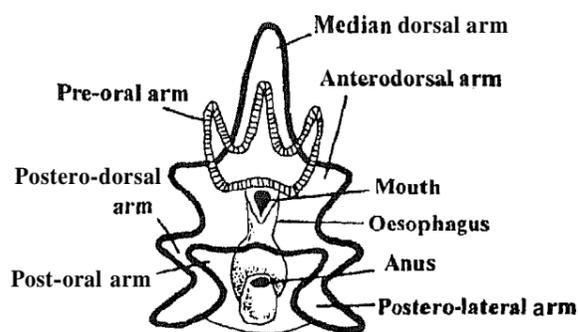


Fig. 21.6: Bipinnaria Larva of star fish

Habit and Habitat

The bipinnaria larva swims freely in sea water and feeds on diatoms.

Geographical Distribution

Asterias and its bipinnaria larva are found in shallow waters in North Temperate seas and are also found abundantly on North Atlantic Coast. It also occurs in India and U.S.A.

21.6 TERMINAL QUESTION

1. Name the two subphyla of the phylum Echinodermata.

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2. Which is the subphylum that includes stalked echinoderms?

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3. To which class of Echinodermata do sea urchins belong?

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4. If you are given an assortment of invertebrates, how will you pick out the echinoderms using any two distinguishing features?

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5. From among a tray of sea stars (starfish) and brittle stars, how will you separate the two? Give only two distinguishing features.

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